Evanston Municipal Operations Zero Emissions Strategy

Fleetwood Jourdain Community Center – Evanston, Illinois

Mayor’s Office
2100 Ridge Avenue
Evanston, IL 60201-2798
T 847.866.2979
www.cityofevanston.org

August 17, 2021

Greetings,

In 2018, the Evanston City Council adopted its most recent Climate Action and Resilience Plan (CARP), establishing ambitious climate-related goals. These targets cover a diverse range of topics and achieving them will require a broad array of policy and programmatic interventions.

One of the goals relates to the City's own internal operations, specifically, calling for municipal operations to be carbon neutral by 2035. This is no small feat: not only does the City of Evanston employ hundreds of people and deploy diverse fleets of vehicles that perform highly complex functions, but we also maintain a water treatment plant. This sophisticated facility engages in energy-intensive activity and must operate at a high level at all times in order to guarantee access to clean, safe water not only to Evanston's 78,000 residents but also to our visitors and residents of several nearby municipalities to whom we provide water.

As challenging as it might be to achieve this goal, it is essential that we start here. First of all, the City cannot possibly ask our residents and partners to engage in this difficult work if we are unwilling to do so ourselves. Secondly, we have a critical opportunity, by succeeding in this effort, to demonstrate that dramatic climate action, though not easy, is possible. Finally, and perhaps most importantly, we must model a willingness to accept tough tradeoffs in pursuit of our climate goals. These decisions are not easy, and these actions are not free, at least in the short term. But they are worth it.

This document outlines three different scenarios that would enable us to achieve this 2035 goal. In so doing, it not only charts a potential course for our City as we implement CARP, but it also informs all of us about some of the choices that lie ahead. That is, it is both a necessary blueprint and an invaluable educational tool.

I would like to thank everyone who worked so hard to create this document, from City staff, to consultants, to our Utilities Commission and City Council. I am especially grateful to the many community activists who have advocated on this issue with tenacity, strategy, and deep knowledge. It is your passion and hard work that gives me confidence not only that we can achieve this specific goal, but also that we have the capacity to meet the climate crisis with the kind of action it requires. Thank you.

Sincerely,

Daniel Biss
Mayor, City of Evanston

Acknowledgements

City Council and the Mayor
Mayor Daniel Biss
1st Ward Councilmember Clare Kelly
2nd Ward Councilmember Peter Braithwaite
3rd Ward Councilmember Melissa A. Wynne
4th Ward Councilmember Jonathan Nieuwsma
5th Ward Councilmember Bobby Burns
6th Ward Councilmember Thomas M. Suffredin
7th Ward Councilmember Eleanor Revelle
8th Ward Councilmember Devon Reid
8th Ward Councilmember Cicely L. Fleming

Members of the Utilities Commission
Richard Shure, Chair
Tucker Partel, Vice Chair
Carl Bova
David Everhart
Christopher Skey
George Varela

Consultant Support
Elevate
Anthena Gore, Project Manager
Vito Greco
Sandra Henry
Lucas Kappel
Kristofer Kiszynski
Elena Savona
Mary Jo Warskow
Lindy Wordlaw

Center for Neighborhood Technology
Cyatharine Alias
Jennifer McGraw

City Staff
Erika Storlie, City Manager
Kimberly Richardson, Deputy City Manager
Kelley A. Gandurski, Deputy City Manager
Luke Stowe, Administrative Services Director
David Stoneback, Public Works Agency Director
Kumar Jensen, Chief Sustainability and Resilience Officer
Lara Biggs, Capital Planning and Engineering Bureau Chief
Sean Ciolek, Division Manager of Facilities & Fleet Management
Stefanie Levine, Senior Project Manager
Shane Cary, Architect/Project Manager
Anil Khatkhate, ADA/CIP Project Manager
Jessica Hyink, Transportation and Mobility Coordinator
Susie Hall, Management Analyst
Kenneth Palmer, Facilities & Fleet Supervisor
Paul Moyano, Senior Project Manager
Liam Engel, Sustainability Fellow
Ajiah Gilbert, Sustainability Fellow

Table of Contents

Executive Summary

During two great challenges of 21st century, the City of Evanston has remained steadfast and even strengthened its commitment to immediate and decisive action on climate equity and community resilience. The looming threats of global warming, resulting in acute shocks such as flooding and urban heat island effect, couple with the current global health crisis of COVID-19, have challenged every city to respond, act and expand its efforts to serve its community. The City of Evanston has proven to be a nationally-recognized leader in these uncertain times, as in June the City was named an "All-America City" by the National Civic League for its strategic approaches for building a more equitable and resilient community. Demonstrative efforts include the City of Evanston becoming the first city in the United States to establish a local reparations program, and establishing a city-operated one-stop shop for community resources in response to dire community needs. In addition, Evanston's decades-long action on climate and equity have paved the way for bold, inclusive, and innovative initiatives that set an international example for how cities can center equity and move their climate goals forward.

In 2018, the City Council, led by Mayor Stephen H. Hagerty, adopted the Evanston Climate and Resilience Plan (CARP), the City's third climate action plan that accelerated the City's increasingly progressive climate goals over the last two decades. The strategies in CARP sought to reduce emissions that are the root cause of climate change (mitigation) while simultaneously preparing for the impacts of climate change by addressing our ability to adapt and respond (resilience). CARP outlined strategies for the entire community and specific goals pertaining to City of Evanston municipal operations including carbon neutrality for municipal operations by 2035. We define carbon neutrality as having a net zero carbon footprint, which refers to achieving net zero carbon dioxide emissions by balancing carbon emissions with carbon removal (often through carbon offsetting) or simply eliminating carbon emissions altogether (the transition to a "post-carbon economy"). This document, the Evanston Municipal Operations Zero Emissions Strategy (ZES), outlines three different scenarios for achieving carbon neutrality in municipal operations by 2035 against the business-as-usual (BAU) baseline (Figure 1).

By employing nine strategies at varying penetration rates by scenario, City of Evanston can achieve carbon neutrality by 2035. Scenario 1 is the most aggressive and is characterized by reducing municipal square footage by 10% through rightsizing, aggressive energy efficiency measures and electrification by limiting natural gas consumption to just the water treatment plant, which is largely connected to emergency backup generation. It features onsite renewable energy at full generation capacity on municipal rooftops while employing offsite renewable energy procurement to meet at least 50% of electricity needs in 2035. Scenario 1 includes replacing a significant portion of vehicles with electric vehicles and biofuels, reducing the number of vehicles while improving maintenance, and reducing overall vehicle miles traveled. Remaining emissions would be addressed by the purchase of renewable energy credits, renewable gas certificates and other appropriate, locally-sourced offsets.

Scenarios 2 and 3 including the same strategies with varying penetrations, although Scenario 3 does not include any elimination of municipal square footage (rightsizing). All scenarios rely on the purchase of renewable energy credits, renewable gas certificates or carbon offsets.

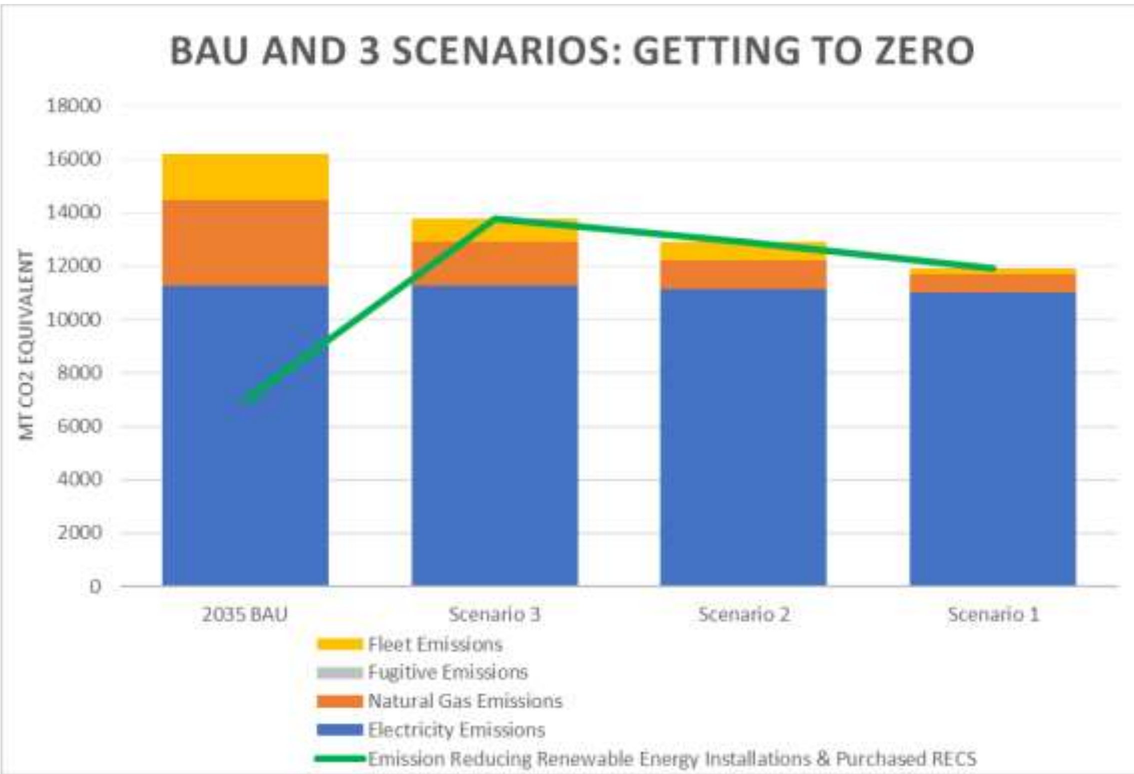

Figure 1. Getting to Zero – 3 Scenarios against Business-As-Usual

While the scenarios described are aggressive, there are three constraints in particular that present as top challenges to achieving the goal of carbon neutrality. As mentioned, the water treatment plant will continue to rely on natural gas for its emergency backup generation, which will represent approximately 40% of emission in the 2035 BAU. Secondly, electrifying buildings will result in a temporary increase in electricity emissions. As the electric grid continues to decarbonize, "fuel-switching" means that buildings will eventually benefit from decreasing emissions. Decarbonizing the grid is an external factor which will take time; in the interim electricity emissions can be mitigated by deploying onsite or offsite renewable energy. Third, there will be remaining electricity, natural gas and fuel consumption in 2035 that will result in leftover emissions, even with full implementation of strategies. This is not uncommon. The purchase of renewable energy certificates and offsets will play a role in the City of Evanston's carbon neutrality. Other relevant challenges will be noted as the scenarios are explained.

Table 1. Strategies – Evanston Zero Emissions Strategy

Strategies	
Buildings and Streetlights Strategies	
1	Rightsizing
2	Energy Efficiency
3	Electrification
4	Onsite Renewable Energy
5	Offsite Renewable Energy
6	Efficient Streetlights
Fleet Strategies	
7	Clean Fuel Technologies: Electric Vehicle + Biofuels
8	Fleet Management and Rightsizing
9	Vehicle Miles Traveled (VMT) Reduction

The technology associated with the strategies shown in Table 1 exists now and can be implemented immediately, particularly those that are not likely to be replaced by emerging technologies by 2035. This includes widely accepted energy efficiency strategies, onsite renewable energy, electric vehicles and even heat pump technology in smaller buildings. As Evanston moves from adoption of this plan to execution of the strategies, it will be incumbent upon those responsible for its implementation to identify the appropriate timeframe for each strategy – which in some cases is likely to be impacted by the financial means to support it.

Implementation costs for the Evanston Zero Emissions Strategy fall into two segments: one-time investment costs (construction, infrastructure, etc.) and annual operating expenditures (Table 2). The values noted are meant to indicate a magnitude of costs, and do not replace the need for independent financial analysis on a project-by-project basis. Annual costs overall represent a total annual savings in comparison to current operations, but savings versus costs vary between each strategy and scenario.

Table 2. Implementation Costs by Scenario (estimated)

Cost Range	Scenario 1	Scenario 2	Scenario 3
One Time Costs (Range)	$70,469,013 to $75,294,906	$52,817,915 to $57,770,806	$35,762,002 to $40,841,891
Annual Cost Savings	($3,700,273)	($1,929,819)	($1,433,271)

Three years after the unanimous decision to adopt the Evanston Climate and Resilience Plan (CARP), the City of Evanston is taking strategic action for a carbon neutral future. The Evanston Municipal Operations Zero Emissions Strategy builds on decades of climate action described in the CARP, and calls for the municipality to a be model of equity-centered, outcome-focused and ambitious climate action that achieves the goal of carbon neutrality by 2035.

Section 1. An Introduction – Municipal Operations Zero Emissions Strategy

The role of city government at the City of Evanston is accurately reflected in its own mission statement, which underscores the commitment "to promoting the highest quality of life for all residents by providing fiscally sound, responsive municipal services and delivering those services equitably, professionally, and with the highest degree of integrity." Evanston's mission describes an action-oriented and progressive City, committed to serving its constituents and those who live, work and play in Evanston.

The City of Evanston has taken significant steps to reduce the environmental impacts, particularly to reduce greenhouse gas emissions (GHGs), harmful emissions that are proven to cause climate change. Given that the impacts of climate change are no longer debatable and the reality that those least equipped to confront climate change typically face the most immediate threats in a changing world, the absence of climate action is unacceptable and does not align with the City's mission.

This City of Evanston Municipal Operations Zero Emissions Strategy (ZES) examines three separate pathways the City can take to reduce its emissions, decarbonize, and offset all its operational GHGs by 2035. This is no simple endeavor. As shown in the 2018 Evanston Municipal GHG Inventory, GHG sources electricity and natural gas consumption in municipal buildings, streetlights and traffic lights, and fossil fuel combustion of the City's vehicle fleet – essentially all of Evanston's municipal energy infrastructure. The ZES uses actual City data, policies and insight from stakeholders and City staff to form different strategies for the City to achieve carbon neutrality for its entire operations by 2035. The City is focusing on municipal operations first in order to serve as a model for how other cities and private property in Evanston can achieve the same ambitious goals. The City of Evanston has an established track record of climate action. Evanston achieved the goals of its first climate plan (2008) within five years and its second (2014) within two years. Over the last 15 years three different City administrations – Mayor Lorraine H. Morton, Mayor Elizabeth Tisdahl, and Mayor Stephen H. Hagerty – have pushed the envelope towards climate action, adopting ambitious goals in concert with leaders around the world, and most recently aligning Evanston's climate efforts with the 2015 Paris Climate Accord. In 2018, Evanston became the first city in Illinois to set the goals of achieving 100% renewable electricity by 2030 and carbon neutrality by 2050, through adoption of the Climate Action and Resilience Plan (CARP). Notably, along with the stated 2050 goal, CARP set forth the commitment that "the City of Evanston will continue to lead by example by setting ambitious goals for municipal operations," which include carbon neutrality for municipal operations by 2035. Mayor Daniel Biss, elected in 2021, will carry on this legacy of ambitious action through the pursuit of even more aggressive action than his predecessors in order to ensure the City makes good on its climate commitments. See Appendix 1 for the City of Evanston Climate Action Timeline.

This Strategy aligns with several long-term priorities held by City leadership. These include investments in City infrastructure and facilities such as fleet and facilities, enhancing community development and job creation opportunities by supporting climate action and resilience goals, expanding affordability and equity across the community and city operations, and stabilizing long-term finances through responsible management of city assets.

The City of Evanston Municipal Operations Zero Emissions Strategy is a visionary and action-oriented document that outlines how through its municipal operations, the City can continue to lead by example towards its vision of "creating the most livable city in America."

The City's commitment to demonstrative leadership and its vision served as the foundation for organizing the approaches to emission reduction, which are characterized by prioritizing direct and aggressive emissions reductions ahead of more indirect actions. These approaches to emission reduction are ranked from most desirable to least:

1. Prevention of energy consumption by retiring or eliminating energy consuming assets
2. Avoiding any new fossil fuel infrastructure in the construction of new municipal buildings (e.g. natural gas, fuel oil)
3. Energy efficiency, or reducing energy use through building design, retrofit, and management
4. Onsite renewable energy generation (and storage)
5. Offsite renewable energy procurement
6. Continued consumption of onsite fossil fuels as efficiently as possible, with planned transition to non-fossil fuel systems

The scope of the ZES centers around municipal operations and thus will significantly impact capital planning projects for municipal assets, particularly buildings, and the City's process for vehicle replacement in the City fleet. The ZES outlines three different scenarios that range from most aggressive to least aggressive to achieve carbon neutrality through a set of actions. Each action carries an emissions reduction potential and other benefits, and a set of financial considerations that will require careful and more detailed analyses by the City. The ZES is meant to serve as a guide for decision-making in the current local political and financial contexts. Specific project costs will require further engineering and financial analyses on a case-by-case basis to inform final City Council decisions. The costs included in this document are meant to provide a reference for the magnitude and relative financial impact and should not be taken as a rigorous financial analysis.

The subsequent report sections go into further detail around the business-as-usual (BAU) scenario (if no meaningful change is made to current policies) and each of the three carbon neutrality scenarios.

Section 2. Establishing a Baseline: The 2018 Municipal Greenhouse Gas Inventory

Noted in the 2018 Climate Action and Resilience Plan, the City's municipal operations only account for approximately 1% of Evanston's total greenhouse gas emissions. Since the ZES is meant to target municipal operations only, it is important to understand the breakdown of the City's GHG profile in order to determine a pathway to carbon neutrality.

Evanston's 2018 Emissions Baseline

In 2018, municipal operations emitted 21,184 metric tons of carbon dioxide equivalent ($MTCO_2e$). As shown in Figure 1, 80% of the City's 2018 municipal operations emissions are attributed to buildings, 12% to fleet, and 8% to streetlights.

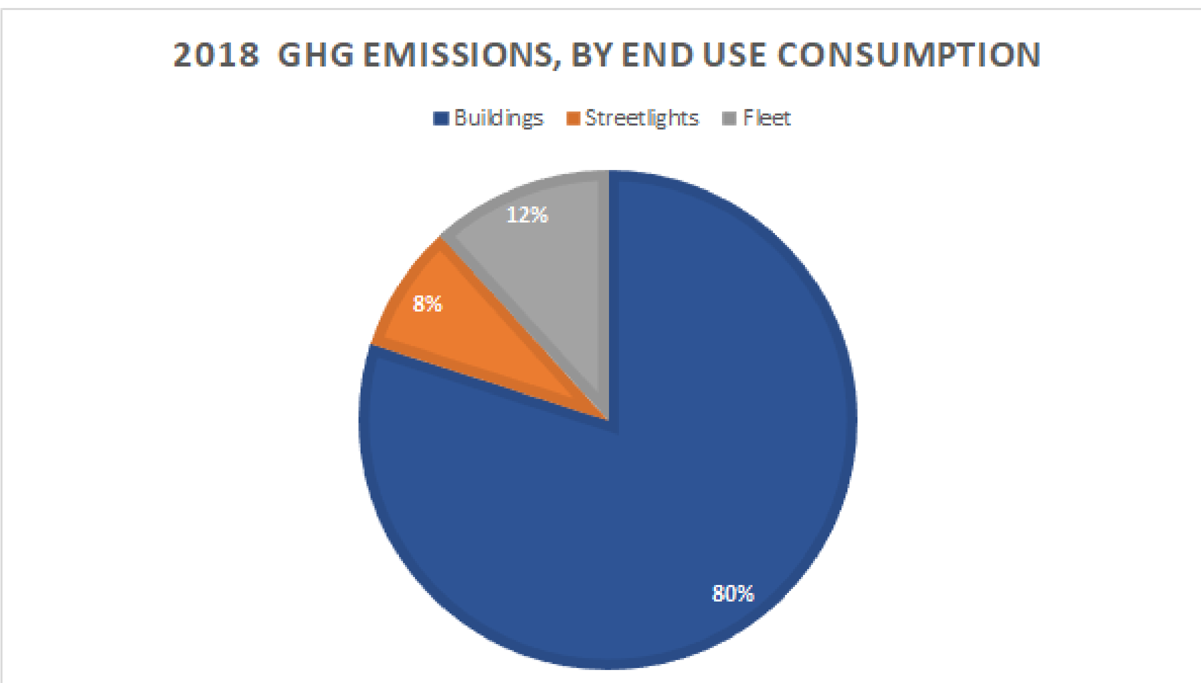

Figure 2. City of Evanston 2018 GHG Emissions, by End Use Consumption

When examining only the emissions associated with building operations, 80.6% is attributed to electricity consumption and 19.4% is attributed to natural gas combustion. However, for total emissions, 72% is attributed electricity consumption (64% in buildings with the remaining 8% by streetlights), 16% is attributed to natural gas combustion, and 12% attributed to fleet (Figure 2).

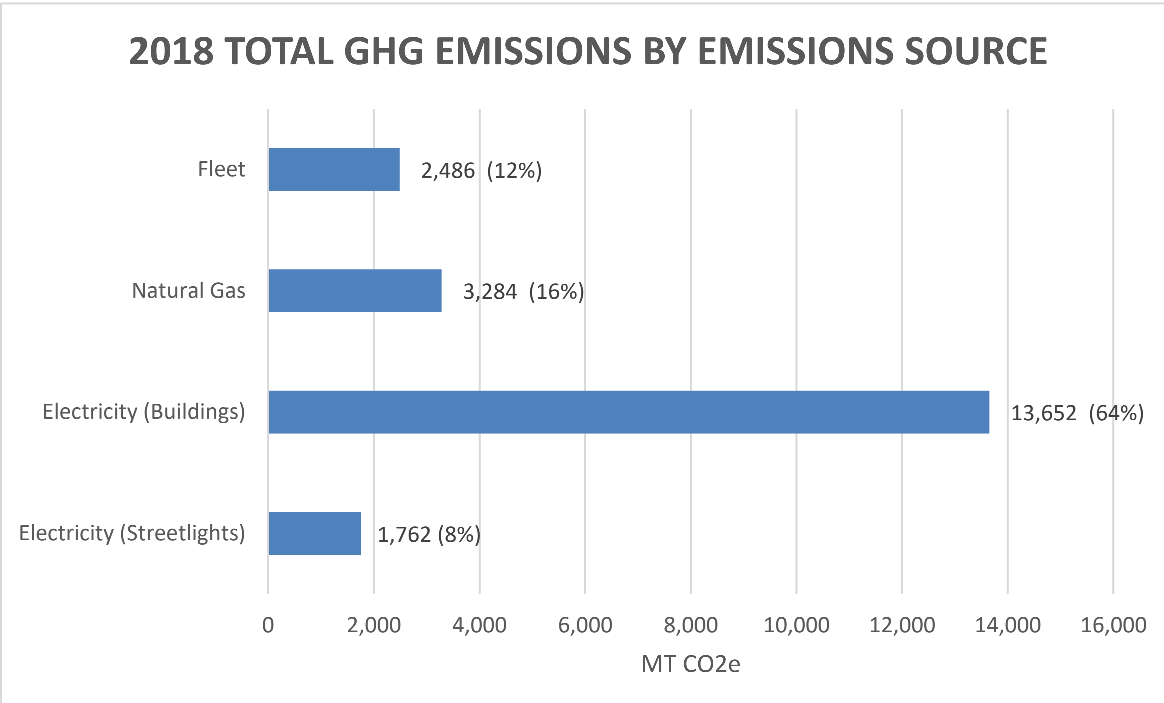

Figure 3. City of Evanston 2018 Total GHG Emissions, by Emissions Source

Emissions by Scope

Established greenhouse gas accounting protocols categorize emissions within one of the following standard emissions scopes:

Direct Emissions (Scope 1)

Direct emissions (Scope 1) occur from onsite combustion or mobile sources that are directly controlled by an organization, such as fuel combustion in buildings and vehicles. In the City of Evanston's municipal operations, Scope 1 emissions come from natural gas consumption used for heating in buildings, and fuel consumption of the City vehicle fleet, and account for 27.2% of the City's emissions (Figure 3).

Indirect Emissions (Scope 2)

Indirect emissions (Scope 2) derive from the purchase of electricity, steam, heat, and cooling. These emissions are deemed indirect because they occur offsite at the site of generation, rather than at the organization's building or facility; however, the responsibility or ownership of said emissions rests with the organization because they are solely a result of the organization's energy consumption. In the City of Evanston's municipal operations, Scope 2 emissions are attributable to the electricity consumption within buildings, streetlights, and traffic lights, and represent 72.8% of the City's total emissions associated with municipal operations (Figure 3).

Other Emissions (Scope 3)

Scope 3 emissions are from activities that are not included in the Scope 1 and 2, such as employees' commutes or supply chain emissions. Because Scope 3 activities are outside of an organization's control, they require additional resources to obtain data and are typically not required to be reported in GHG inventories. In the City of Evanston's 2018 GHG Inventory, there are no Scope 3 emissions associated with the City's municipal operations. However, as shown in Figure 4, there remain opportunities around employee commuting, business travel, and purchasing – to name a few – in which the City of Evanston can continue to exert its influence in reducing emissions at the broader community scale. Scope 3 emissions are not covered within the scope of the ZES.

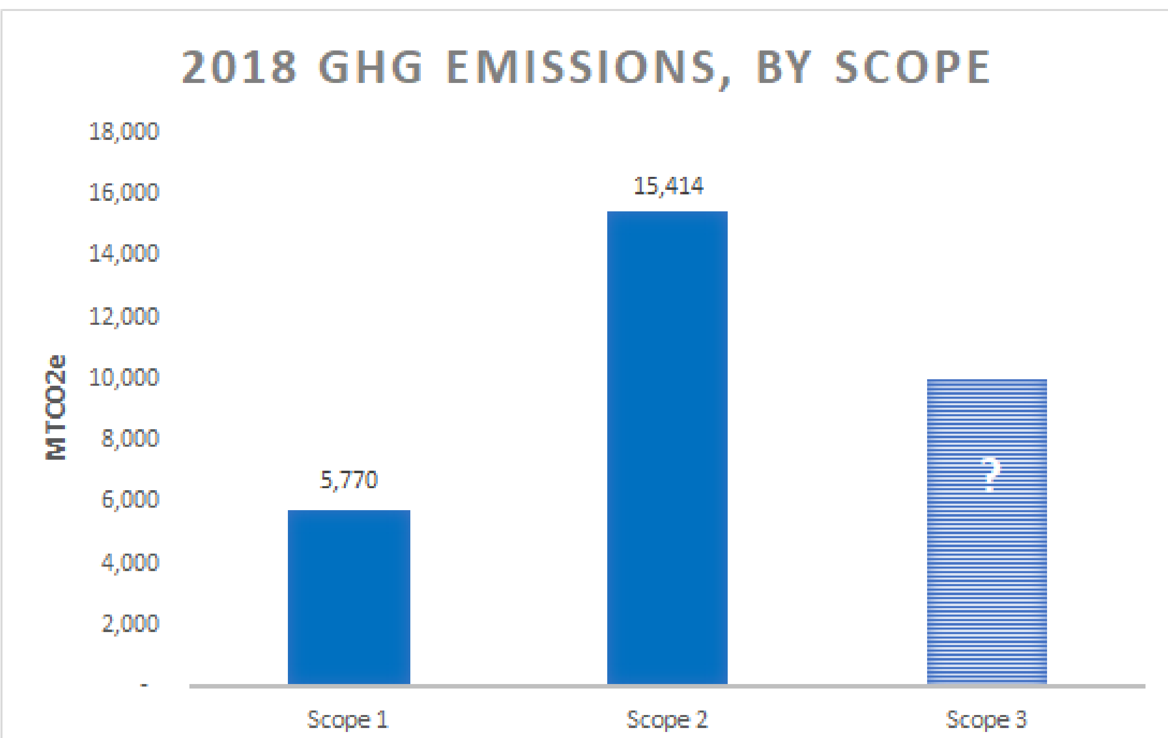

Figure 4. City of Evanston 2018 GHG Emissions, by Scope

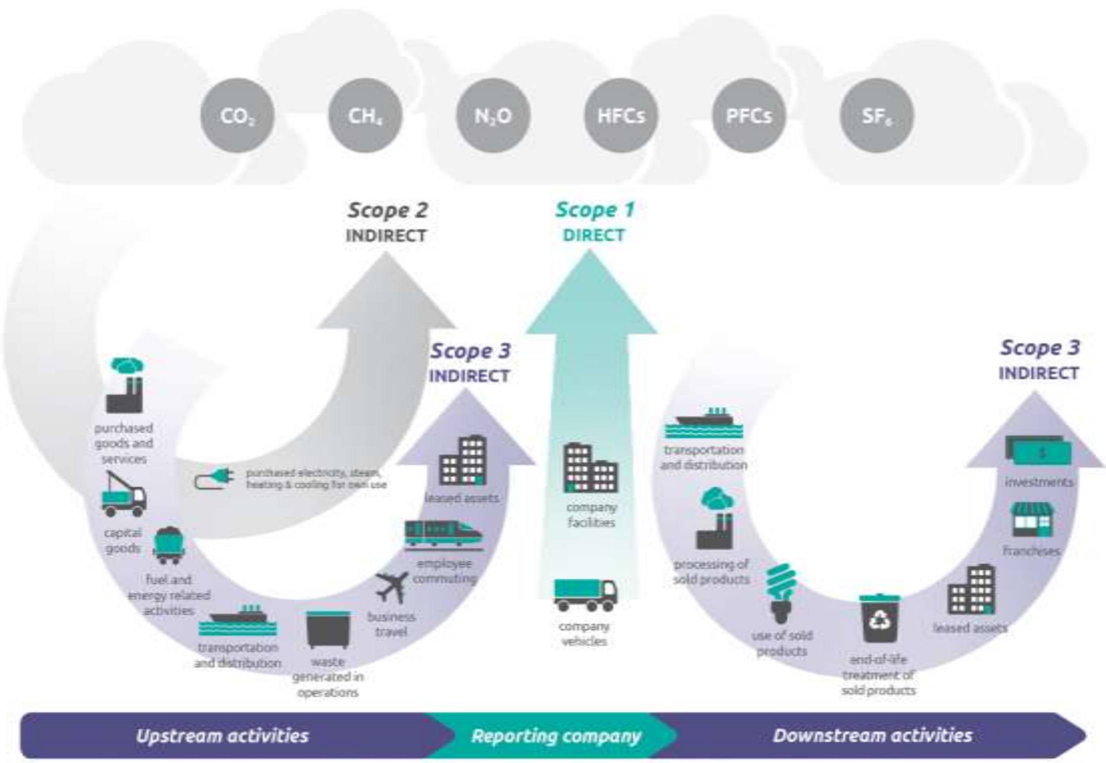

Figure 5. Depiction of Direct and Indirect Emissions (Scope 1, 2 and 3 Emissions)[1]

Business as Usual

In order to determine the realm of possibilities in devising pathways to carbon neutrality, comparison against a baseline is necessary. The Intergovernmental Panel on Climate Change defines a baseline as "the state against which change is measured ... in the context of transformation pathways, the term 'baseline scenarios' refers to scenarios that are based on the assumption that no mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted. Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort."[2]

In 2035 without taking additional measures, municipal operations are projected to emit 16,193 metric tons of carbon dioxide equivalent (MTCO2e) (Figure 4). This represents a reduction of 23% from 2018 emissions. There are seven primary factors that lead to this number:

---

[1] U.S. Environmental Protection Agency, EPA Center for Corporate Climate Leadership, website accessed April 30, 2021 https://www.epa.gov/climateleadership/scope-1-and-scope-2-inventory-guidance

[2] Intergovernmental Panel on Climate Change, Data Distribution Center, Glossary B https://www.ipcc-data.org/guidelines/pages/glossary/glossary_b.html

1. Electricity grid continues to decarbonize
2. Demand for cooling grows with climate change
3. Demand for heating falls with climate change
4. Fuel efficiency of vehicles improves
5. Electric vehicles become more common
6. Building equipment efficiency improves
7. Building energy performance improves with stronger energy and building codes

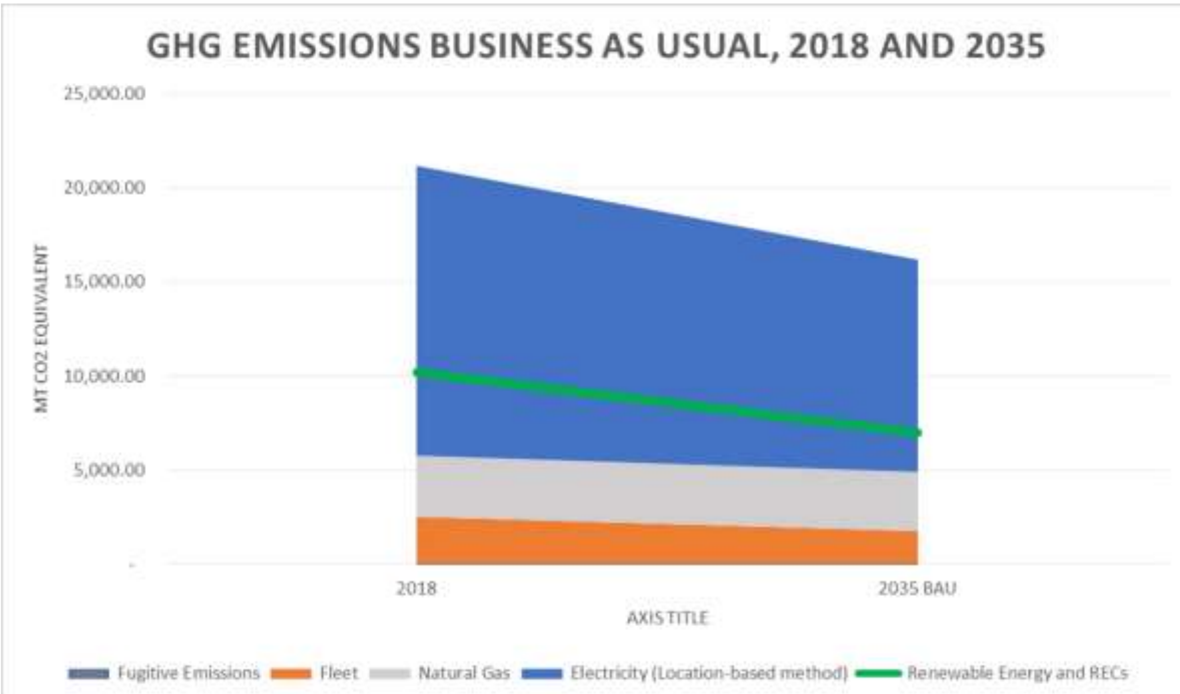

Figure 6. City of Evanston Projected 2035 Business as Usual Scenario

Carbon Neutrality: Three Pathways to Success

In order to achieve carbon neutrality in municipal operations by 2035, the City of Evanston will need to take deliberate and aggressive steps to reduce energy consumption in buildings and streetlights, electrify buildings, reduce fuel consumption of the municipal fleet, and offset any remaining greenhouse gas emissions.

The following section depicts three different pathways for achieving this goal, and nine strategies with varying impact within each scenario:

- Scenario 1: Transformative Change
- Scenario 2: Fundamental Change
- Scenario 3: Initial Change

Section 3. Evanston's Carbon Neutrality Roadmap

The 2018 Evanston Municipal GHG Inventory quantified Scope 1 and Scope 2 GHG emissions from electricity and natural gas consumption in municipal buildings, streetlights and traffic lights, and fossil fuel combustion of the City's vehicle fleet. According to the 2018 GHG Inventory, the emissions attributable to municipal operations are 21,184 metric tons of carbon dioxide equivalent ($MTCO_2e$), which is approximately 1% of the community wide GHG emissions. Using that baseline as a guide, the 2018 Evanston Climate Action and Resilience Plan (CARP) established three goals for municipal operations: 1) 100% renewable electricity by 2020, 2) zero waste by 2030, and 3) carbon neutrality by 2035. This third goal is the primary focus of the Evanston Municipal Operations Zero Emissions Strategy (ZES), which identifies the pathways that the City of Evanston can take to achieve the goal of carbon neutrality for municipal operations by 2035.

To assess and identify the strategies for aggressive emissions reductions, the City focused on three main components, which informed the development of the ZES: 1) the analysis of Evanston's municipal fleet, 2) the development of three case studies to achieve zero emissions at three municipal facilities, and 3) the development of three carbon neutrality scenarios, achievable by 2035, against a determined business-as-usual (BAU) scenario. The ZES provides three scenarios for consideration, each providing a pathway for the City to proactively reduce emissions, decarbonize its energy-consuming assets, and offset all remaining GHG emissions through the procurement of verifiable renewable energy credits (RECs).

Evanston has identified nine strategies – five related to buildings, one to streetlights, and three to the vehicle fleet. Depending on the rate of adoption, these strategies are projected to provide the City with three distinct scenarios for achieving its carbon neutrality goal by 2035. Figure 5 depicts the interplay between GHG emission reductions and the strategies recommended for adoption. Each scenario of the ZES represents aggressive, bold action that is demonstrative of Evanston's longstanding commitment to meaningful climate action; any of the scenarios will result in a significant departure from the 2035 business-as-usual. The different scenarios depict the realm of possibility and offer choices, particularly across strategies with implementation that is heavily dependent on other factors, such as financial resources, capital planning processes, vehicle replacement practices, commitment of municipal leadership, and changes in technology.

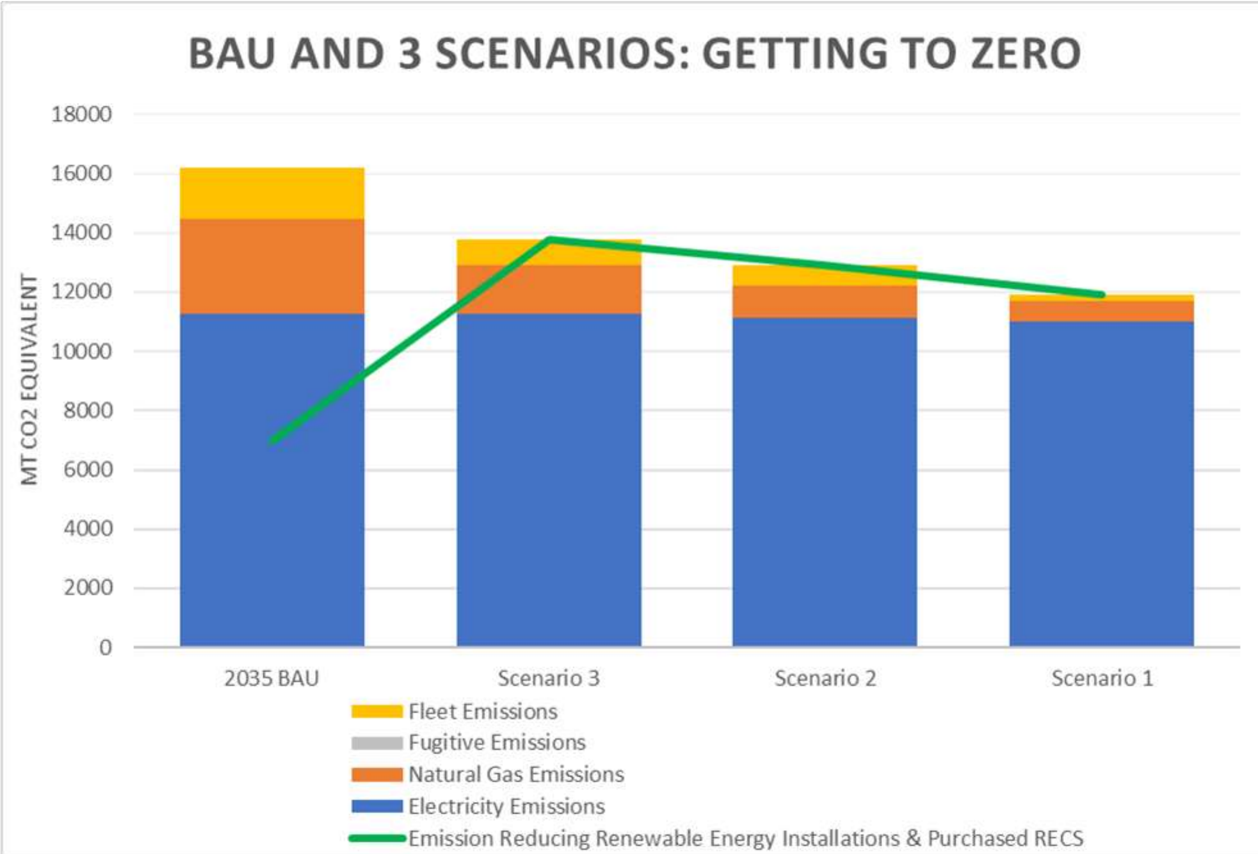

Figure 7. Scenarios 1, 2 and 3

Scenario 1 – Transformative Change

This scenario represents the highest, most aggressive penetration of strategies and results in the lowest reliance on RECs to achieve carbon neutrality by 2035. It represents transformative change from the 2035 business-as-usual scenario.

Scenario 2 – Fundamental Change

While still aggressive, this scenario represents a lower penetration of strategies. It features less aggressive targets for Vehicle Miles Traveled (VMT) reduction, energy efficiency, electrification, and renewable energy (onsite and offsite). This scenario requires 62% more RECs than Scenario 1 but is more aggressive approach than Scenario 3.

Scenario 3 – Initial Change

This scenario is the least aggressive of the three scenarios. It features the lowest penetration level of strategies for fleet electrification, VMT reduction, energy efficiency, electrification, and renewable energy. It does not account for rightsizing the building equipment. This scenario requires 41% more RECs than Scenario 2. It should be noted that Scenario 3 still represents significant operational change from 2035 business-as-usual.

The Role of Renewable Energy

This Strategy outlines key emission-reducing strategies including rightsizing, electrification and efficiency of buildings and fleet, and onsite and offsite renewable energy. To achieve carbon neutrality it will be necessary to offset any remaining GHG emissions upon the implementation of the strategies presented in these scenarios. While the grid is rapidly decarbonizing, it will not be fully "clean" over this planning timeframe, 15 years from today, and there will still be some fossil fuel consumption in buildings and vehicles. In fact, 40-42% of remaining emissions in 2035 scenarios will be attributed to water treatment, with limited opportunity to reduce the electricity and natural gas consumption associated with its operations. As such, after the implementation of all strategies, Evanston will need to offset remaining GHG emissions via the procurement of Renewable Energy Credits (RECs).

RECs are a regulated, market-based tool that measure the environmental and societal value of renewable energy generation. One REC represents one generated megawatt hour (MWh) of renewable electricity. The purchase of RECs is tracked and can only be sold once so that another entity cannot claim the same benefits. RECs can be used to lower Scope 2 emissions from purchased electricity, and because the purchase of RECs guarantees that the power is from a renewable source that only the buyer can claim credit for, they can be purchased from any location. However, by purchasing RECs through the vehicle of a Power Purchase Agreement (PPA) or a Virtual Power Purchase Agreement (VPPA), Evanston may be able to wield more purchasing power demands that could include locational or proximity boundaries from whence such RECs are generated, thereby assuring that other benefits connected to the purchase and development of renewable energy, such as the investment in jobs and the economy, are realized closer to home, instead of thousands of miles away. [3,4,5] More recently established, Renewable Natural Gas Certificates (RNG) function in a similar manner and can be utilized to lower Scope 1 emissions from onsite natural gas combustion. One RNG represents one metric million British thermal unit (MMBTU) of natural gas.[6]

[3] National Renewable Energy Laboratory. "Renewable Electricity: How Do You Know You Are Using It?" August 2015. https://www.nrel.gov/docs/fy15osti/64558.pdf

[4] U. S. Department of Energy. Guide to Purchasing Green Power. September 2018. https://www.epa.gov/sites/production/files/2016-01/documents/purchasing_guide_for_web.pdf

[5] U.S. Environmental Protection Agency Green Power Partnership. "Offsets and RECs: What's the Difference?" February 2018. https://www.epa.gov/sites/production/files/2018-03/documents/gpp_guide_recs_offsets.pdf

[6] Weisberg, Peter. "Renewable Natural Gas – A new tool to address natural gas emissions." May 2020. https://3degreesinc.com/resources/renewable-natural-gas/

3.1 Strategies: Buildings + Streetlights

The 2018 GHG emissions attributable to Evanston's building portfolio and streetlights were 18,698 metric tons of carbon dioxide equivalent ($MTCO_2e$), or 88.2% of the total municipal operations inventory.[7] The source of these emissions was electricity and natural gas consumption in approximately 100 electric accounts and 40 natural gas accounts that include municipal facilities and streetlights. Figure 6 depicts 19 of the largest managed sites operated by the City of Evanston and includes a water treatment facility, the Civic Center, three parking decks, six public safety facilities, seven community spaces (arts, recreation, library), and the Service Center, but there are numerous smaller facilities that are not shown because square footage is not available.

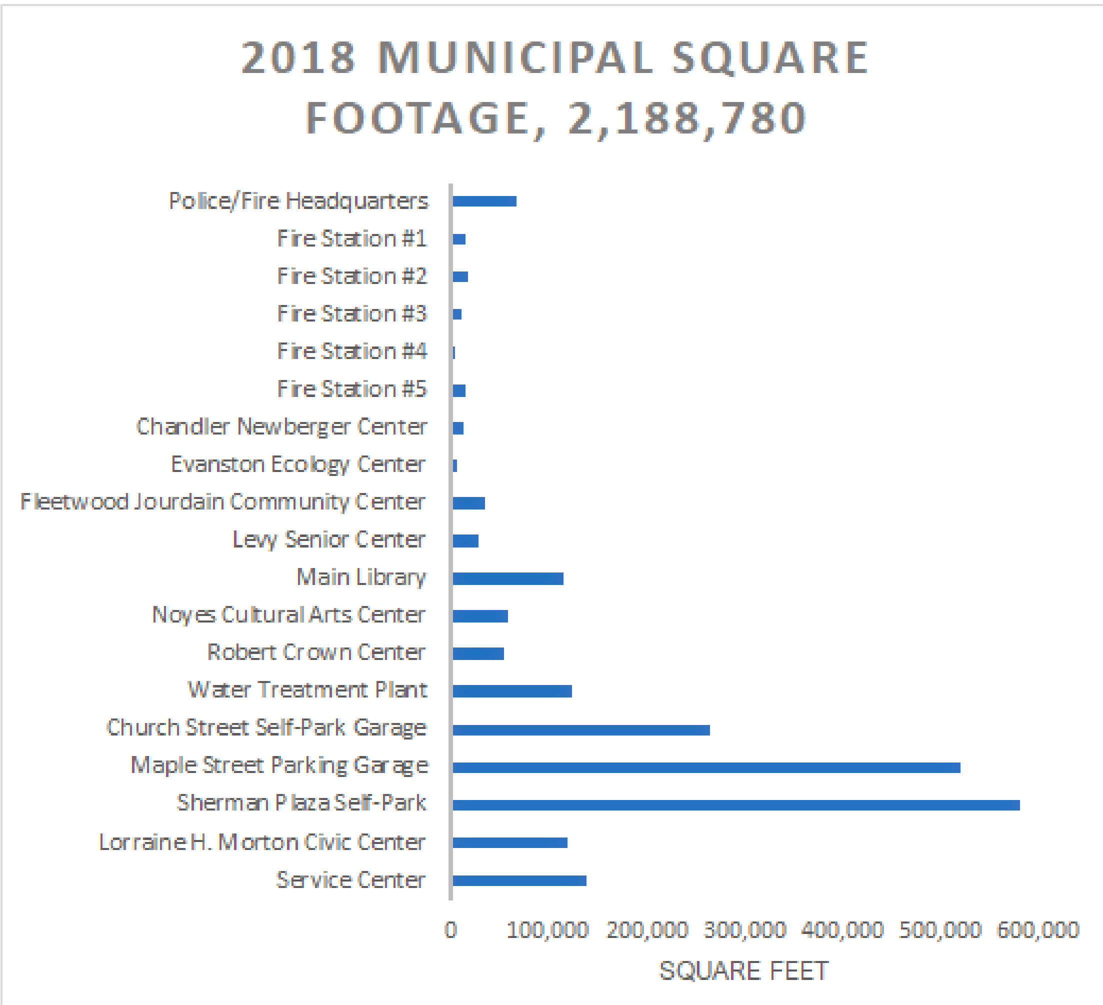

Figure 8. Evanston Municipal Buildings, Square Footage[8]

[7] Streetlights account for 1,764 metric tons, with the remainder due to electricity and natural gas consumption in the 19 buildings across Evanston's building portfolio.

[8] Source for square footage: ENERGY STAR Portfolio Manager. Notes: 1) Square footage from smaller facilities was not available and therefore not included in this figure. 2) Robert Crown Center has since undergone a major renovation and rebuild.

A closer examination of Evanston's largest buildings grouped by use or type shows that 62% of square footage is parking garages. Community Centers and City Hall/Public Works buildings represent 14% and 12% respectively of the entire square footage while water and police/fire are both at 6% (Figure 7). The water treatment plant is characterized by very efficient operations with limited opportunity for energy savings, and improvements in parking garages will primarily occur with lighting upgrades. The building strategies with the highest impact on emissions reduction–electrification and energy efficiency—will occur in approximately one third (32%) of Evanston's largest municipal buildings, as noted in Figure 6.

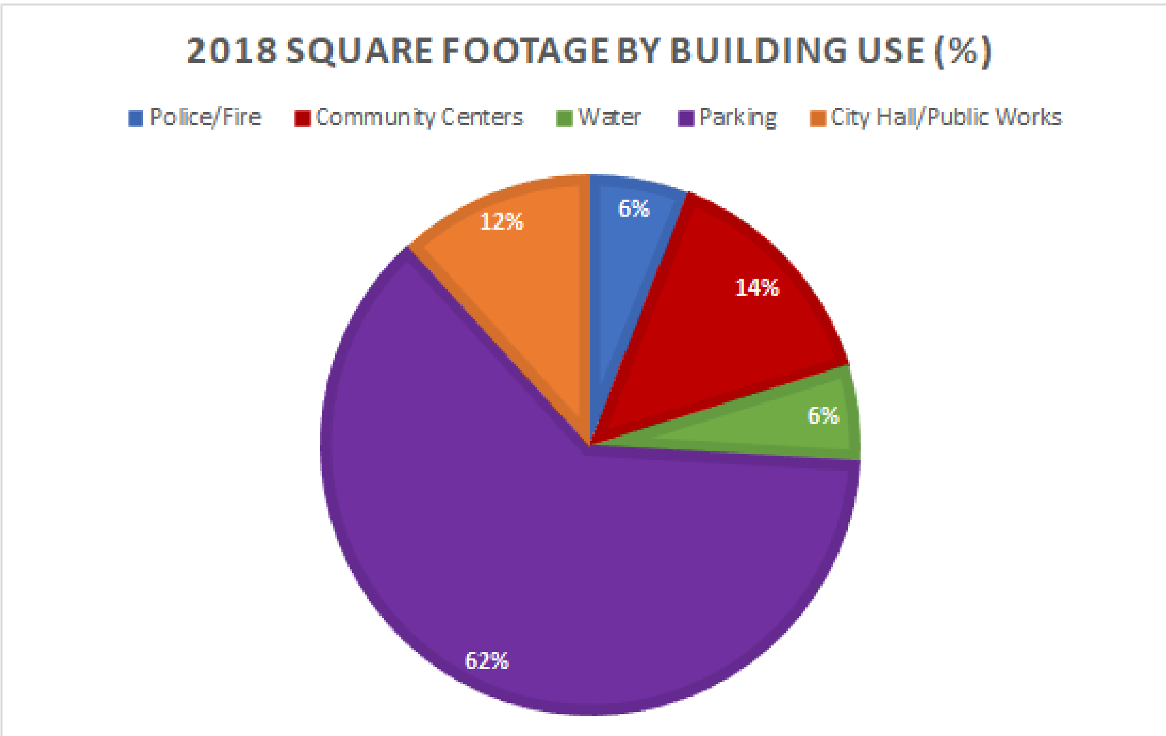

Figure 9. Evanston Municipal Buildings, Square Footage by Building Use[9]

Figures 10 and 11 depict 2018 electricity and natural gas consumption by building type. These buildings represent 37% of total 2018 electricity consumption, and nearly 80% of natural gas consumption (78%)meaning there is significant impact potential for reducing emissions by taking decisive action now in those buildings.[10]

[9] Source for square footage: ENERGY STAR Portfolio Manager. Notes: 1) Square footage from smaller facilities was not available and therefore not included in this figure.

[10] The addition of streetlight efficiency as a strategy means that nearly half of 2018 electricity consumption (48%) will be addressed.

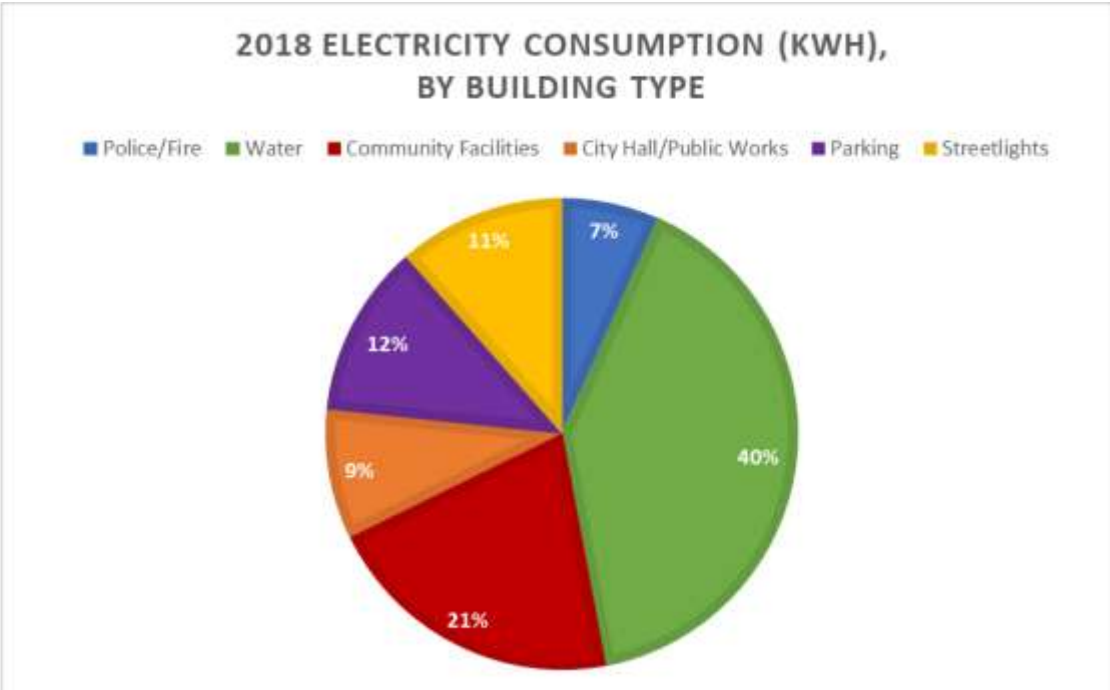

Figure 10. 2018 Electricity Consumption, Buildings (by Type) and Streetlights[11]

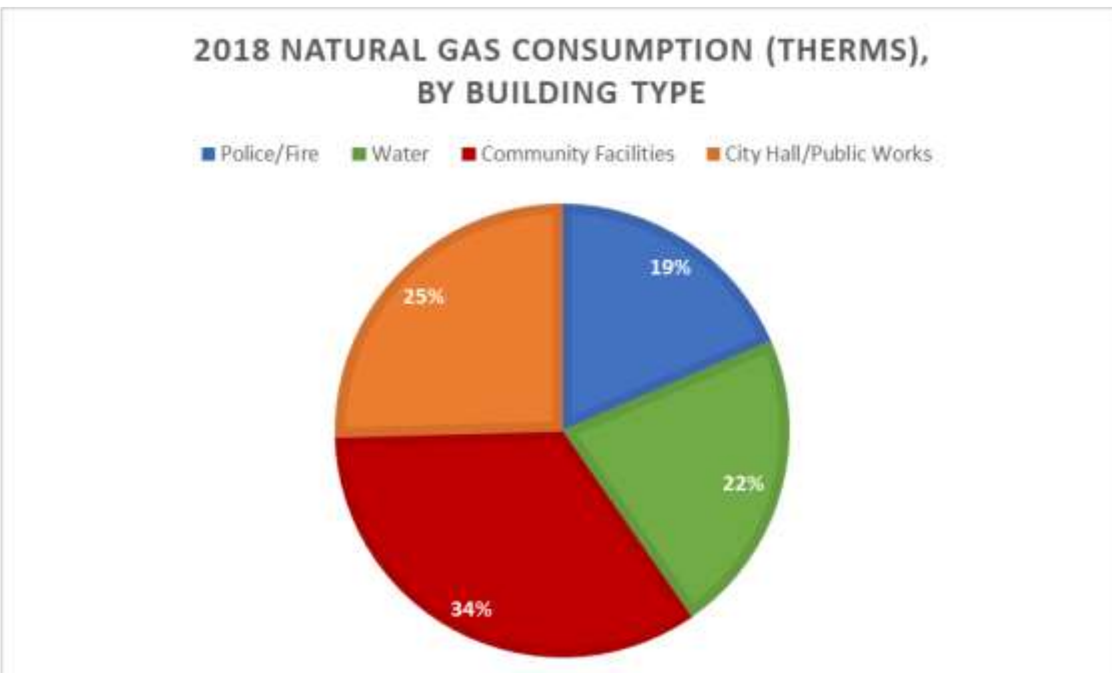

Figure 11. 2018 Natural Gas Consumption, Buildings (by Type) Note: There is no natural gas consumption associated with City of Evanston's parking garages or streetlights.[12]

[11] Source: 2018 Municipal GHG Raw Data.

[12] Source: 2018 Municipal GHG Raw Data.

To inform the development of ZES, the team conducted three case studies that assessed the opportunity for carbon neutrality at specific municipal facilities – Fire Station #1, Fleetwood Community Center, and the Service Center. The three case studies can be found in Appendix 2. The findings of the case studies were extrapolated to the buildings portfolio and streetlights to provide the pathways to carbon neutrality by 2035.

The multi-pronged strategies presented in this section focus on energy efficiency, renewable energy, electrification, and rightsizing. It is important to note that building electrification increases electricity consumption and therefore adds electricity emissions, but as the electricity grid continues to increasingly be powered by cleaner fuels like wind and solar with a decreasing reliance on coal, those emissions are projected to rapidly decrease in the long term. And importantly, it is expected that the emissions mix of the electric grid will change over time, in the near term, emissions due to electricity can be directly offset by on-site renewable energy systems.

In this same context, within these buildings strategies there will be residual emissions. As noted above there is very little opportunity to reduce natural gas emissions associated with water treatment operations (~40% a BAU 2035 scenario). Water treatment is a high energy intensive process, despite Evanston's efficiently run operations. These residual emissions underscore the importance of aggressive action in all other buildings.

To achieve carbon neutrality through one of the three scenarios the City must reduce its electricity and natural gas consumption through rightsizing, electrification, efficiency and renewable energy. These actions will set the stage for accelerated emissions reductions as the grid continues to decarbonize in the future.

Timing

The implementation of building strategies includes a combination of immediate actions and those that may require more careful capital planning. Across the entire building portfolio, energy efficiency could begin immediately in some buildings, particularly those with Heating, Ventilation, and Air Conditioning (HVAC) systems ready for immediate replacement. Prioritizing these strategies will result in a departure from the current capital improvement planning (CIP) process and, due to associated investment costs, it will likely result in other CIP investments being adjusted to a later timeframe. The City is well positioned to take action now to assure high performance buildings are optimized to help achieve carbon neutrality. Installation of on-site renewable energy systems and building electrification require additional planning and longer investment timelines. The feasibility of on-site renewable energy systems should be carefully assessed and coordinated with efforts to electrify buildings first, when possible. Rightsizing the City's building footprint may involve additional stakeholder processes and time. While the technology to implement these strategies already exists, it remains advantageous for Evanston to stay apprised of emerging building technologies that continue to improve and provide increasing levels of energy savings and emissions reductions. The City of Evanston will serve as an example for other like-minded municipalities working to lead the charge in addressing climate change in their communities. See Table 8 at the end of this section for additional timeframe considerations.

Cost Analysis

A high-level cost estimate was created for each of the scenarios and includes significant one-time investments related to construction, installation and infrastructure improvements, and ongoing annual costs and savings associated with electricity, natural gas and fuel consumption; renewable energy credits; and maintenance. The largest costs are associated with construction and infrastructure investments, and decisions on pathways early on will likely determine expenditures and timing. For instance, if rightsizing the portfolio and 100% electrification of all buildings are both adopted, it makes financial sense to implement rightsizing first, then coordinate electrification with energy efficiency strategies. Estimated costs are provided in a range for each scenario, but should be considered as indicators of the scale of cost rather than as forecasts. See Tables 5 and 6 at the end of this section.

Strategy 1. Rightsizing

Rightsizing Evanston's building portfolio is an immediate opportunity to eliminate energy consumption by retiring space that may not necessarily be needed for the City to serve the people of Evanston. As the world emerges from lockdown due to the global pandemic, this timing presents an opportunity to review the usage of facilities and identify a space utilization strategy for the building portfolio. Additionally, adaptive reuse of municipal buildings for the greater community good can represent positive changes in communities and set an example that prioritizes revitalization versus tear downs and rebuilding. This strategy may impact a variety of stakeholders and should be analyzed further, but with expediency as it informs the remainder of Buildings strategies.
Rightsizing offers immediate emissions reduction potential for Evanston and may be an important consideration to achieve carbon neutrality. Reducing just 10% of square footage will reduce emissions by up to 507 MTCO2e, or 3% against 2035 BAU.

Assumptions

- Scenario 1: Eliminate10% of square footage
- Scenario 2: Eliminate 5% of square footage
- Scenario 3: No elimination of square footage

Benefits

- Reduced emissions
- Reduced operational costs

Implementation Considerations

- Intensive stakeholder process, internally and externally, depending on the site
- Minimal costs associated with transition of assets

Opportunities

- Public/private partnerships for potential adaptive reuse

BEST PRACTICES: ADAPTIVE RE-USE

In adjacent neighboring Chicago, large government buildings such as the former U.S. Post Office and the former Cook County Hospital depict opportunities for reimagining the urban landscape, as commercial and residential spaces bring new character to formerly vacant sites. Some cities like Lancaster, Pennsylvania herald both municipal and community adaptive reuse as the community's evolution over time and ability to shape its own future. While a different use of a property might result in increased emissions at a community scale, it is an opportunity to optimize the building use while preserving existing building stock. This ultimately results in fewer emissions than the full lifecycle emissions of demolition and new construction, no matter how sustainable the construction standards are.

Strategy 2. Energy Efficiency

Energy consumption in buildings represents the majority of Evanston's municipal emissions (80%). Within this 80%, the majority of it (80.6%) is attributed to electricity consumption while 19.4% is attributed to natural gas combustion.

For this reason, assuring that municipal buildings, and the people who work in them, are using energy as efficiently as possible is a crucial component of Evanston's carbon neutrality pathway. The three case studies conducted (Appendix 2) offer a sample of what to expect in the remainder of the City's portfolio. Lighting upgrades, installation of high efficiency heating and cooling systems, and building envelope improvements via air sealing and insulation will result in significant reductions in both electricity and natural gas.

Emerging Technology: Very High Efficiency HVAC (VHE HVAC)

The local electric utility Commonwealth Edison (ComEd) offers a well-funded program focused on research and technical demonstration projects. One of the most recent initiatives of ComEd's Emerging Technologies program is testing a Very High Efficiency HVAC (VHE HVAC) system with significant energy savings potential. Modeling and testing in another market shows potential for 60 to 70% energy savings. The City should stay abreast of the results of this study and potential applications in the municipal buildings.

The City can also impact end user habits with ENERGY STAR® rated office equipment and sustainable behavior office prompts that engage City staff in their respective roles and daily job duties. Experts at the World Resources Institute note that behavioral changes not only support immediate goals but can transfer into other areas of peoples' lives and support broader behavior and attitude shifts needed to achieve aggressive climate goals at the community scale.[13]

By 2035, energy efficiency strategies in municipal buildings will reduce emissions by 1,819 to 2,729 $MTCO_2e$, ranging from 11.2% to 16.9% savings against 2035 BAU.

Assumptions

- Varied savings and penetration rate assumptions for lighting, HVAC systems, envelope, and occupant behavior

Benefits

- Reduced emissions
- Reduced operational costs
- Improved occupant comfort

[13] Nicholas, Katherine and Wynes, Seth. "Changing Behavior to Help Meet Long-Term Climate Targets". World Resources Institute. Accessed on May 8, 2021. https://www.wri.org/climate/expert-perspective/changing-behavior-help-meet-long-term-climate-targets

Implementation Considerations

- Upfront installation/retrofit costs
- Timing of energy conservation measures to align with necessary building, systems repair

Opportunities

- Utility incentives
- Emerging technologies

Strategy 3. Electrification

Natural gas consumption accounted for 15.4% of Evanston's municipal GHG emissions in 2018. These direct Scope 1 emissions originate from combustion of fossil fuels, so eliminating their use as much as possible is a key component of a carbon neutrality goal. Electrification is a fuel switching strategy that replaces fossil fuel burning end uses such as heating, hot water heating, and cooking with systems and appliances that rely on electricity instead of natural gas or fuel oil. Electricity still has associated emissions; however, the electricity grid gets cleaner each year, and can be supplemented by onsite or offsite renewable energy generation. While it is far easier to electrify buildings at the time of construction, the challenge remains in electrification of existing buildings. In some instances it may not be feasible to fully eliminate natural gas consumption in certain buildings by 2035, such as the emergency generator at the water treatment plant. However, in most other instances, removing reliance on natural gas is more reasonable than awaiting the full lifecycle use of the building, since doing so will result in decades of fossil fuel consumption.

Electrifying municipal buildings will significantly reduce emissions associated with fossil fuel heating (natural gas). By transitioning to electricity, Evanston will benefit from the rapidly decarbonizing grid, however, in 2035 these changes will result in a temporary net increase of emissions ranging from 431 to 816 MTCO2e.

Assumptions

- Scenario 1: 100% electrification of all buildings (excluding backup generation for water treatment and other critical facilities)
- Scenario 2: 75% electrification
- Scenario 3: 50% electrification

Benefits

- Reduced natural gas emissions
- Decrease in emissions over time as electric grid continues to decarbonize

Implementation Considerations

- Significant upfront installation/retrofit costs
- Increased electricity consumption and emissions that, if not remediated by onsite renewables, result in higher emissions, even if temporary while the grid continues to improve
- Staff training and potential need for additional staff for ongoing maintenance and operation

Opportunities

- Utility incentives for energy efficiency measures that do not involve fuel-switching
- Emerging technologies, particularly in space heating large facilities

Strategy 4. Onsite Renewable Energy

Evanston currently maintains two onsite solar photovoltaic (PV) systems within its portfolio, at the water treatment facility and Levy Senior Center. In 2018 these systems generated approximately 36,208 kWh, roughly amounting to just 0.12% of Evanston's total electricity consumption. An initial analysis of rooftop square footage and shading shows that the City's rooftops could possibly generate up to 4.6 million kilowatt hours. This potential, paired with decreasing costs of solar technologies, makes onsite solar an important part of Evanston's carbon neutrality pathway.

Evanston municipal building rooftops could support enough onsite solar PV to generate up to 15% (4.6 million kWh) of its total annual electricity consumption in 2035. The deployment of this strategy will reduce emissions from 847 up to 1,694 $MTCO_2e$.[14]

Assumptions

- Scenario 1: 100% of rooftop solar capacity is installed (Solar capacity is estimated at 3,793 kW)
- Scenario 2: 75% of rooftop solar capacity is installed
- Scenario 3: 50% of rooftop solar capacity is installed
- Solar potential includes analysis provided in three case studies
- Utilizes same calculations attributed to the Cook County Solar Map

Benefits

- Increased energy independence
- Offset increased electricity consumption resulting from electrification
- Reduced emissions
- Reduced operational costs

Implementation Considerations

- Installation costs
- Maintenance costs
- Maintenance training and operation

Opportunities

- Utility, state, and federal incentives
- Anticipated federal, state funding incentives due to reestablished climate commitments

Strategy 5. Offsite Renewable Energy

Offsite renewable energy generation allows Evanston to tap into additional solar potential via solar photovoltaic (PV) installation from a nearby location or through a community solar installation. These investments made in sourcing energy from other closely situated renewable sources will aid the City's efforts and mission in a multitude of ways, such as reducing emissions associated with municipal operations, encouraging community choice and access to the benefits of renewable energy by its subscribers, and supporting the local green economy job growth.

[14] Electricity consumption is expected to rise due to removal of natural gas consumption.

Procuring offsite renewable energy is an integral component of reducing Evanston's municipal emissions. By 2035, offsite renewable will meet up to 50% of municipal electricity needs, with a solar GHG equivalent reduction of emissions from 2,250to 5,490 $MTCO_2e$.

Assumptions

- Scenario 1: 50% share of electricity use (after strategies) in 2035
- Scenario 2: 35% share of electricity use (after strategies) in 2035
- Scenario 3: 20% share of electricity use (after strategies) in 2035

Benefits

- Offset increased electricity consumption resulting from electrification
- Reduced emissions
- Green economy job growth
- May increase access to community solar subscriptions for residents if the City is an anchor subscriber

Implementation Considerations

- The selection process of a community solar site may require external capacity or consultation
- Development and installation costs

Opportunities

- Utility, state, and federal incentives
- Anticipated federal, state funding incentives due to reestablished climate commitments

Strategy 6. Efficient Streetlights

Evanston maintains 6,000 streetlights across the city that include 1,800 cobra lights (induction and High Intensity Discharge or HID) and 4,200 Tallmadge ornamental induction lights. In 2018, streetlights emitted 1,764 metric tons of carbon dioxide equivalent ($MTCO_2e$) or 8.3% of the total municipal GHG emissions inventory. Evanston has already implemented some efficient lighting strategies but can continue to improve. The 2018 Streetlight Master Plan Study provides more detail on existing lighting, challenges, and opportunities.

By 2035, energy efficiency streetlights will reduce emissions by 170 to 340 $MTCO_2e$, ranging from 1 to 2% savings against 2035 BAU. [15]

Assumptions

- Cobra HID lights represent 18% of streetlight electricity consumption with an estimated 65% savings potential
- Cobra induction lights represent 6% of streetlight electricity consumption with an estimated 20% savings potential
- Tallmadge induction lights represent 76% of streetlight electricity consumption with an estimated 20% savings potential

Benefits

- Reduced emissions

[15] Analysis of existing streetlights consumption, asset information, and 2019 Streetlight Master Plan.

- Reduced operational costs
- Improved quality of light
- Extended useful life

Implementation Considerations

- Lighting preferences may vary from neighborhood to neighborhood. The City may want to consider resident input and feedback before finalizing decisions.
- Significant upfront installation costs, particularly for the streetlights requiring full replacement due to age and condition of poles, instead of retrofitting only bulbs and fixtures.
- Utility incentives may not cover costs of full pole replacements that may be deemed necessary based on conditions.

Opportunities

- Utility incentives are available for some of the lighting retrofits because a portion of lights already have some level of efficiency. Further, some light replacements might involve full poles and costs not covered by incentives.

3.2 Strategies: Vehicle Fleet

In 2018, Evanston's fleet included 423 vehicles and 156 accessories, emitting 2,485 metric tons of carbon dioxide equivalent ($MTCO_2e$) or 12% of the total municipal GHG emissions inventory. Table 2 depicts the breakdown of Evanston's vehicle fleet, and 2018 total fuel consumed and mileage.

Table 3. 2018 Evanston Fleet by Vehicle Type, Fuel Consumption and Mileage

Vehicle Type	Vehicle Count, Percent of Fleet		2018 Total Gallons of Fuel	2018 Total Mileage
SUV	105	22%	72,954	701,293
Truck Pickup	92	20%	43,645	286,574
Accessory	60	12%	7,436	14,614
Light, Medium, Heavy Duty Public Works Agency Trucks	92	19%	79,877	216,587
Greenways Tractors/ Mowers	7	1%	2,100	14,618
Van	31	7%	12,042	56,666
Car Sedan	30	6%	5,753	78,280
Specialty Vehicle	16	3%	1,699	52,389
Fire Truck	13	3%	20,598	70,685
Watercraft	11	2%	-	-

Motorcycle	7	1%	165	-
Ambulance	5	1%	5,892	35,115
Bus	5	1%	1,593	5,928

Best Practices - Fleet

The fleet strategies identified are informed by best-practice strategies from other cities, particularly those in cold weather climates. Other cities pursuing carbon neutral fleets will be a good resource for learning and problem solving in the coming years. The City of Seattle's, "Green Fleet Action Plan," may be a particularly relevant reference as it incorporates, "the City's commitment to race and social justice, equity and inclusion," and seeks to achieve multiple sustainability benefits with its fleet actions.[16]

By 2035, the fleet's GHG emissions could be reduced to 200-750 $MTCO_2e$ with an investment in clean technologies at a net financial savings for the City. The multi-pronged strategies in this section focus on clean electricity and renewable fuels, additional infrastructure, efficiency of vehicle uses, non-auto modes of transportation, and rightsizing the fleet. For a more detailed analysis, please see the City of Evanston Fleet Action Plan in Appendix 3.

Timing

Most of Evanston's vehicle fleet strategies can begin immediately, while others will need to roll out over time to accommodate planning and investment timelines. In some cases, phasing in new technology adoption will allow the City to take advantage of the rapidly changing zero emissions vehicle market. Taken together, the strategies described here can provide Evanston with a best-in-class, high performance transportation portfolio that sets the bar for cities around the world on responding to the climate crisis. See Table 9 at the end of this section for additional timeframe considerations.

Cost

A high-level cost estimate was created for each of the scenarios. Implementation and operational choices made in the process of decarbonizing the fleet can greatly impact costs, so these values should be considered as indicators of the scale of cost involved rather than as forecasts.

[16] Electrification Coalition, "Drive Electric Northern Colorado: Establishing an EV Accelerator Community," Case Study (Washington (DC): Electrification Coalition, February 2018), https://driveevfleets.org/wp-content/uploads/2018/08/DENC-Full-Case-Study.pdf

Scenario 1 creates total savings over the period from 2021-2035 of $12 million. It has the highest costs for infrastructure and vehicle purchases over business as usual, but it also generates the most savings. Scenario 2 has the lowest total savings at $5 million from 2021-2035. Both Scenarios 2 and 3 have lower investment needs as less of the fleet is transformed to zero carbon fuels, but both achieve lower annual fuel and maintenance savings as a result.

The bulk of the infrastructure investment in each scenario needs to occur in the early to mid-point of the scenario period to support the fleet while it transforms. In 2021 and 2022 investment needed will include electric vehicle charging stations for smaller fleet vehicles. As charging needs grow in future years significant electrical system upgrade is likely required at facilities where vehicles will be charged and those costs are estimated in the scenarios. The on-site solar investment could be spread out over time, but earlier installation is encouraged to capture the electricity cost savings it will generate and its GHG benefits. See Table 7 at the end of this section.

Strategy 7. Clean Fuel Technologies: Electric Vehicle + Biofuels

7.1 Electric Vehicles

Battery electric vehicles (BEVs) are powered by an internal battery that when depleted is recharged by connecting to the electric grid. While this technology may not be suitable for some special purpose vehicles and heavy-duty vehicles at the present time, a large portion of City's sedans, SUVS, trucks, and motorcycles can accommodate this fuel switching approach. Looking ahead, the City will reassess opportunities to include additional vehicle types each year, since this is a rapidly changing technology.

7.2 Biofuels

Biofuels produce carbon emissions upon combustion, but those emissions are considered biogenic. The fuel feedstock comes from currently living biological material which releases CO_2 as part of the global carbon cycle, as opposed to

EMERGING CLEAN FUEL TECHNOLOGIES ON THE HORIZON

As new technologies emerge and are tested on the market, Evanston should stay apprised of these developments that will help the City achieve the cleanest fleet possible. Two of particular interest may be renewable diesel and hydrogen.

Renewable Diesel (RD) is a manufactured hydrocarbon, and of the newer biofuels available on the market today, it may be the best fit for Evanston's needs as a replacement fuel for heavy-duty vehicles. It can be distributed in the same facilities and used in the same engines as conventional diesel fuel. Sources of RD include corn stover, palm oil, fatty acid distillate, tallow (animal fat), and used cooking oil. Currently RD is not widely available outside of the west coast, however if the market changes by 2035 it could replace all diesel usage and eliminate the need for any fossil fuels in the portfolio. In addition to its limited availability, it emits nitrogen oxide (NOx) and other criteria air pollutants.

fossil fuels which release carbon previously stored underground for thousands of years.[17] Thus, biofuels can be low-carbon fuels when sourced responsibly, despite showing significant tailpipe carbon emissions. Unless emerging technologies dictate otherwise, B100 pure biodiesel is the most suitable biofuel for the City of Evanston at this time. B100 is produced from the transesterification of oils and fats. Using B100 can require technology changes in heavy duty vehicles and it has performance limitations in cold weather that may require operations adjustments, which makes emerging technologies quite attractive. Renewable Diesel is a better fit for Evanston's fleet needs if it can be accessed in the market, however B100 is available now and is a necessary low-carbon fuel for Evanston if RD does not become widely available.

(continued) Fuel cell electric vehicles (FCEVs) contain an electrochemical reactor to convert hydrogen and an oxidant to energy. FCEVs create no tailpipe GHG or criteria air pollutant emissions; the chemical byproduct is water vapor and warm air. While hydrogen production has the potential to be low or zero carbon if produced with renewable electricity, today it is typically produced from natural gas and therefore has a fairly high lifecycle GHG footprint. In addition, right now it is very costly due to lack of economies of scale and significant infrastructure costs. Projected wide-use applications of fuel cells include heavy duty trucks, logistic vehicles, forklifts, buses, and passenger vehicles.

In order for the City to achieve carbon neutrality through one of the three scenarios, the City must reduce its fossil fuel vehicle fleet by 55 to 92% through rightsizing and replacing those vehicles with a mix of electric and biofuel vehicles, leading to a fuel consumption reduction of 70 to 95%, as shown in Table 3.

Table 4. Carbon Neutral Fleet Scenarios, Count of Vehicles and Fuel Use in 2035
Note: 2018 Values are Adjusted from the 2018 GHG Inventory to Account for Fleet Data Updates

	Count of Fossil Fuel Vehicles	Count of Electric Vehicles	Count of Biofuel Vehicles	2035 Total Gallons of Fossil Fuel	2035 kWh Electricity	2035 Gallons Biofuel
2018 (Adjusted)	*381*	*0*	*86*	*343,480*	*0*	*20,468*
Scenario 1	31	235	76	17,269	751,951	53,057
Scenario 2	116	178	74	67,566	558,434	46,522
Scenario 3	170	127	83	101,503	378,318	49,975

Assumptions

- In 2018, electric vehicles are estimated to emit 0.5 kg CO_2e per kWh
- Assumes on-site solar to offset portion of necessary electricity use

[17] IEA Bioenergy, "Fossil vs Biogenic CO2 Emissions | Bioenergy," *Technology Collaboration Programme* (blog), 2020, https://www.ieabioenergy.com/iea-publications/faq/woodybiomass/biogenic-co2/; UC Davis, "Biogenic Carbon," *Science and Climate* (blog), accessed July 16, 2020, https://climatechange.ucdavis.edu/climate-change-definitions/biogenic-carbon/

Benefits

- Reduced Emissions
- Reduced Costs (relative: higher purchase price; lower maintenance costs over time)
- Improved Air Quality

Implementation Considerations

- Investment costs: incrementally higher vehicle price
- Investment costs: significant upfront costs for vehicle charging infrastructure
- Investment costs: B100 can require installation of new technology in existing vehicles
- Staff training for ongoing maintenance and operation

Opportunities

- Federal and state funding, particularly as national leadership recommits to climate action
- Rapidly evolving technology advancements
- Emerging set of best practices from other cities

Loveland, Colorado's EV Ambassadors: The City of Loveland, Colorado mobilized electric vehicle ambassadors that worked with City departments to promote use of the City's new electric vehicles. A 10,000-mile challenge was implemented to incentivize employees' use of the pooled fleet of Nissan Leafs before any fossil fuel vehicles.[18]

Strategy 8. Fleet Management and Rightsizing

8.1 Rightsizing

The current Evanston fleet includes many vehicles with low annual mileage, even excluding the lowest mileage values that may not have miles recorded or may be equipment hours of usage – 201 vehicles (43% of the total fleet) recorded between 1,000 and 10,000 miles in 2018. The median mileage was just 4,233 miles, as compared to the U.S. average of 11,800.[19,20] This presents an opportunity for combining vehicle uses and rightsizing the fleet.

---

[18] Electrification Coalition, "Drive Electric Northern Colorado: Establishing an EV Accelerator Community," Case Study (Washington (DC): Electrification Coalition, February 2018), https://driveevfleets.org/wp-content/uploads/2018/08/DENC-Full-Case-Study.pdf

[19] This analysis of fuel economy and 2018 mileage excludes vehicles that were indicated as sold, or 2019 and later model years, as well as those with 0 or negative or other significant outlier data points for fuel or mileage. Exclusions are intended to allow for a full-year's analysis of typical fleet activity as of 2018.

[20] "Annual Vehicle Distance Traveled in Miles and Related Data - 2018 (1) by Highway Category and Vehicle Type," Federal Highway Administration, November 2019, https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm.

For example, the City of Seattle has instituted a policy to eliminate fleet vehicles used less than 2,400 miles per year (200 miles per month).[21]

Hours, days, and purposes of vehicle usage should be tracked to identify cases where one new vehicle could serve the same utility of two or more existing vehicles. The reasons for rightsizing include: 1) the higher up-front cost of alternative fuel vehicles make them a more effective investment if they are used more,[22] 2) induced demand has shown when a vehicle is available individuals tend to find reasons to use it instead of seeking alternatives, 3) encouraging only essential vehicle use will reduce fuel consumption and GHG emissions, and 4) freeing up space now used for vehicle parking will support installation of zero carbon infrastructure, green stormwater infrastructure, or other sustainability and resilience actions.

8.2 Fuel Economy

The overall fuel economy of vehicles for sale in the market is improving, so much of this change will occur naturally with fleet turnover; however procurement with a focus on fuel economy should be a priority.[23] Additionally, smaller, lighter vehicles should be chosen when they can meet City needs. The typical passenger vehicle in the current fleet is a sports utility vehicle (SUV) or pickup truck. Replacing some of these vehicles with sedans would save energy, emissions, fuel cost, and purchase cost. In the case of electric vehicles, choosing smaller vehicles can reduce charging times and increase driving range. The electronic traction control in electric vehicles can help even smaller models handle snow and ice well.[24] Staff members should be encouraged and enabled to use vehicles efficiently to support the City's climate goals. There are informational tools that can give drivers feedback on the efficiency of their vehicle usage and trainings available on "eco-driving" to teach best practices for achieving fuel economy.[25] Enforcement of the City's existing anti-idling policy could also reduce fuel usage.

8.3 Tracking

Improvements in data quality control with Evanston's existing fleet and fuel tracking systems will enable closer management of vehicle activity and emissions. An assessment of fleet data found gaps that should be amended, including mileage data that was not recorded during fueling and lack of differentiation in reports between hours and miles of vehicle activity. A new data management structure will be needed to better represent the fleet's energy and performance data as electric vehicles are adopted. Specifics include, "energy consumed (kWh), vehicle

---

[21] City of Seattle, "Green Fleet Action Plan: An Updated Action Plan for the City of Seattle," 2019. https://www.seattle.gov/Documents/Departments/FAS/FleetManagement/2019-Green-Fleet-Action-Plan.pdf

[22] Best practice is 10,000 to 12,000 miles annually, but that may be an unrealistically high target for Evanston's needs. Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide," Guide (Washington (DC): National Association of Regional Councils, 2016), https://static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/5c3e30734ae237da7d84cf2c/1547579509097/Electric%2BVehicle%2BProcurement%2BBest%2BPractices%2BGuide%2BFinal.pdf

[23] U.S. Department of Energy, Energy Information Administration, "Annual Energy Outlook," (2018). Light duty vehicles are projected to improve fuel efficiency 40% by 2035, commercial light trucks 21%, and freight trucks 25%. https://www.eia.gov/outlooks/aeo/pdf/appa.pdf

[24] Jukka Kukkonen, Fresh Energy, "Electric vehicles are great winter cars," February 11, 2019. https://fresh-energy.org/electric-vehicles-are-great-winter-cars/#

[25] "Eco Driving Tools," Energypedia, November 7, 2014, https://energypedia.info/wiki/Eco_Driving_Tools

state of charge (SOC) before, during, and after trips, charge times and duration."[26] Additionally, Evanston may consider including real time data collection within zero-emission vehicles to give drivers and fleet managers more insight into usage and performance.[27]

8.4 Procurement

Procurement goals can ensure the decarbonization of the fleet happens in a timely manner. The decisions made in the next 5 years will shape Evanston's 2035 fleet. The City of Los Angeles set a goal of 50% electric light duty vehicles by 2017 and now is working toward 100% zero-emissions sedans by 2021. Additionally, their procurement process dictates considering zero-emission vehicles first for all procurement of new equipment.[28] As vehicle technologies are changing rapidly, leasing may be a good option to increase fleet turnover. [29] The Climate Mayors Electric Vehicle Purchasing Collaborative has information on electric vehicle purchasing and leasing.[30] Early decommissioning of fossil fuel fleet vehicles and ending the practice of transferring older vehicles between departments may help Evanston meet its climate targets sooner.

Funding and Financing for Low-Carbon Vehicles Continues to Evolve

Large providers of the necessary infrastructure technology may offer financing themselves and service models exist in the sustainable infrastructure realm wherein capital cost is borne by private implementers. Outreach to vendors, vehicle manufacturers, and the electric utility may identify additional funding and financing incentives. In 2017, for example, San Francisco Bay Area municipalities partnered with an auto dealership to allow the dealership to receive the federal tax incentive for electric vehicle purchases in place of the non-taxed public agencies and the dealership lowered the vehicle sales prices as a result.[31]

8.5 Maintenance

Maintenance is another important aspect of fleet management that is crucial to GHG emission reductions. Performance of vehicles depends on regular maintenance.[32] Transitioning the fleet to more electric vehicles is likely to save maintenance costs, as electric vehicles do not have the fluids and moving parts of internal

[26] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide," 13.
[27] "AC Transit Zero-Emissions Bus Rollout Plan: Alameda Contra Cost Transit District Oakland, CA."
[28] Michael Samulon, Update on LA Municipal Fleet Zero Emissions Goals, Phone, August 19, 2020.
[29] "Electric Vehicles and the City of New Bedford" (Massachusetts Department of Environmental Protection, October 9, 2018), https://www.mass.gov/files/documents/2018/10/09/massevip-newbedford.pdf.
[30] Climate Mayors Electric Vehicle Purchasing Collaborative https://driveevfleets.org/
[31] Georgetown Climate Center, "Capturing the Federal EV Tax Credit for Public Fleets: A Case Study of a Multi-Jurisdictional Electric Vehicle Fleet Procurement in Alameda County, California," April 2017. https://www.georgetownclimate.org/files/report/Capturing-the-Federal-EV-Tax-Credit-for-Public-Fleets%20-%20Case%20Study.pdf
[32] Oak Ridge National Laboratory, "Keeping Your Vehicle in Shape," Fuel Economy.Gov, accessed December 8, 2020, //www.fueleconomy.gov/feg/maintain.jsp.

combustion engines and have much fewer manufacturer recommended maintenance tasks.[33] However, the transition will require maintenance staff training and time for learning the new technologies to enable maintenance staff to safely keep the fleet at top performance levels. An important GHG to track and manage in the future is the purchase of refrigerant gas used in most automobile air conditioning systems, which has a high global warming potential. However, this may be less of an issue going forward as these gases are phased out of vehicles.

By 2035, through fleet management and rightsizing, Evanston could see an improvement in MPG (miles per gallon) by 80 to 174%. The following scenarios provide goals that include reductions which will need further analysis of staffing and operations in order to determine their feasibility.

Assumptions

- Scenario 1: Assumes fuel economy of new vehicle purchases will be increased by 50%
- Scenario 1: Assumes a reduction of 125 vehicles by 2035
- Scenario 2: Assumes fuel economy of new vehicle purchases will be increased by 45%
- Scenario 2: Assumes a reduction of 99 vehicles by 2035
- Scenario 3: Assumes fuel economy of new vehicle purchases will be increased by 42%
- Scenario 3: Assumes a reduction of 87 vehicles by 2035

Benefits

- Reduced emissions
- Reduced maintenance costs
- Improved air quality

Implementation Considerations

- Incremental costs: fleet management software, tracking tools and/or programs

Opportunities

- Federal and state funding/incentives, particularly as national leadership recommits to climate action
- Emerging set of best practices from other cities

Strategy 9. Vehicle Miles Traveled (VMT) Reduction

City of Evanston vehicles logged at least 1.5 million miles in 2018. A balanced portfolio of emissions reduction action requires that the vehicle miles traveled for city business decrease 20-30% by 2035. That is much easier to envision now than it might have been even a year ago, as the COVID-19 pandemic has forced new ways of working. Policies and strategies to achieve VMT reduction can include trip reduction, travel efficiency, and use of alternative transportation modes.

9.1 Trip Reduction

Ensuring staff have the tools and resources they need to avoid traveling will be the most cost-effective fleet strategy. Departments should be given clear data on their vehicle use with associated targets for reduction.

[33] Harto, Chris, et al "Electric Vehicle Owners Spending Half as Much on Maintenance Compared to Gas-Powered Vehicle Owners, Finds New CR Analysis."

Additional technology for online meetings and conferences should be provided where needed to reduce travel. Some of trip reduction is a cultural shift – if leadership shows a preference for virtual meetings or avoiding travel it will set the tone. Trip reduction can also be made fun through a competition between departments. Consider also if the locations of staff and activities can be shifted to reduce travel needs between facilities. Out of town business travel is not yet recorded in Evanston's municipal operations GHG inventory but tracking of it should begin and targets should be set to limit its use to essential needs.

9.2 Travel Efficiency

When travel in Evanston fleet vehicles is necessary it should be done efficiently. Routes for vehicles such as garbage trucks should continue to be analyzed for efficiency – fuel savings may be possible by changing routes or adjusting vehicle overnight parking locations. Carpooling among all staff for City business should be expected and rewarded. A staff survey or travel diary may identify ways in which trips for multiple purposes can be combined to save mileage, as well.

9.3 Alternative Modes

Evanston is a multi-modal city and City operations should take advantage of that. Staff should be encouraged, expected, and rewarded for traveling to meetings virtually, by bicycle, on foot, or by public transit. Current vehicle uses should be analyzed to determine use purposes that could be replaced by other modes. The City conducting its operations on foot, by bicycle, or on transit makes its commitment to carbon-neutrality visually present in the community. Balancing this with current staffing needs is an important consideration. Some of these alternative modes may be weather-dependent, so the City may want to provide a limited number of taxi vouchers or other back up transportation options to staff (these should be carefully tracked as they would be part of the City's operational carbon footprint).

9.4 Staff Commutes

Staff commutes are outside of the scope of Evanston's municipal operations GHG inventory, however best practice for climate action would encourage staff to reduce the GHG emissions associated with their commute. The strategies listed in this VMT Reduction section can be applied to commutes as well. Policies such as subsidized transit passes, or payments for staff who walk, bike, or carpool are all also supportive of reducing staff commute emissions. The location of City facilities should be prioritized for location efficiency and access by transit and other non-auto transportation modes. Electric charging stations could be made available to staff who commute or carpool by personal vehicle to encourage clean vehicle use.

By 2035, through VMT reduction strategies, vehicle miles traveled could be reduced by 20 to 30%.

Assumptions

- Scenario 1: Assumes a 2035 VMT reduction by 30%
- Scenario 2: Assumes a 2035 VMT reduction by 25%

- Scenario 3: Assumes a 2035 VMT reduction by 20%

Benefits

- Reduced emissions
- Reduced maintenance costs
- Improved air quality

Implementation Considerations

- Incremental costs: staff communications, incentive programs

Opportunities

- Federal and state funding/incentives, particularly as national leadership recommits to climate action
- Emerging set of best practices from other cities

3.3 Strategy Summary

The buildings, streetlights and fleet strategies of the Evanston Zero Emissions Strategy result in significant emissions reductions from 2018, by 43.8% in Scenario 1, 39.1% in Scenario 2 and 34.9% in Scenario 3. Against BAU 2035, those reductions are 26.5%, 20.3% and 14.9%, respectively. As shown below in Table 4, after implementation of strategies, there are expected to be residual emissions in 2035 associated with both electricity and natural gas. Over time as the grid continues to decarbonize, electricity emissions will rapidly decrease, and future technologies may offer opportunities for more climate-friendly backup generation at the water plant. In the meantime, renewable energy credits for electricity (RECs) and natural gas (RNG) can be procured to achieve the carbon neutrality goal. Scenario 1 most closely aligns with the hierarchy of carbon neutrality priorities Evanston identified at the onset of this study, featuring the highest adoption rates for the prevention of consumption by eliminating assets (rightsizing), electrification, energy efficiency, and both onsite and offsite renewable energy. Scenario 2 still aligns with these priorities but with slightly lower adoption rates, while Scenario 3 removes rightsizing and has lower adoption rates of all other strategies. In summary, all scenarios allow Evanston to reasonably achieve carbon neutrality through the purchase of RECs.

Table 5. Net Emissions after strategy implementation and renewable energy credits

2035	Scenario 1	Scenario 2	Scenario 3
Emissions by Source after strategies	**MTCO2e**	**MTCO2e**	**MTCO2e**
Electricity	10,980	11,117	11,252
Renewable Energy (onsite + offsite)	(7,184)	(5,161)	(3,097)
Natural Gas	704	1,090	1,634
Fugitive Emissions (associated with natural gas)	2	3	5
Fleet	221	695	895
Remaining Emissions after strategies	**MTCO2e**	**MTCO2e**	**MTCO2e**
Electricity	3,796	5,955	8,155
Natural Gas (includes fugitive emissions)	706	1,093	1,639
Purchased Renewable Energy Credits	**MTCO2e**	**MTCO2e**	**MTCO2e**
Electricity (RECs)	3,796	5,955	8,155
RNG Credits	706	1,093	1,639
Net Emissions	**0**	**0**	**0**

Cost Analysis

A key purpose of the ZES was to determine carbon neutrality feasibility by 2035 and the potential pathways for achieving it. To this end, a high-level cost estimate was created for each of the scenarios including two types of cost considerations: one-time investment costs, and annual, ongoing expenditures. The values noted are meant to indicate a magnitude of costs, and do not replace the need for independent financial analysis on a project-by-project basis.

The significant one-time investments are the largest cost, and involve electrification and efficiency construction, installation and infrastructure improvements. Ongoing annual costs and savings are directly associated with electricity, natural gas and fuel consumption; renewable energy credits; and maintenance. As shown in Table 5, the range in one-time cost investment for these scenarios ranges from $35 million to $75 million, a wide range that is dependent on varying adoption rates of each strategy. Annual operating cost savings (Table 6) range from $1.4 million to $3.7 million.

Table 6. Total One-Time Costs by Scenario, All Strategies

Strategies	Scenario 1		Scenario 2		Scenario 3	
Total Buildings[1]	$38,832,613	$43,658,506	$30,193,115	$35,146,006	$21,378,802	$26,458,691
Electrification + Efficiency	*$7,358,821*	*$12,184,715*	*$7,552,474*	*$12,505,365*	*$7,746,128*	*$12,826,016*
Onsite Renewables	*$8,116,592*		*$6,087,444*		*$4,058,296*	
Offsite Renewables	*$23,357,199*		*$16,553,196*		*$9,574,379*	
Streetlights[2]	$14,966,400		$11,224,800		$7,483,200	
Fleet Infrastructure[3]	$16,000,000		$12,000,000		$8,200,000	
Fleet – Change in Purchase[4]	$670,000		($600,000)		($1,300,000)	
Total One-Time Costs	**$70,469,013 to 75,294,906**		**$52,817,915 to $57,770,806**		**$35,762,002 to $40,841,891**	

Notes: Full set of assumptions is provided in Appendix 4.

1. Buildings: One-time estimated costs associated with electrification, energy efficiency, onsite and offsite renewable energy are provided as a range of low-end and high-end estimated costs based on dollar amount by square footage, informed by the case studies.
2. Streetlights: Tallmadge lights, 1/3 with pole replacement, remaining 2/3 as fixtures only with labor; Cobra head fixture only with labor
3. Fleet Infrastructure: Estimated electric vehicle chargers, onsite solar and electrical system upgrades
4. Fleet Change in Purchase Cost: Estimated added cost of electric vehicles over BAU and the savings from fewer vehicles

Table 7. Annual Costs by Scenario, All Strategies

Strategies	Scenario 1	Scenario 2	Scenario 3
Buildings			
Electricity + Natural Gas Cost Savings[1]	($803,213)	($625,528)	($424,541)
Added Electricity Cost[2]	$569,396	$438,801	$300,369
Streetlights			
Electricity Cost Savings[3]	($61,433)	($46,074)	($30,716)
Renewable Energy Credits			
Electricity (RECs) Cost[4]	$62,376	$97,854	$133,993
RNG Credits Cost[4]	$132,600	$205,129	$307,624
Fleet			
Fuel Cost Savings[5]	($400,000)	($300,000)	($220,000)
Maintenance Cost Savings[6]	($3,200,000)	($1,700,000)	($1,500,000)
Annual Cost Savings	**($3,700,273)**	**($1,929,819)**	**($1,433,271)**

Notes: Full set of assumptions is provided in Appendix 4.
1. Electricity and natural gas cost savings based on findings from case studies and extrapolated against full building portfolio
2. Added electricity costs based on average kilowatt hour cost from case studies (6.6 cents per kWh)
3. Streetlights savings via Streetlight Master Plan Study; analysis of savings opportunity via utility incentives analysis
4. Electricity RECs assumed at $6 per MWH for new solar generation; RNG Credits assumed at $10 per MMBTU
5. Fuel savings include increased fuel economy, reduced vehicle miles traveled, cost savings from self-generating electricity with on-site solar and the cost savings of grid electricity over other transportation fuels. Annual value. All cost values in today's dollars.
6. Maintenance savings is an estimate based on Evanston's reported 2018 fleet maintenance costs per mile, maintenance cost differentials reported for New York City's electric fleet, and reductions in vehicle miles traveled in each scenario. Annual value.

Finally, costs associated with installation and construction, as well as annual cost savings may depend on timing of implementation. The technology associated with these strategies exists right now, and as such, a number of them could be implemented immediately, particularly those that are not likely to be replaced by emerging technologies by 2035. This may include widely accepted energy efficiency strategies, onsite renewable energy, electric vehicles and even heat pump technology in smaller buildings. As Evanston moves from adoption of this plan to execution of the strategies, it will be incumbent upon those responsible for its implementation to identify the appropriate timeframe for each strategy – which in some cases is likely to be impacted by the financial means to support it, as well as municipal leadership. Table 9 below examines timeframe considerations for each strategy. Immediate references implementation within a year of the ZES adoption, short term from one to two years, medium from two to five years, and long term at giver years and beyond.

Table 8. Implementation Timeframe of Strategies

Strategies	Timeframe	Notes
Buildings and Streetlights		
Rightsizing	Short	With committed municipal leadership and stakeholder engagement, this could occur relatively quickly.
Electrification	Medium to Long	Timeframe may depend on scale of adoption; should be coordinated with other building strategies.
Energy Efficiency	Immediate to Medium	Could begin immediately, but there may be reason to coordinate with electrification and onsite solar, which may lengthen the timing.
Streetlights	Long	Depending on whether full pole replacement is needed versus the challenging payback period due to Evanston's already somewhat efficient lighting, there may be a desire to sideline this for more tangible, upfront savings.
Onsite Solar Energy	Short to Medium	Could be implemented immediately if funding is in place
Offsite Solar Energy	Long	Given the amount of community solar desired to offset City electricity consumption, full implementation will likely require longer term planning and investment; emerging funding opportunities could reduce timeframe.
Fleet Strategies		
Clean Fuel Technologies	Immediate to Long	EV and biofuel vehicle purchases can be initiated almost immediately, but broader fleet purchases and infrastructure investment will require planning and funding alignment; emerging funding opportunities could reduce timeframe.
Fleet Management and Rightsizing	Immediate to Short	Could begin immediately; not contingent upon timing of other fleet strategies.
VMT Reduction	Immediate	Could begin immediately, and aligns quite well with assessing work travel habits as workers return to the workplace; not contingent upon the timing of other fleet strategies.

Section 4. Next Steps

During the development of Evanston ZES, key municipal staff were engaged and consulted throughout the planning process. Building upon this collaborative approach, key City leadership will broaden its engagement among staff, relevant vendors, and other stakeholders to formalize its commitment and path forward to achieving carbon neutrality for municipal operations by 2035.

Operationalize Strategies

Concurrent with broad stakeholder engagement, City leadership will identify existing mechanisms to implement the strategies within the ZES. For example, energy efficiency and renewable energy strategies should be incorporated into the capital planning process with careful input from engineers and facility management staff. Fleet improvements should inform the vehicle replacement program. The successful implementation of strategies will require careful implementation oversight, with clearly identified staff responsible for each strategy who devise interim steps and metrics to gauge progress.

Evaluation and Monitoring

As strategies are operationalized and become a part of staff daily duties and expectations, it is important to establish a regular framework for assessing the overall progress of the ZES. Evaluation will include reporting on metrics for each strategy, identification of successes and challenges, and an overall assessment of progress, with results that are shared with external stakeholders across the community. Many of the strategies involve a departure from years past that will involve new experiences for municipal staff. Capturing both quantitative metrics and qualitative anecdotal experiences of those driving electric vehicles or gauging occupancy comfort and functionality through surveys and other tools will provide important information as part of this evaluation, the latter lending to storytelling that is beneficial for people in the community considering their own carbon footprint. Common timeframes for evaluation include 1-year and 3-year increments.

External Engagement

The City of Evanston will remain engaged in conversations with local and national partners, as well as the host of national and international frameworks that focus on aggressive climate goals and carbon neutrality. These include but are not limited to Carbon Neutral Cities, C40, and Urban Sustainability Directors Network. These relationships continue to provide guidance on best practices and emerging trends in climate mitigation, adaptation, and resiliency.

Financial Support and Implementation

Financing the implementation of the ZES strategies represents a significant investment for the City of Evanston, one that goes above and beyond current operational budgets. There are several options for the City to consider, and the funding mix will likely include multiple sources.

- **Government Subsidy.** As the federal government recommits to climate priorities, there will be unprecedented levels of funding and incentives available. Evanston will stay abreast of these opportunities and aggressively seek support whenever possible.
- **Municipal Green Bonds.** Green bonds or climate bonds function like typical municipal bonds, as a type of loan in which the borrower (in this case, the City) owes the holders (creditors who purchase bonds) a debt in order to fund climate-related projects.
- **Internal Revolving Loan Fund**. Evanston may want to consider establishing an internal revolving loan fund, which function like a regular RLF. An internal RLF is initiated with a set-aside amount of capital funds that pay for specific projects. Funds are "lent" to projects, and the savings from that project are used to repay the RLF, at which point monies can be applied to new projects.
- **Utility Incentives.** Evanston will consider all available utility-based incentives for building and streetlight energy efficiency improvements. It should be noted that said incentives cannot be applied for fuel-switching improvements, however.
- **Cook County C-PACE Program.** Commercial Property Assessed Clean Energy programs allow commercial building owners to finance renewable energy and energy efficiency improvements and some site-specific electric vehicle charging improvements, based on the anticipated energy savings that will be generated by the project. Evanston should examine Cook County's new program to determine if it is possibly a good funding fit for any number of projects.
- **Energy Performance Contracting.** The City can partner with a reputable ESCO (energy service company) to self-finance facility energy improvements utilizing anticipated costs savings that will be achieved in the project.
- **Corporate Philanthropy.** Evanston is a climate leader. The City should consider encouraging corporations or corporate foundations to join them in partnership to fund certain projects as part of the ZES. For example, engaging a heat pump manufacturer to donate technology for one or several buildings, or connecting with the emerging electric vehicle market for heavy duty vehicles. These projects could be in exchange for community partnership and storytelling. Corporations may be inclined to consider such ideas, particularly in communities where motivated constituents could possibly be persuaded to make similar purchases for their own homes.
- **Fee Increase.** The City could increase fees it collects in all or any number of areas.

Appendix 1.
City of Evanston Climate Action Timeline*

2006
- Mayor Lorraine H. Morton signs the **U.S. Mayors Climate Protection Agreement**

2008
- **Evanston Climate Action Plan** is adopted

2009
- **Evanston Climate Action Plan Year 1 Report 2008-2009** is released

2012
- **Evanston Climate Action Plan Update Report** is released

2013
- Achieved goals of the 2008 Evanston Climate Action Plan

2014
- **Evanston Livability Plan** is adopted
- Evanston is named **2015 Earth Hour U.S. Capital** by the World Wildlife Fund

2015
- Mayor Elizabeth Tisdahl signs the **Global Covenant of Mayors**

2016
- Achieved goals of the 2014 Evanston Livability Plan

2017
- Evanston awarded Gold designation through the U.S. Department of Energy's **SolSmart** designation program
- Mayor Stephen H. Hagerty joins the **Mayors for 100% Clean Energy**
- Mayor Stephen H. Hagerty commits to **Paris Climate Accord Emissions Reductions**

2018
- **Evanston Climate Action and Resilience Plan** is adopted
- Evanston is **first city in Illinois to set goal to achieve 100% renewable electricity** by 2030 and carbon neutrality by 2050

2019
- Evanston is **first city in Illinois to be certified as a Community Wildlife Habitat** by the National Wildlife Federation

2020
- Evanston is designated a **Gold Walk Friendly Community** by the Walk Friendly Communities Program
- Evanston's *Learn the Recycling Basics* video wins **Silver** for Not-for-Profit, *Keep Food and Liquids Out of Your Recycling Cart* wins **Silver** for Public Interest/Awareness, **Bronze** for Use of 3D Animation and **Hometown Media Award**

2021
- *Evanston Municipal Operations Zero Emissions Strategy completed*

*as of June 2021

Appendix 2.

Case Study Excerpts for Fire Station #1, Fleetwood Jourdain Community Center, and Service Center

Evanston Fire Station #1

Net Zero Emissions Study

NOTE: This is an excerpt of the full report.

Fire Station #1
1332 Emerson Street
Evanston, IL 60201
Assessment Date: 09/04/202
Final Report: 03/24/2021

Submitted by:
Elevate Energy
322 S. Green Street, Suite 300
Chicago, IL 60607

Executive Summary

Elevate Energy (Elevate) has completed a Net Zero Emissions Study of Evanston's Fire Station #1. Elevate inspected the property, analyzed historical utility bills, and calculated changes in energy use associated with the proposed facility upgrades. Based on these findings, we present several options to achieve net zero emissions. The paths include consideration of energy conservation measures (ECMs), electrification of heating equipment, installation of on-site photovoltaic (PV) systems, development of off-site/community PV projects, virtual power purchase agreements (VPPA), and renewable energy credits (RECs).

This report presents ECMs and includes electrification of equipment that currently use natural gas. Together, these recommended measures will cost $133,100 to implement. It will increase site electricity use from 142,920 kWh to 347,099 kWh and eliminate the use of natural gas. Electrification positions the facility for emissions reductions through direct on-site renewable energy generation, local community solar projects, virtual power purchase agreements (VPPA), and the purchase of renewable energy certificates (RECs).

The facility has sufficient roof area for 3,457 square feet of photovoltaic panels. This PV system will have a 62 kWp nameplate capacity and will provide 71.1 MWh of zero-carbon electricity annually. The panels will meet nearly 21% of electricity use after electrification. This leaves approximately 276 MWh of energy which can be provided by 200 kW of local community solar projects. Alternatively, clean energy can be purchased via a VPPA to offset the energy metered by ComEd. Lastly, RECs may be purchased to offset the carbon emissions associated with the facility's operations.

Descriptions of the seven scenarios and their net present values are presented in the below table. Based on the financial analysis, we recommend pursuing Scenario 1, 4, or 7.

Table 1: Financial Summary of Paths to Net Zero Emissions

	Description	Net Present Value
Scenario 1	ECMs/Electrification, RECs	$(224,887)
Scenario 2	ECMs/Electrification, On-site PV, RECs	$(241,230)
Scenario 3	ECMs/Electrification, On-site PV, Off-site/Community PV	$(261,184)
Scenario 4	ECMs/Electrification, VPPA	$(214,511)
Scenario 5	ECMs/Electrification, On-site PV, VPPA	$(233,243)
Scenario 6	ECMs/Electrification, On-site PV PPA, Off-site/Community PV PPA	$(335,755)
Scenario 7	ECMs/Electrification, On-site PV PPA, VPPA	$(232,767)

A description of recommended ECMs is presented in Section 5. The financial summary of the different paths to net zero is presented in Section 7 and the detailed analysis is provided in the Appendix.

Section 7: Path to Zero Emissions

Proposed Path to Zero Emissions

The proposed path to achieve net-zero emissions follows four main steps:

1) Reduction of facility energy requirements through energy conservation measures
2) Electrification of all loads currently met using natural gas
3) Installation of on-site solar photovoltaic system to meet energy needs
4) Procurement of off-site clean energy for the facility's remaining energy needs

The following section provides more details about why this approach has been chosen and the considerations involved in each step.

Global Warming Impact of Refrigerants

The impact of the global warming potential (GWP) of refrigerant leakage associated with facility operations has not been included in the emissions analysis. In practice, the refrigerant loss should be accounted for when calculating greenhouse gas emissions. However, while refrigerant leakage may eventually occur as equipment ages, the time when the leakage may occur, and the quantity that may leak, are difficult to predict. Leakage will depend on factors such as manufacturing quality, quality of field installation, and maintenance of equipment. The uncertainty associated with this estimation does not help inform the decision-making process. Instead, the recommendations presented below, if implemented, will minimize the impact of refrigerant leakage.

To minimize the impact on facility emissions that may result from potential refrigerant leakage, we recommend identifying and repairing refrigerant leaks instead of replacing lost refrigerant. In addition, when selecting new equipment, we recommend using refrigerants with lower GWP values. These include hydrofluorocarbon (HFCs) and hydrofluoroolefin (HFO) refrigerants. Table 2 below provides a list of current refrigerants and alternative refrigerants with lower GWP values.

Table 2: Current and Alternative Refrigerants

Current Refrigerant / GWP	Alternative Refrigerant / GWP
R-410A / 1,924	R-32 / 677 R-454B / 467 R-466A / 696 R-470A / 909
R-134a / 1,120	R-513A / 573 R-515B / 299 R-1234ze / 1
R-123 / 79	R-514A / 2 R-1234zd / 1

The availability of products that use these lower GWP refrigerants will increase as 2025 approaches, since the state of California will no longer allow the sale of equipment that uses refrigerants that have GWP values greater than 750 beyond that date, and the market will adjust accordingly. In addition, hydrocarbon refrigerants, which have some of the lowest GWP values, cannot currently be used in larger cooling systems due to flammability concerns. As building and safety system codes are updated to address these concerns, larger cooling systems that use these refrigerants will be introduced to the market. In the longer term, equipment using carbon dioxide, ammonia, and water will also become more widely available.

Carbon Offsets and Electrification of Heating Loads

There are multiple paths that an organization may follow to achieve net zero emissions in their operations. For facilities that use fuels on-site that produce carbon emissions, organizations attempting to achieve zero carbon emissions must purchase carbon offsets. Carbon offsets are created by developing a project that prevents CO_2 emissions or acts as a carbon sink. A carbon sink is a long-term carbon store such as a forest. These carbon offsets can be purchased by an organization that produces carbon emissions to, in theory, achieve net zero emissions.

There are several reasons why we do not presently find the use of carbon offsets as part of a viable approach to net zero emissions. The methods currently employed to sequester and store carbon, which underly the purchase of carbon offsets, all suffer from one or more shortcomings, which are briefly explained.

The least expensive and most popular method of carbon sequestration is land reforestation or afforestation. While currently inexpensive, this method is unlikely to remain so as the amount of land available for this activity is limited. As many large organizations have revealed their decarbonization plans in 2020-21, it has become evident that many of them must use carbon offsets since CO_2 emissions cannot be avoided in their operations. As more organizations pursue carbon offsets based on reforestation, the price will quickly increase making this path increasing expensive.

Beyond cost, the amount of CO_2 removed from the atmosphere depends on the stability of the new forest, the mix of different species of trees that are planted, and how the land was previously used. Without intensive care, these newly planted forests may die, which has already happened to some reforested areas. Lastly, parts of the world are already becoming susceptible to the effects of climate change such as wildfires, which places these newly forested areas at risk.

Other potential methods of carbon sequestration include ecosystem restoration, soil capture, biochar, ocean fertilization, ocean alkalinization, direct air carbon capture, and bioenergy with carbon capture and storage. When considering these technologies regarding technological readiness, CO_2 removal potential, cost, permanence of removal, and social/environmental impact, none are currently viable, nor do they appear as if they will be in the near future.

Given these considerations, we recommend that the City of Evanston pursue the electrification of loads currently met with natural gas. For the Community Center, this includes water heating and space heating. As described in Section 5, we recommend replacing the natural gas water heater with a hybrid heat pump water heater and replacing the furnaces with cold-climate air source heat pumps.

Baseline Emissions

To determine the CO_2 equivalent emissions currently emitted due to the facility's energy consumption, the emissions associated with electricity generation and the combustion of the natural gas were calculated and summed. To determine the emissions associated with electricity generation, the carbon intensity value for the RFC West subregion of the EPA's Emissions and Generation Resource Integrated Database (156.07 kg per million BTUs) was multiplied by the annual electricity use of 224,493 kWh. To determine the natural gas associated emissions, the carbon intensity value of natural gas combustion (53.11 kg per million BTUs) was multiplied by the annual natural gas use of 23,396 therms. Based on 2019 utility data, the total CO_2 equivalent emissions for the facility are 243,776 kg.

Energy Conservation and Electrification Measures

The schedule for implementation of the proposed energy conservation and electrification measures should consider the age of the existing equipment being replaced, the 2035 target date to achieve net-zero emissions, and considerations of price decreases that can be expected as some of the recommended technologies mature in the marketplace. Based on consideration of these factors, the following implementation schedule is recommended.

Table 3: Recommended ECM/Electrification Implementation Schedule

Energy Conservation Measures	Year of Implementation	Justification
ECM 1 – Improve Building Tightness	2021	- Immediate reduction in energy use
ECM 2 - Replace Existing Lamps with LED Lamps	2021	- Immediate reduction in energy use - Improved lighting quality
ECM 3 – Replace AHU with ASHP AHU	2035	- The AHUs are currently 3 years old and have a service life of 25 years. We recommend operating them for as long as possible and therefore replacing them at the latest possible date.
ECM 4 – Replace Existing Boiler with Electric Resistance Boiler	2035	- The hot water boilers are 3 years old. They have a service life of about 20 years. We recommend replacing them at the latest possible date.
ECM 5 – Replace Hot Water Heaters with ASHP Water Heaters	2031	- Recommend replacement upon failure of existing equipment (assumed 2031)

On-site Photovoltaic System

Based on the solar analysis included in the Appendix, the facility can accommodate a 200.8 kWp photovoltaic system, which can generate 243.9 MWh of electricity per year. The cost of the on-site system is estimated at $431,720. As part of the path to net-zero emissions, for some scenarios we estimate installation of the on-site PV system in 2026 to offset the site energy use. At this time, we estimate the system will cost 70% of the current cost or $302,204. If the City of Evanston decides to implement all the recommended measures and fully electrify the building, the on-site solar would generate enough electricity to meet approximately 31% of the annual energy use.

Alternatively, the on-site PV system could be financed under a power purchase agreement (PPA). Under a PPA, the City of Evanston would pay nothing for the PV system installation or maintenance but would agree to purchase the electricity that the system produces for the life of the system. We assume that the developer would require a 10-year simple payback period for the investment. Using the system cost provided above and assuming that no financial incentives are available and that the RECs associated with the energy production are retained by the City, the cost of electricity would be $0.1287/kWh.

Off-site Photovoltaic System and Renewable Energy Credits

Two accounting approaches are considered for the purposes of determining the amount of off-site renewable energy that must be purchased in addition to the solar energy produced on-site. These include 1) an approach described in ASHRAE-189.1-2017, *Standard for the Design of High-Performance Green Buildings,* and 2) an approach described in the Passive House Institute of the United States (PHIUS) SourceZero.

Based on ASHRAE 189.1-2017, the remaining energy needs can be met through off-site renewable energy generation, community solar projects, and virtual power purchase agreements (VPPA). Under a VPPA, the City would pay a fixed price for the energy that is generated by a power plant and the associated renewable energy certificate (REC) that result from that power generation. If the ASHRAE methodology is followed, only 75% of the energy purchase counts towards the energy use by the building. In other words, for every kilowatt-hour of electricity metered by the utility, 1.33 kWh must be purchased from these off-site renewable energy plants. The cost of electricity purchased under the VPPA is assumed to be the same as the current cost of electricity for the facility.

If the PHIUS SourceZero approach is used, the same energy sources (off-site renewable energy generation, community solar projects, and virtual power purchase agreements) and factor (0.75 or 75%) that are described in ASHRAE 189.1 apply. However, the PHIUS SourceZero approach also allows for the purchase of renewable energy certificates (RECs) with a 20% factor applied. These differ from a VPPA in that the clean energy underlying the creation of the REC is not purchased. Therefore, if this approach is considered, 5 kWh of RECs will be purchased for every 1 kWh metered by the utility. The cost per REC is estimated to be $6.00/MWh or $0.006/kWh.

The off-site PV system required to meet all remaining energy needs has a nameplate capacity of 585 kWp and estimated cost of approximately $1,257,000. As part of the path to net-zero emissions, for some scenarios we estimate installation of the on-site PV system in 2026. At that time, we estimate the system will cost 70% of the current cost or $880,425.

Like the on-site PV system, the off-site PV systems could be financed under a PPA and the same cost of electricity as the on-site system is assumed in the scenarios where an off-site PPA is considered.

Energy, Financial, and CO_2e Emissions Analyses

Financial analyses were performed comparing seven different scenarios to achieve net-zero emissions. A description of the scenarios and resulting net present values are provided in Table 4. The assumptions and calculations for the different scenarios are provided in the Appendix.

Table 4: Financial Summary of Path to Net Zero Emissions

	Description	Net Present Value
Scenario 1	ECMs/Electrification, RECs	$(434,397)
Scenario 2	ECMs/Electrification, City Owned On-site PV, RECs	$(497,249)
Scenario 3	ECMs/Electrification, City Owned On-site PV, City Owned Off-site/Community PV	$(686,661)
Scenario 4	ECMs/Electrification, VPPA	$(408,197)
Scenario 5	ECMs/Electrification, On-site PV, VPPA	$(480,917)
Scenario 6	ECMs/Electrification, On-site PV PPA, Off-site/community PV PPA	$(625,827)
Scenario 7	ECMs/Electrification, On-site PV PPA, VPPA	$(465,166)

Figure 1 shows the change in electricity and natural gas use over time due to energy conservation measure implementation and electrification based on the implementation schedule shown in **Error! Reference source not found.**. This implementation schedule is the same for all scenarios. Initially, the site electricity use decreases because of the weatherization and lighting projects, but eventually increases when the heating loads are electrified in 2035.

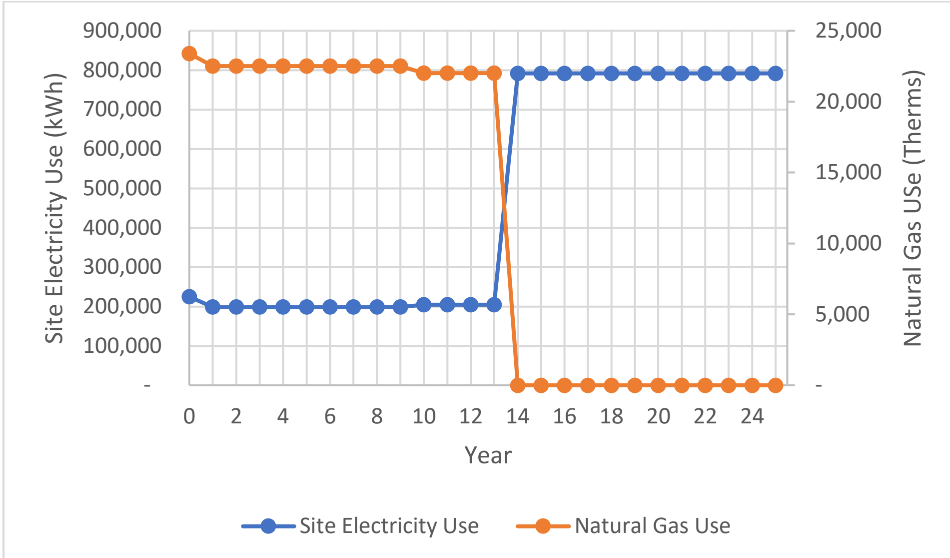

Figure 1: Site Electricity Use and Natural Gas Use over Time

Figure 2 illustrates the path to net zero emissions based on the recommended scenarios. These are scenarios 1, 4, and 7, which have the highest net present value. Under scenario 1, in year 1, ECM 1 and ECM 2 are implemented, and RECs are purchased for all electricity use. In years 3 through 5, RECs are purchased for one third of the electricity purchased from the utility. In years 6 through 8, RECs are purchased for two thirds of the electricity purchased from the utility. In year 9 and beyond, RECs are purchased for all electricity purchased from the grid. In year 10, ECM 5 is implemented. Finally, in year 14, ECMs 3 and 4 are implemented, all natural gas-fired equipment is eliminated, and the building reaches its net-zero emission target.

Under scenario 4, ECMs are implemented as described above. Beginning in year 3, one third of electricity is procured via a VPPA. In year 6, two thirds of electricity is procured via the VPPA. In year 9, all electricity is procured via VPPA. Finally, in year 14, ECMs 3 and 4 are implemented, the natural gas-fired equipment is retired, and the building reaches its net-zero emission target.

Under scenario 7, the same path as scenario 4 is followed except that an on-site PV system is installed in year 5 and all electricity not provided by the PV system is procured via VPPA beginning in year 5. The PV installation is financed using a PPA.

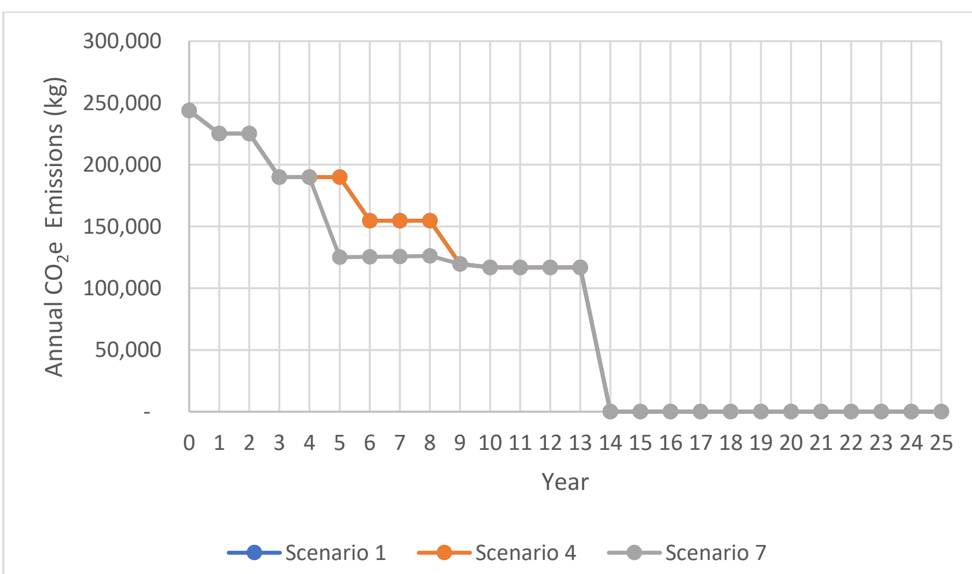

Figure 2: Source CO2e Emissions over Time

Figure 3 illustrates the annual additional expenditures above the current utility costs that will be required to implement the three scenarios and Table 5 provides the implementation costs and the annual operating costs before and after implementation of the measures to achieve net-zero emissions.

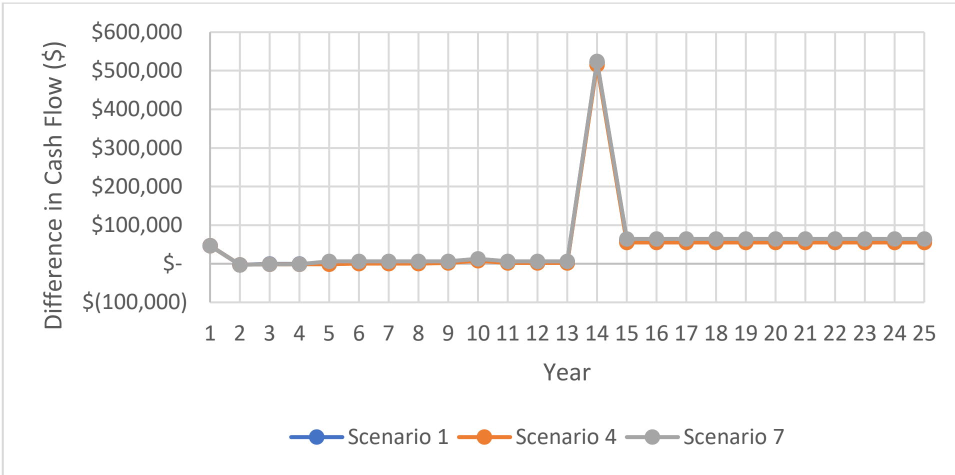

Figure 3: Change in Annual Expenditures over 25 yr. Period

Table 5: Net-zero Emission Implementation and Operating Costs

Scenario	Total Implementation Cost	Annual Operating Costs before Implementation (2019)	Annual Operating Cost after Implementation
1	$515,750	$34,341	$95,484
4	$515,750		$89,546
7	$515,750		$98,771

Evanston Fleetwood-Jourdain Center

Net Zero Emissions Study

NOTE: This is an excerpt of the full report.

Fleetwood Community Center
1655 Foster Street
Evanston, IL 60201

Assessment Date: 09/03/2020

Final Report: 03/24/2021

Submitted by:
Elevate Energy
322 S. Green Street, Suite 300
Chicago, IL 60607

ELEVATE ENERGY
Smarter energy use for all

Executive Summary

Elevate Energy (Elevate) has completed a Net Zero Emissions Study for Evanston's Fleetwood Jourdain Community Center. Elevate inspected the property, analyzed historical utility bills, and calculated changes in energy use associated with the proposed facility upgrades. Based on these findings, we present several options to achieve net zero emissions. The paths include consideration of energy conservation measures (ECMs), electrification of heating equipment, installation of on-site photovoltaic (PV) systems, development of off-site/community PV projects, virtual power purchase agreements (VPPA), and renewable energy credits (RECs).

This report presents ECMs, which include electrification of equipment that currently use natural gas. Together, these recommended measures will cost between $457,000 and $574,500 to implement and will increase site electricity use from 224,493 kWh to 791,809 kWh and eliminate the use of natural gas. Electrification positions the facility for emissions reductions through direct on-site renewable energy generation, local community solar projects, virtual power purchase agreements (VPPA), and the purchase of renewable energy certificates (RECs).

The facility has sufficient roof area for 11,195 square feet of photovoltaic panels. This PV system will have a 200.8 kWp nameplate capacity and will provide 243.9 MWh of zero-carbon electricity annually. The panels will meet nearly 31% of electricity use after electrification. This leaves approximately 550 MWh of energy which can be provided by 585 kW of local community solar projects. Alternatively, clean energy can be purchased via a VPPA to offset the energy metered by ComEd. Lastly, RECs may be purchased to offset the carbon emissions associated with the facility's operations.

Descriptions of the seven scenarios and their net present values are presented in the below table. Based on the financial analysis, we recommend pursuing Scenario 1, 4 or 7.

Table 6: Financial Summary of Paths to Net Zero Emissions

	Description	Net Present Value
Scenario 1	ECMs/Electrification, RECs	$(434,397)
Scenario 2	ECMs/Electrification, On-site PV, RECs	$(497,249)
Scenario 3	ECMs/Electrification, On-site PV, Off-site/Community PV	$(686,661)
Scenario 4	ECMs/Electrification, On-site PV, VPPA	$(408,197)
Scenario 5	ECMs/Electrification, VPPA	$(480,917)
Scenario 6	ECMs/Electrification, On-site PV PPA, Off-site/Community PV PPA	$(625,827)
Scenario 7	ECMs/Electrification, On-site PV PPA, VPPA	$(465,166)

A description of recommended ECMs is presented in Section 5. The financial summary of the different paths to net zero is presented in Section 7.

Section 7: Path to Zero Emissions

Proposed Path to Zero Emissions

The proposed path to achieve net-zero emissions follows four main steps:

1) Reduction of facility energy requirements through energy conservation measures

2) Electrification of all loads currently met using natural gas

3) Installation of on-site solar photovoltaic system to meet energy needs

4) Procurement of off-site clean energy for the facility's remaining energy needs

The following section provides more details about why this approach has been chosen and the considerations involved in each step.

Global Warming Impact of Refrigerants

The impact of the global warming potential (GWP) of refrigerant leakage associated with facility operations has not been included in the emissions analysis. In practice, the refrigerant loss should be accounted for when calculating greenhouse gas emissions. However, while refrigerant leakage may eventually occur as equipment ages, the time when the leakage may occur, and the quantity that may leak, are difficult to predict. Leakage will depend on factors such as manufacturing quality, quality of field installation, and maintenance of equipment. The uncertainty associated with this estimation does not help inform the decision-making process. Instead, the recommendations presented below, if implemented, will minimize the impact of refrigerant leakage.

To minimize the impact on facility emissions that may result from potential refrigerant leakage, we recommend identifying and repairing refrigerant leaks instead of replacing lost refrigerant. In addition, when selecting new equipment, we recommend using refrigerants with lower GWP values. These include hydrofluorocarbon (HFCs) and hydrofluoroolefin (HFO) refrigerants. Table 2 below provides a list of current refrigerants and alternative refrigerants with lower GWP values.

Table 7: Current and Alternative Refrigerants

Current Refrigerant / GWP	Alternative Refrigerant / GWP
R-410A / 1,924	R-32 / 677 R-454B / 467 R-466A / 696 R-470A / 909
R-134a / 1,120	R-513A / 573 R-515B / 299 R-1234ze / 1
R-123 / 79	R-514A / 2 R-1234zd / 1

The availability of products that use these lower GWP refrigerants will increase as 2025 approaches, since the state of California will no longer allow the sale of equipment that uses refrigerants that have GWP values greater than 750 beyond that date, and the market will adjust accordingly. In addition, hydrocarbon refrigerants, which have some of the lowest GWP values, cannot currently be used in larger cooling systems due to flammability concerns. As building and safety system codes are updated to address these concerns, larger cooling systems that use these refrigerants will be introduced to the market. In the longer term, equipment using carbon dioxide, ammonia, and water will also become more widely available.

Carbon Offsets and Electrification of Heating Loads

There are multiple paths that an organization may follow to achieve net zero emissions in their operations. For facilities that use fuels on-site that produce carbon emissions, organizations attempting to achieve zero carbon emissions must purchase carbon offsets. Carbon offsets are created by developing a project that prevents CO_2 emissions or acts as a carbon sink. A carbon sink is a long-term carbon store such as a forest. These carbon offsets can be purchased by an organization that produces carbon emissions to, in theory, achieve net zero emissions.

There are several reasons why we do not presently find the use of carbon offsets as part of a viable approach to net zero emissions. The methods currently employed to sequester and store carbon, which underly the purchase of carbon offsets, all suffer from one or more shortcomings, which are briefly explained.

The least expensive and most popular method of carbon sequestration is land reforestation or afforestation. While currently inexpensive, this method is unlikely to remain so as the amount of land available for this activity is limited. As many large organizations have revealed their decarbonization plans in 2020-21, it has become evident that many of them must use carbon offsets since CO_2 emissions cannot be avoided in their operations. As more organizations pursue carbon offsets based on reforestation, the price will quickly increase making this path increasing expensive.

Beyond cost, the amount of CO_2 removed from the atmosphere depends on the stability of the new forest, the mix of different species of trees that are planted, and how the land was previously used. Without intensive care, these newly planted forests may die, which has already happened to some reforested areas. Lastly, parts of the world are already becoming susceptible to the effects of climate change such as wildfires, which places these newly forested areas at risk.

Other potential methods of carbon sequestration include ecosystem restoration, soil capture, biochar, ocean fertilization, ocean alkalinization, direct air carbon capture, and bioenergy with carbon capture and storage. When considering these technologies regarding technological readiness, CO_2 removal potential, cost, permanence of removal, and social/environmental impact, none are currently viable, nor do they appear as if they will be in the near future.

Given these considerations, we recommend that the City of Evanston pursue the electrification of loads currently met with natural gas. For the Community Center, this includes water heating and space heating. As described in Section 5, we recommend replacing the natural gas water heater with a hybrid heat pump water heater and replacing the furnaces with cold-climate air source heat pumps.

Baseline Emissions

To determine the CO_2 equivalent emissions currently emitted due to the facility's energy consumption, the emissions associated with electricity generation and the combustion of the natural gas were calculated and summed. To determine the emissions associated with electricity generation, the carbon intensity value for the RFC West subregion of the EPA's Emissions and Generation Resource Integrated Database (156.07 kg per million BTUs) was multiplied by the annual electricity use of 224,493 kWh. To determine the natural gas associated emissions, the carbon intensity value of natural gas combustion (53.11 kg per million BTUs) was multiplied by the annual natural gas use of 23,396 therms. Based on 2019 utility data, the total CO_2 equivalent emissions for the facility are 243,776 kg.

Energy Conservation and Electrification Measures

The schedule for implementation of the proposed energy conservation and electrification measures should consider the age of the existing equipment being replaced, the 2035 target date to achieve net-zero emissions, and considerations of price decreases that can be expected as some of the recommended technologies mature in the marketplace. Based on consideration of these factors, the following implementation schedule is recommended.

Table 8: Recommended ECM/Electrification Implementation Schedule

Energy Conservation Measures	Year of Implementation	Justification
ECM 1 – Improve Building Tightness	2021	- Immediate reduction in energy use
ECM 2 - Replace Existing Lamps with LED Lamps	2021	- Immediate reduction in energy use - Improved lighting quality
ECM 3 – Replace AHU with ASHP AHU	2035	- The AHUs are currently 3 years old and have a service life of 25 years. We recommend operating them for as long as possible and therefore replacing them at the latest possible date.
ECM 4 – Replace Existing Boiler with Electric Resistance Boiler	2035	- The hot water boilers are 3 years old. They have a service life of about 20 years. We recommend replacing them at the latest possible date.
ECM 5 – Replace Hot Water Heaters with ASHP Water Heaters	2031	- Recommend replacement upon failure of existing equipment (assumed 2031)

On-site Photovoltaic System

Based on the solar analysis included in the Appendix, the facility can accommodate a 200.8 kWp photovoltaic system, which can generate 243.9 MWh of electricity per year. The cost of the on-site system is estimated at $431,720. As part of the path to net-zero emissions, for some scenarios we estimate installation of the on-site PV system in 2026 to offset the site energy use. At this time, we estimate the system will cost 70% of the current cost or $302,204. If the City of Evanston decides to implement all the recommended measures and fully electrify the building, the on-site solar would generate enough electricity to meet approximately 31% of the annual energy use.

Alternatively, the on-site PV system could be financed under a power purchase agreement (PPA). Under a PPA, the City of Evanston would pay nothing for the PV system installation or maintenance but would agree to purchase the electricity that the system produces for the life of the system. We assume that the developer would require a 10-year simple payback period for the investment. Using the system cost provided above and assuming that no financial incentives are available and that the RECs associated with the energy production are retained by the City, the cost of electricity would be $0.1287/kWh.

Off-site Photovoltaic System and Renewable Energy Credits

Two accounting approaches are considered for the purposes of determining the amount of off-site renewable energy that must be purchased in addition to the solar energy produced on-site. These include 1) an approach described in ASHRAE-189.1-2017, *Standard for the Design of High-Performance Green Buildings,* and 2) an approach described in the Passive House Institute of the United States (PHIUS) SourceZero.

Based on ASHRAE 189.1-2017, the remaining energy needs can be met through off-site renewable energy generation, community solar projects, and virtual power purchase agreements (VPPA). Under a VPPA, the City would pay a fixed price for the energy that is generated by a power plant and the associated renewable energy certificate (REC) that result from that power generation. If the ASHRAE methodology is followed, only 75% of the energy purchase counts towards the energy use by the building. In other words, for every kilowatt-hour of electricity metered by the utility, 1.33 kWh must be purchased from these off-site renewable energy plants. The cost of electricity purchased under the VPPA is assumed to be the same as the current cost of electricity for the facility.

If the PHIUS SourceZero approach is used, the same energy sources (off-site renewable energy generation, community solar projects, and virtual power purchase agreements) and factor (0.75 or 75%) that are described in ASHRAE 189.1 apply. However, the PHIUS SourceZero approach also allows for the purchase of renewable energy certificates (RECs) with a 20% factor applied. These differ from a VPPA in that the clean energy underlying the creation of the REC is not purchased. Therefore, if this approach is considered, 5 kWh of RECs will be purchased for every 1 kWh metered by the utility. The cost per REC is estimated to be $6.00/MWh or $0.006/kWh.

The off-site PV system required to meet all remaining energy needs has a nameplate capacity of 585 kWp and estimated cost of approximately $1,257,000. As part of the path to net-zero emissions, for some scenarios we estimate installation of the on-site PV system in 2026. At that time, we estimate the system will cost 70% of the current cost or $880,425.

Like the on-site PV system, the off-site PV systems could be financed under a PPA and the same cost of electricity as the on-site system is assumed in the scenarios where an off-site PPA is considered.

Energy, Financial, and CO_2e Emissions Analyses

Financial analyses were performed comparing seven different scenarios to achieve net-zero emissions. A description of the scenarios and resulting net present values are provided in Table 4. The assumptions and calculations for the different scenarios are provided in the Appendix.

Table 9: Financial Summary of Path to Net Zero Emissions

	Description	Net Present Value
Scenario 1	ECMs/Electrification, RECs	$(434,397)
Scenario 2	ECMs/Electrification, City Owned On-site PV, RECs	$(497,249)
Scenario 3	ECMs/Electrification, City Owned On-site PV, City Owned Off-site/Community PV	$(686,661)
Scenario 4	ECMs/Electrification, VPPA	$(408,197)
Scenario 5	ECMs/Electrification, On-site PV, VPPA	$(480,917)
Scenario 6	ECMs/Electrification, On-site PV PPA, Off-site/community PV PPA	$(625,827)
Scenario 7	ECMs/Electrification, On-site PV PPA, VPPA	$(465,166)

Figure 1 shows the change in electricity and natural gas use over time due to energy conservation measure implementation and electrification based on the implementation schedule shown in **Error! Reference source not found.**. This implementation schedule is the same for all scenarios. Initially, the site electricity use decreases because of the weatherization and lighting projects, but eventually increases when the heating loads are electrified in2035.

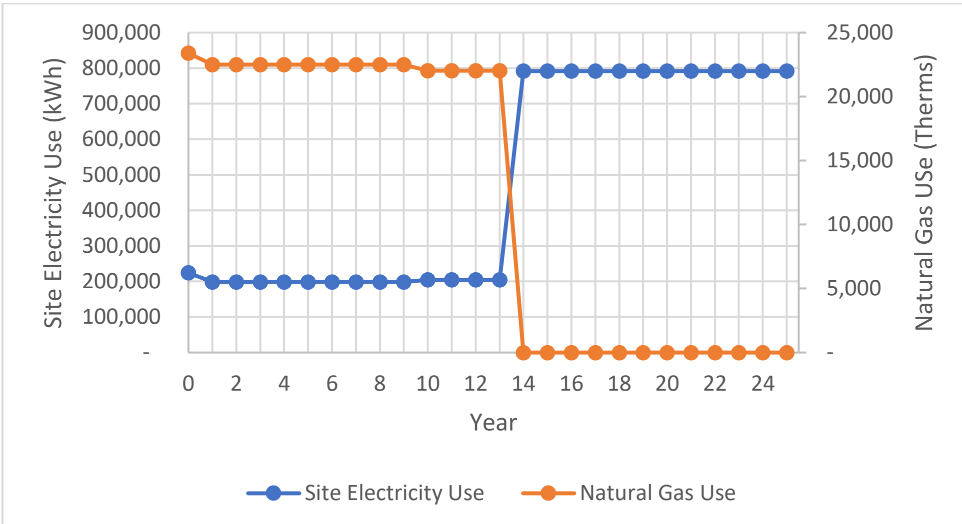

Figure 4: Site Electricity Use and Natural Gas Use over Time

Figure 2 illustrates the path to net zero emissions based on the recommended scenarios. These are scenarios 1, 4, and 7, which have the highest net present value. Under scenario 1, in year 1, ECM 1 and ECM 2 are implemented, and RECs are purchased for all electricity use. In years 3 through 5, RECs are purchased for one third of the electricity purchased from the utility. In years 6 through 8, RECs are purchased for two thirds of the electricity purchased from the utility. In year 9 and beyond, RECs are purchased for all electricity purchased from the grid. In year 10, ECM 5 is implemented. Finally, in year 14, ECMs 3 and 4 are implemented, all natural gas-fired equipment is eliminated, and the building reaches its net-zero emission target.

Under scenario 4, ECMs are implemented as described above. Beginning in year 3, one third of electricity is procured via a VPPA. In year 6, two thirds of electricity is procured via the VPPA. In year 9, all electricity is procured via VPPA. Finally, in year 14, ECMs 3 and 4 are implemented, the natural gas-fired equipment is retired, and the building reaches its net-zero emission target.

Under scenario 7, the same path as scenario 4 is followed except that an on-site PV system is installed in year 5 and all electricity not provided by the PV system is procured via VPPA beginning in year 5. The PV installation is financed using a PPA.

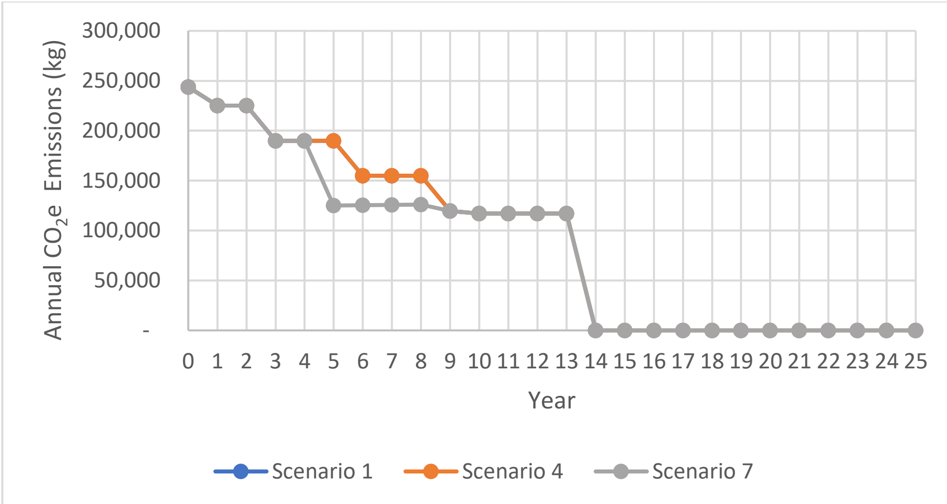

Figure 5: Source CO2e Emissions over Time

Figure 3 illustrates the annual additional expenditures above the current utility costs that will be required to implement the three scenarios and Table 5 provides the implementation costs and the annual operating costs before and after implementation of the measures to achieve net-zero emissions.

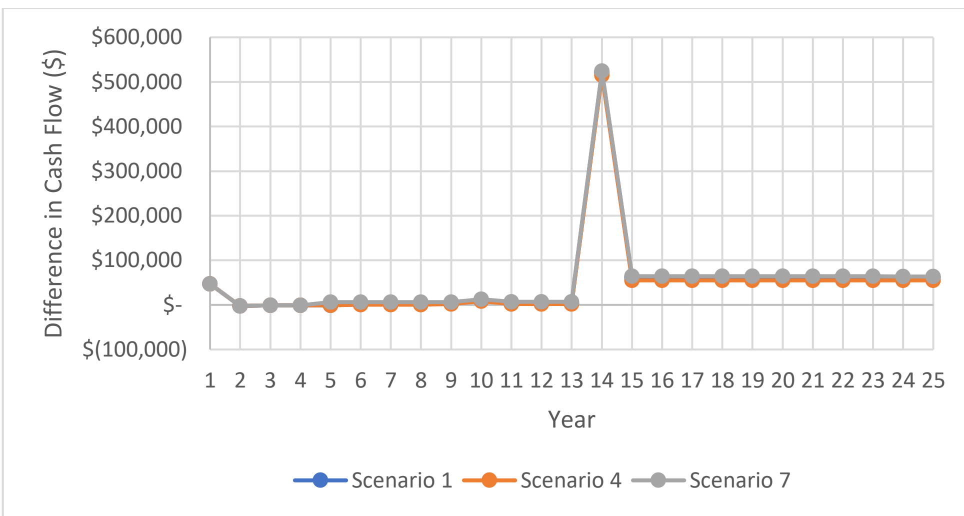

Figure 6: Change in Annual Expenditures over 25 yr. Period

Table 10: Net-zero Emission Implementation and Operating Costs

Scenario	Total Implementation Cost	Annual Operating Costs before Implementation (2019)	Annual Operating Cost after Implementation
1	$515,750	$34,341	$95,484
4	$515,750		$89,546
7	$515,750		$98,771

Evanston Service Center

Net Zero Emissions Study

NOTE: This is an excerpt of the full report.

Evanston Service Center
2020 Asbury Avenue
Evanston, IL 60201

Assessment Date: 09/10/2020 and 09/23/2020

Final Report: 03/24/2021

Submitted by:
Elevate Energy
322 S. Green Street, Suite 300
Chicago, IL 60607

ELEVATE ENERGY
Smarter energy use for all

Executive Summary

Elevate Energy (Elevate) has completed a Net Zero Emissions Study for Evanston's Service Center. We inspected the property, analyzed historical utility bills, and calculated changes in energy use associated with the proposed facility upgrades. Based on these findings, we present several options to achieve net zero emissions. The paths include consideration of energy conservation measures (ECMs), electrification of heating equipment, installation of on-site photovoltaic (PV) systems, development of off-site/community PV projects, virtual power purchase agreements (VPPA), and renewable energy credits (RECs).

This report presents ECMs, which include electrification of equipment that currently use natural gas. Together, these recommended measures will cost approximately $1.8 to $2.2 million to implement and will increase site electricity use from 1,162,704 kWh to 2,593,024 kWh (based on 2019 baseline) and eliminate the use of natural gas. Electrification positions the facility for emissions reductions through direct on-site renewable energy generation, local community solar projects, virtual power purchase agreements (VPPA), and the purchase of renewable energy certificates (RECs).

The facility has sufficient roof area for 47,746 square feet of photovoltaic panels. This PV system will have an 856 kWp nameplate capacity and will provide 1,161 MWh of zero-carbon electricity annually. The panels will meet nearly 38% of electricity use after electrification. This leaves approximately 2,197 MWh of energy which can be provided by 2 MW of local community solar projects. Alternatively, clean energy can be purchased via a VPPA to offset the energy metered by ComEd. Lastly, RECs may be purchased to offset the carbon emissions associated with the facility's operations.

Descriptions of the seven scenarios and their net present values are presented in the below table. Based on the financial analysis, we recommend pursuing Scenario 1, 4 or 7.

Table 11: Financial Summary of Paths to Net Zero Emissions

	Description	Net Present Value
Scenario 1	ECMs/Electrification, RECs	$(1,994,480)
Scenario 2	ECMs/Electrification, On-site PV, RECs	$(2,430.588)
Scenario 3	ECMs/Electrification, On-site PV, Off-site/Community PV	$(3,433,160)
Scenario 4	ECMs/Electrification, On-site PV, VPPA	$(1,813,966)
Scenario 5	ECMs/Electrification, VPPA	$(2,319,880)
Scenario 6	ECMs/Electrification, On-site PV PPA, Off-site/Community PV PPA	$(2,991,735)
Scenario 7	ECMs/Electrification, On-site PV PPA, VPPA	$(2,242,740)

A description of recommended ECMs is presented in Section 5. The financial summary of the different paths to net zero is presented in Section 7.

Section 7: Path to Zero Emissions

Proposed Path to Zero Emissions

The proposed path to achieve net-zero emissions follows four main steps:

1) Reduction of facility energy requirements through energy conservation measures
2) Electrification of all loads currently met using natural gas
3) Installation of on-site solar photovoltaic system to meet energy needs
4) Procurement of off-site clean energy for the facility's remaining energy needs

The following section provides more details about why this approach has been chosen and the considerations involved in each step.

Global Warming Impact of Refrigerants

The impact of the global warming potential (GWP) of refrigerant leakage associated with facility operations has not been included in the emissions analysis. In practice, the refrigerant loss should be accounted for when calculating greenhouse gas emissions. However, while refrigerant leakage may eventually occur as equipment ages, the time when the leakage may occur, and the quantity that may leak, are difficult to predict. Leakage will depend on factors such as manufacturing quality, quality of field installation, and maintenance of equipment. The uncertainty associated with this estimation does not help inform the decision-making process. Instead, the recommendations presented below, if implemented, will minimize the impact of refrigerant leakage.

To minimize the impact on facility emissions that may result from potential refrigerant leakage, we recommend identifying and repairing refrigerant leaks instead of replacing lost refrigerant. In addition, when selecting new equipment, we recommend using refrigerants with lower GWP values. These include hydrofluorocarbon (HFCs) and hydrofluoroolefin (HFO) refrigerants. Table 2 below provides a list of current refrigerants and alternative refrigerants with lower GWP values.

Table 12: Current and Alternative Refrigerants

Current Refrigerant / GWP	Alternative Refrigerant / GWP
R-410A / 1,924	R-32 / 677 R-454B / 467 R-466A / 696 R-470A / 909
R-134a / 1,120	R-513A / 573 R-515B / 299 R-1234ze / 1
R-123 / 79	R-514A / 2 R-1234zd / 1

The availability of products that use these lower GWP refrigerants will increase as 2025 approaches, since the state of California will no longer allow the sale of equipment that uses refrigerants that have GWP values greater than 750 beyond that date, and the market will adjust accordingly. In addition, hydrocarbon refrigerants, which have some of the lowest GWP values, cannot currently be used in larger cooling systems due to flammability concerns. As building and safety system codes are updated to address these concerns, larger cooling systems that use these refrigerants will be introduced to the market. In the longer term, equipment using carbon dioxide, ammonia, and water will also become more widely available.

Carbon Offsets and Electrification of Heating Loads

There are multiple paths that an organization may follow to achieve net zero emissions in their operations. For facilities that use fuels on-site that produce carbon emissions, organizations attempting to achieve zero carbon emissions must purchase carbon offsets. Carbon offsets are created by developing a project that prevents CO_2 emissions or acts as a carbon sink. A carbon sink is a long-term carbon store such as a forest. These carbon offsets can be purchased by an organization that produces carbon emissions to, in theory, achieve net zero emissions.

There are several reasons why we do not presently find the use of carbon offsets as part of a viable approach to net zero emissions. The methods currently employed to sequester and store carbon, which underly the purchase of carbon offsets, all suffer from one or more shortcomings, which are briefly explained.

The least expensive and most popular method of carbon sequestration is land reforestation or afforestation. While currently inexpensive, this method is unlikely to remain so as the amount of land available for this activity is limited. As many large organizations have revealed their decarbonization plans in 2020-21, it has become evident that many of them must use carbon offsets since CO_2 emissions cannot be avoided in their operations. As more organizations pursue carbon offsets based on reforestation, the price will quickly increase making this path increasing expensive.

Beyond cost, the amount of CO_2 removed from the atmosphere depends on the stability of the new forest, the mix of different species of trees that are planted, and how the land was previously used. Without intensive care, these newly planted forests may die, which has already happened to some reforested areas. Lastly, parts of the world are already becoming susceptible to the effects of climate change such as wildfires, which places these newly forested areas at risk.

Other potential methods of carbon sequestration include ecosystem restoration, soil capture, biochar, ocean fertilization, ocean alkalinization, direct air carbon capture, and bioenergy with carbon capture and storage. When considering these technologies regarding technological readiness, CO_2 removal potential, cost, permanence of removal, and social/environmental impact, none are currently viable, nor do they appear as if they will be in the near future.

Given these considerations, we recommend that the City of Evanston pursue the electrification of loads currently met with natural gas. For the Service Center, this includes water heating and space heating. As described in Section 5, we recommend replacing the natural gas water heater with a hybrid heat pump water heater and replacing the furnaces with cold-climate air source heat pumps.

Baseline Emissions

To determine the CO_2 equivalent emissions currently emitted due to the facility's energy consumption, the emissions associated with electricity generation and the combustion of the natural gas were calculated and summed. To determine the emissions associated with electricity generation, the carbon intensity value for the RFC West subregion of the EPA's Emissions and Generation Resource Integrated Database (156.07 kg per million BTUs) was multiplied by the annual electricity use of 1,162,704 kWh. To determine the natural gas associated emissions, the carbon intensity value of natural gas combustion (53.11 kg per million BTUs) was multiplied by the annual natural gas use of 101,140 therms. Based on 2019 utility data, the total CO_2 equivalent emissions for the facility is 1,156,307 kg.

Energy Conservation and Electrification Measures

The schedule for implementation of the proposed energy conservation and electrification measures should consider the age of the existing equipment being replaced, the 2035 target date to achieve net-zero emissions, and considerations of price decreases that can be expected as some of the recommended technologies mature in the marketplace. Based on consideration of these factors, the following implementation schedule is recommended.

Table 13: Recommended ECM/Electrification Implementation Schedule

Energy Conservation Measures	Year of Implementation	Justification
ECM 1 – Improve Building Tightness	2021	- Immediate reduction in energy use
ECM 2 - Replace Existing Lamps with LED Lamps	2021	- Immediate reduction in energy use - Improved lighting quality
ECM 3 – Replace AHUs with ASHP AHUs	2026	- Condensing units are currently 14-20 years old and will likely need replacement in the next 5 years. - Lower GWP refrigerants should be available at this time.
ECM 4 – Electrify Radiant Heaters, Fan Coil Units, Unit Heaters, and Baseboards	2031	- Boiler is 16 years old and should last another 10 years. We recommend replacing at that time.
ECM 5 – Replace Water Heater with Air Source Heat Pump Water Heaters	2031	- Replace upon failure of the existing water heaters - Most of the existing water heaters are newer and lower GWP refrigerants should be available at time of replacement

On-site Photovoltaic System

Based on the solar analysis included in the Appendix, the facility can accommodate an 856 kWp photovoltaic system, which can generate 1,161 MWh of electricity per year. The cost of the on-site system is estimated at $2,240,000. As part of the path to net-zero emissions, for some scenarios we assume installation of half of the on-site PV system in 2026 and the other half in 2031. We estimate the system will cost 70% of the current cost or $1,568,000. If the City of Evanston decides to implement all the recommended measures and fully electrify the building, the on-site solar would generate enough electricity to meet approximately 38% of the annual energy use.

Alternatively, the on-site PV system could be financed under a power purchase agreement (PPA). Under a PPA, the City of Evanston would pay nothing for the PV system installation or maintenance but would agree to purchase the electricity that the system produces for the life of the system. We assume that the developer would require a 10-year simple payback period for the investment. Using the system cost provided above and assuming that no financial incentives are available and that the RECs associated with the energy production are retained by the City, the cost of electricity would be $0.1287/kWh.

Off-site Photovoltaic System and Renewable Energy Credits

Two accounting approaches are considered for the purposes of determining the amount of off-site renewable energy that must be purchased in addition to the solar energy produced on-site. These include 1) an approach described in ASHRAE-189.1-2017, *Standard for the Design of High-Performance Green Buildings,* and 2) an approach described in the Passive House Institute of the United States (PHIUS) SourceZero.

Based on ASHRAE 189.1-2017, the remaining energy needs can be met through off-site renewable energy generation, community solar projects, and virtual power purchase agreements (VPPA). Under a VPPA, the City would pay a fixed price for the energy that is generated by a power plant and the associated renewable energy certificate (REC) that result from that power generation. If the ASHRAE methodology is followed, only 75% of the energy purchase counts towards the energy use by the building. In other words, for every kilowatt-hour of electricity metered by the utility, 1.33 kWh must be purchased from these off-site renewable energy plants. The cost of electricity purchased under the VPPA is assumed to be the same as the current cost of electricity for the facility.

If the PHIUS SourceZero approach is used, the same energy sources (off-site renewable energy generation, community solar projects, and virtual power purchase agreements) and factor (0.75 or 75%) that are described in ASHRAE 189.1 apply. However, the PHIUS SourceZero approach also allows for the purchase of renewable energy certificates (RECs) with a 20% factor applied. These differ from a VPPA in that the clean energy underlying the creation of the REC is not purchased. Therefore, if this approach is considered, 5 kWh of RECs will be purchased for every 1 kWh metered by the utility. The cost per REC is estimated to be $6.00/MWh or $0.006/kWh.

The off-site PV system required to meet all remaining energy needs has a nameplate capacity of 2 MW and estimated cost of $4,300,000. As part of the path to net-zero emissions, for some scenarios we estimate installation of the on-site PV system in 2031. At that time, we estimate the system will cost 70% or $3,010,000.

Like the on-site PV system, the off-site PV systems could be financed under a PPA and the same cost of electricity as the on-site system is assumed in the scenarios where an off-site PPA is considered.

Energy, Financial, and CO_2e Emissions Analyses

Financial analyses were performed comparing seven different scenarios to achieve net-zero emissions. A description of the scenarios and resulting net present values are provided in Table 14. The assumptions and calculations for the different scenarios are provided in the Appendix.

Table 14: Financial Summary of Path to Net Zero Emissions

	Description	Net Present Value
Scenario 1	ECMs/Electrification, RECs	$(1,994,480)
Scenario 2	ECMs/Electrification, City Owned On-site PV, RECs	$(2,430.588)
Scenario 3	ECMs/Electrification, City Owned On-site PV, City Owned Off-site/Community PV	$(3,433,160)
Scenario 4	ECMs/Electrification, VPPA	$(1,813,966)
Scenario 5	ECMs/Electrification, On-site PV, VPPA	$(2,319,880)
Scenario 6	ECMs/Electrification, On-site PV PPA, Off-site/community PV PPA	$(2,991,735)
Scenario 7	ECMs/Electrification, On-site PV PPA, VPPA	$(2,242,740)

Figure 7 shows the change in electricity and natural gas use over time due to energy conservation measure implementation and electrification based on the implementation schedule shown in

Table 13. This implementation schedule is the same for all scenarios. Initially, the site electricity use decreases because of the weatherization and lighting projects, but eventually increases when the heating loads are electrified in year 10. Natural gas use is eliminated by year 10.

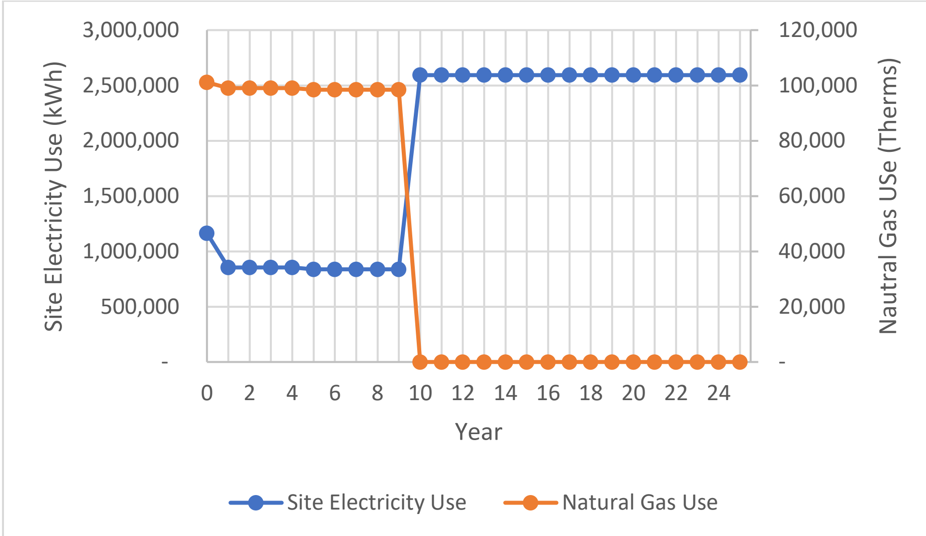

Figure 7: Site Electricity Use and Natural Gas Use over Time

Figure 8 illustrates the path to net zero emissions based on the recommended scenarios. These are scenarios 1, 4, and 7, which have the highest net present value. Under scenario 1, in year 1, ECM 1 and ECM 2 are implemented. In years 3 through 5, RECs are purchased for one third of the electricity purchased from the utility. In year 5, ECM 3 is implemented. In years 6 through 8, RECs are purchased for two thirds of the electricity purchased from the utility. In year 9 and beyond, RECs are purchased for all electricity purchased from the grid. Finally, in year 10, ECMs 4 and 5 are implemented, all natural gas-fired equipment is retired, and the building reaches its net-zero emission target.

Under scenario 4, ECMs are implemented as described above. Beginning in year 3, one third of electricity is procured via a VPPA. In year 6, two thirds of electricity is procured via the VPPA. In year 9, all electricity is procured via VPPA. Finally, in year 10, ECMs 3 and 4 are implemented and the building reaches its net-zero emission target.

Under scenario 7, the same path as scenario 4 is followed except that an on-site PV system (50% of eventual full system capacity) is installed in year 5 and all electricity not provided by the PV system is procured via VPPA beginning in year 5. In year 10, the remaining 50% of the full system capacity is installed. The reason that the PV system installation is split into two phases is because the complete 856 kWp system produces more electricity than the site can use until after implementation of ECMs 4 and 5. Therefore, we aligned completion of the system with implementation of these measures. The PV installation is financed under a PPA.

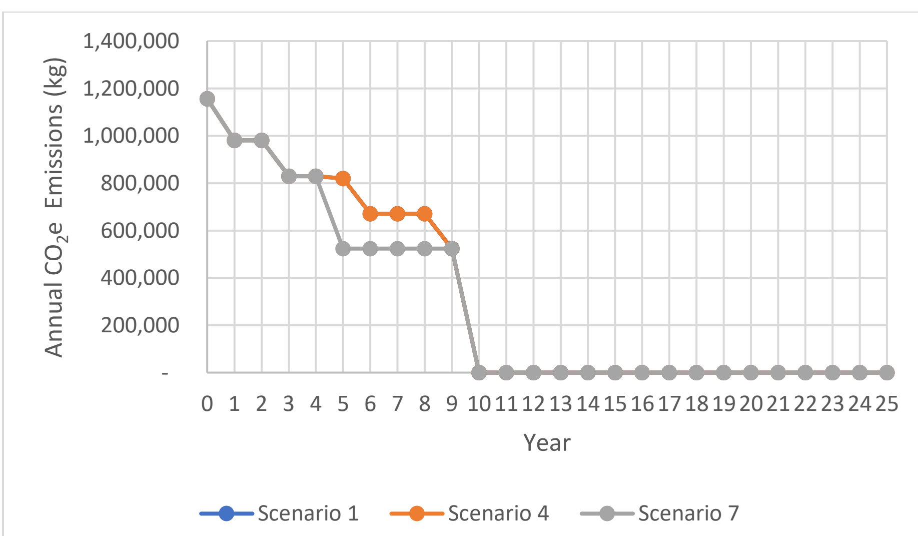

Figure 8: Source CO2e Emissions over Time

Error! Reference source not found. illustrates the annual additional expenditures above the current utility costs that will be required to implement the three scenarios and Table 15 provides the implementation costs and the annual operating costs before and after implementation of the measures to achieve net-zero emissions.

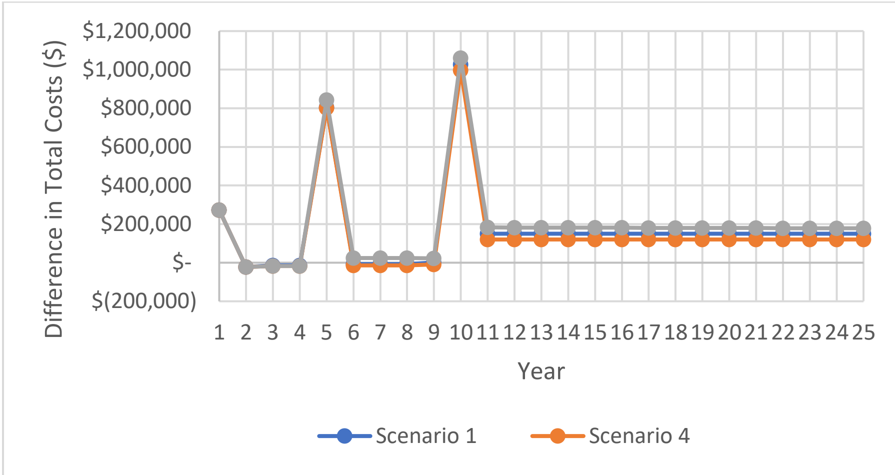

Figure 9: Change in Annual Expenditures over 25 yr. Period

Table 15: Net-zero Emission Implementation and Operating Costs

Scenario	Total Implementation Cost	Annual Operating Costs before Implementation (2019)	Annual Operating Cost after Implementation
1	$1,993,000	$132,744	$283,266
4	$1,993,000		$253,014
7	$1,993,000		$315,737

Appendix 3.
City of Evanston Fleet Action Plan

City of Evanston Carbon Neutral Fleet Action Plan

April 30, 2021

Prepared By:

Center for Neighborhood Technology

Elevate

Table of Contents

Introduction

In December 2018, the City of Evanston's City Council unanimously approved the City's third climate action plan, the Climate Action and Resilience Plan (CARP). The CARP sets a target of carbon neutrality by 2035 for all municipal operations, which includes the City's fleet. In 2019, Elevate Energy (Elevate) and Center for Neighborhood Technology (CNT) were selected to help the City of Evanston craft its Municipal Operations Zero Emissions Strategy. One task of the project was to analyze the City's current fleet data and provide potential pathways to a carbon neutral fleet. This report discusses the analysis findings and the scenarios in which the City of Evanston can reduce energy use and transition away from natural gas and fossil fuel consumption to a carbon neutral fleet.

CNT examined the City of Evanston's municipal fleet and best practices from other communities to recommend strategies for moving towards a carbon neutral fleet. Three scenarios of carbon neutrality were developed, ranging from a nearly zero carbon strategy to a more moderate, but still significant, transformative approach. All three scenarios focus on clean electricity and renewable fuels powering a smaller and efficiently-used fleet with carbon offset purchases used to address the share of fossil fuel vehicles that remain in the 2035 fleet for reasons of technology limitations, special use, or performance needs.

In 2018, Evanston's fleet emitted 2,485 metric tons of carbon dioxide equivalent ($MTCO_2e$) or 12% of the total municipal operations inventory. By 2035, the fleet's GHG emissions could be reduced to 200 to 750 $MTCO_2e$ with an investment in clean technologies at a net financial savings for the City.

The fleet assessment in the appendix describes the 423 vehicles[1] and 156 accessories in the municipal fleet in 2018 and describes the existing vehicles with performance metrics that are used to inform the strategies described here. Decarbonizing Evanston's fleet will need to be a multi-pronged effort that involves fuel switching, additional infrastructure, efficiency of vehicle uses, non-auto modes of transportation, and rightsizing the fleet (Table 1).

The strategies identified here were informed by best-practice strategies from other cities, particularly those in cold weather climates. Other cities pursuing carbon neutral fleets will be a good resource for learning and problem solving in the coming years. The City of Seattle's, "Green Fleet Action Plan," may be a particularly relevant reference as it incorporates, "the City's commitment to race and social justice, equity and inclusion," and seeks to achieve multiple sustainability benefits with its fleet actions.

Most of Evanston's strategies can begin immediately, while others will need to roll out over time to accommodate planning and investment timelines. In some cases, phasing in new technology adoption will allow the City to take advantage of the rapidly changing zero emissions vehicle market. Taken together, the strategies described here can provide Evanston with a best-in-class, high performance transportation portfolio that sets the bar for cities around the world on responding to the climate crisis.

[1] Excluding 51 unknown entries.

Table 1. Carbon Neutral Fleet Scenarios

2035	Scenario 1	Scenario 2	Scenario 3
VMT Reduction from 2018	30%	25%	20%
MPG Improvement of Fleet From 2018 (Includes Electric Vehicles)	174%	109%	80%
Share of 2018 VMT Biofuel	14%	14%	17%
Share of 2018 VMT Electric	50%	40%	30%
Share of Electric Vehicle kWh as On-Site Solar	70%	45%	30%
Offsets (MTCO2e)	260	507	884
Net Emissions MTCO2e	**0**	**0**	**0**

Another result of a cleaner, more efficient fleet is a more cost-effective fleet. The scenarios would create sizable fuel and maintenance savings as described further in the cost impact section of this plan. Each scenario requires a significant infrastructure investment to transform the fleet's fueling system and install onsite solar electric generation, but the investment is more than offset by the savings created. Electric vehicles have a higher upfront cost than comparable internal combustion vehicles, but there are substantial cost reductions created in each scenario by rightsizing the fleet and purchasing fewer vehicles overall as a result.

The financial benefit of transforming the fleet would be an estimated total net savings of $12 million (Scenario 1), $5 million (Scenario 2), or $7 million (Scenario 3) as compared to business as usual over the 15 year period from 2021 to 2035. Additional financial analysis is required to verify the energy savings provided in the scenarios.

Clean Fuels and Technologies

Evanston's carbon neutral fleet will require a transition to alternative fuels. Evanston's current fleet primarily uses fossil fuels, with 27% of the fleet using a "B20" blend of 80% diesel and 20% biodiesel. Evanston's carbon neutral fleet scenarios include a significant shift to electric vehicles paired with the adoption of an appropriate zero emissions fuel for heavy duty vehicles. Fossil fuels may continue to play a small role in specialized vehicles for reasons of technology availability or performance—between 5% and 30% of 2018's fossil usage.

Table 2. Carbon Neutral Fleet Scenarios, Count of Vehicles and Fuel Use in 2035

	Count of Fossil Fuel Vehicles	Count of Electric Vehicles	Count of Biofuel Vehicles	2035 Total Gallons of Fossil Fuel	2035 kWh Electricity	2035 Gallons Biofuel
2018 (Adjusted)	381	0	86	343,480	0	20,468
Scenario 1	31	235	76	17,269	751,951	53,057
Scenario 2	116	178	74	67,566	558,434	46,522
Scenario 3	170	127	83	101,503	378,318	49,975
2018 Values are Adjusted from the 2018 GHG Inventory to Account for Fleet Data Updates						

Electricity

The primary alternative fuel recommended for Evanston's fleet is electricity. Battery electric vehicles (BEVs) are powered by an internal battery that when depleted is recharged by connecting to the electric grid. Electric vehicles in the carbon neutral scenarios comprise 33% to 69% of the fleet in 2035. A 100% electric fleet is not included in the scenarios because electric special purpose vehicles and heavy-duty vehicles may not be fully available to meet Evanston's needs by that date, but Evanston should re-assess this prospect in the coming years.

Electric vehicles are typically more expensive than internal combustion engine vehicles, but they have low maintenance requirements and high fuel efficiency, which can make them more cost effective over their lifespan.

Transitioning to electric vehicles will require charging stations and upgrades to electrical infrastructure to support additional demand. A range of charging technologies will be necessary to accommodate the vehicle types in Evanston's fleet as large vehicles demand more power.[2, 3] Backup generation should be installed for critical services to ensure vehicles can be charged even in times of power disruption. Evanston should watch for federal and state funding and financing opportunities for these upgrades. Evanston may be able to expand its network of charging infrastructure by making some chargers available for public use at certain hours or by partnering with local private entities and institutions to share chargers. Argonne National Labs has been conducting applied research on electric fleet charging and may be a good partner for Evanston on this topic. The city should also keep apprised of opportunities for state or federal funding for this infrastructure as the U.S. recommits to climate action.

Changes in fleet operations may be required as charging times impact usage patterns[4] One option for decreasing charging time is to have "stationary batteries built into charging stations" that would then charge the vehicles' battery.[5] By including stationary batteries in charging stations, the charging station does not solely depend on the electric grid to charge the vehicle; it can also pull power from the stationary battery. Charging the car with the grid-sourced energy and battery-sourced energy can decrease the required charging time of a vehicle.[6] Charging stationary batteries can also allow electricity load shifting, which may provide financial benefits by decreasing electricity demand charges or enabling charging at lower cost times of electricity use.

Additionally, municipalities need to be observant of BEV charging during winter weather since the range can see up to a 40% reduction. There are several best management practices: using a battery management system to recharge vehicles which will regulate the charge rate appropriately to the weather, maintaining a minimum 20% charge to allow the vehicle to warm itself, and limiting use of unnecessary accessories.[7, 8]

Staff members will need to be trained on electric vehicle use. In the City of Loveland, Colorado electric vehicle ambassadors worked with departments to promote use of the vehicles.[9] Additionally, there was a 10,000-mile challenge to incentivize employees to prioritize using the pooled fleet of Nissan Leafs

---

[2] Bohn, Theodore. "Multi-Port, 1+MW Charging System for Medium- and Heavy-Duty EVs: What We Know and What Is on the Horizon?" Presented at the U.S. Department of Energy Clean Cities, Online, January 7, 2020. https://cleancities.energy.gov/files/u/news_events/document/document_url/525/ANL_CleanCities_MW_plus_WhatsAhead_Jan7_2020.pdf

[3] Steven Nadel and Eric Junga, "Electrifying Trucks: From Delivery Vans to Buses to 18-Wheelers" (Washington DC: American Council for an Energy-Efficiency Economy, January 2020), 9, https://www.aceee.org/sites/default/files/pdfs/electric_trucks_1.pdf

[4] "AC Transit Zero-Emissions Bus Rollout Plan: Alameda Contra Cost Transit District Oakland, CA," Zero Emissions Future (Oakland, CA: AC Transit, June 10, 2020), http://www.actransit.org/wp-content/uploads/AC-Transit-ZEB-Rollout-Plan_06102020.pdf

[5] "Ready for Work" (Cambridge, MA: Union of Concerned Scientists, December 11, 2019), 11, https://www.ucsusa.org/resources/ready-work

[6] Andy Colthorpe, "Energy Storage and EVs: 'Batteries on Wheels' and ESS for Charging Stations," *Energy Storage News* (blog), March 5, 2020, https://www.energy-storage.news/news/energy-storage-and-evs-batteries-on-wheels-and-ess-for-charging-stations.

[7] Gregory Van Tighem, "Tips to Managing Electric Vehicle Range in Winter," Fleet Forward, July 9, 2019, https://www.fleetforward.com/335711/tips-to-managing-electric-vehicle-range-in-winter

[8] Phil Romba, "Extreme Temps Affect Electric Truck Batteries," Transport Topics, April 26, 2019, https://www.ttnews.com/articles/extreme-temps-affect-electric-truck-batteries

[9] Electrification Coalition, "Drive Electric Northern Colorado: Establishing an EV Accelerator Community," Case Study (Washington (DC): Electrification Coalition, February 2018), https://driveevfleets.org/wp-content/uploads/2018/08/DENC-Full-Case-Study.pdf

before any fossil fuel vehicles.[10] These sort of training and encouragement steps may ease the transition to this new technology.

Grid-sourced battery electric vehicles are not zero emissions—the U.S. EPA reports that electricity sources in the Evanston subregion (RFC West) emitted approximately 0.5 kg CO_2e per kWh in 2018. The electricity grid has been decarbonizing in recent years, and that trend is expected to continue, but electricity in the region is not projected to be zero carbon by 2035. For that reason, the Evanston carbon neutral fleet scenarios include on-site renewable generation to meet at least 30% to 70% of estimated fleet kWh use.

Evanston intends to use onsite renewable energy to make its operations fully carbon neutral. The RFC West emissions factor stays relevant even in that scenario, because GHG accounting protocols typically require "location-based" accounting of electricity GHGs, which would entail applying the RFC West emissions factor to all grid-connected electricity use. The purchase of renewable energy toward the goal of carbon neutrality is accounted for with a second "market-based" emissions accounting approach, and both location-based and market-based GHG emissions must be reported. A full explanation of these dual accounting approaches is provided in the *GHG Protocol Scope 2 Guidance*.[11] Strategies to reduce grid-sourced electricity use, such as through on-site renewable electricity production, will reduce GHG emissions for both reporting approaches.

As Evanston pursues renewable energy investments it should seek to align that with its equity goals, such through job opportunities as Seattle, WA[12] or conducting racial equity impact analysis like Minneapolis, MN.[13] Considering project investment dollars through an equity lens can create opportunities to support businesses and communities of color. For example, the location of offsite renewable energy could provide a resilient energy resource and jobs in an underinvested community in the region with a well-designed partnership.

Biofuels

Biofuels, such as biodiesel, ethanol, and renewable diesel, produce carbon emissions upon combustion, but those emissions are considered biogenic. The fuel feedstock comes from currently living biological material which releases CO_2 as part of the global carbon cycle, as opposed to fossil fuels which release carbon previously stored underground for thousands of years.[14] Thus, biofuels can be low-carbon fuels when sourced responsibly, despite showing significant tailpipe carbon emissions. Evanston's carbon neutral fleet scenarios include 20% to 22% biofuel powered vehicles.

RENEWABLE DIESEL

Of the newer biofuels available on the market today, Renewable Diesel (RD) may be the best fit for Evanston's needs as a replacement fuel for heavy-duty vehicles. It can be distributed in the same facilities and used in the same engines as conventional diesel fuel. Sources of RD include corn stover, palm oil, fatty acid distillate, tallow (animal fat), and used cooking oil. The largest domestic market of RD fuel is California due to that state's low

[10] Electrification Coalition, "Drive Electric Northern Colorado: Establishing an EV Accelerator Community," Case Study (Washington (DC): Electrification Coalition, February 2018), https://driveevfleets.org/wp-content/uploads/2018/08/DENC-Full-Case-Study.pdf
[11] World Resources Institute, "GHG Protocol Scope 2 Guidance: An Amendment to the GHG Protocol Corporate Standard," 2015. https://ghgprotocol.org/sites/default/files/standards/Scope%202%20Guidance_Final_Sept26.pdf The *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories* includes similar guidance.
[12] Philip Saunders, "Green Fleet Action Plan: An Updated Action Plan for the City of Seattle" (Seattle, WA: City of Seattle Department of Finance and Administrative Services, Fleet Management, 2019), https://www.seattle.gov/Documents/Departments/FAS/FleetManagement/2019-Green-Fleet-Action-Plan.pdf.
[13] Brette Hjelle et al., "Green Fleet Policy Update - REIA (Standard)," Legislative Information Management System of Minneapolis, MN, February 3, 2021, https://lims.minneapolismn.gov/File/RacialEquity/7421
[14] IEA Bioenergy, "Fossil vs Biogenic CO2 Emissions | Bioenergy," *Technology Collaboration Programme* (blog), 2020, https://www.ieabioenergy.com/iea-publications/faq/woodybiomass/biogenic-co2/; UC Davis, "Biogenic Carbon," *Science and Climate* (blog), accessed July 16, 2020, https://climatechange.ucdavis.edu/climate-change-definitions/biogenic-carbon/

carbon fuel standard.[15] Several heavy-duty vehicle fleets have transitioned to RD: 375 diesel-powered vehicles in Oakland, Eugene Water & Electric Board in Oregon, and Charlotte Water in North Carolina.[16]

If RD becomes fully viable for Evanston by 2035, it could replace all diesel usage and eliminate the need for any fossil fuels in the portfolio, but RD has several drawbacks at this time.

1) Foremost, it is of limited availability outside the west coast—a RD manufacturing facility is slated for construction in Illinois, but until that or another source is online it may be difficult for Evanston to source this fuel.[17] Several other zero carbon options for heavy duty vehicles are discussed in this action plan for that reason. Initiating a buying pool with other local fleets may enable a local stronger RD market.
2) Another consideration is that RD emits nitrogen oxide (NO_x) and other criteria air pollutants that are harmful to health—though at slightly lower rates than conventional diesel.[18,19]
3) There are concerns about the sustainability and scalability of this fuel source nationwide, so RD may ultimately be a transitional or niche use fuel, and Evanston should consider that in its planning.

B100

B100 biofuels are produced from the transesterification of oils and fats, as opposed to RD, which is a hydrocarbon manufactured through other processes.[20] B100 can require technology changes in heavy duty vehicles and it has performance limitations in cold weather that may require operations adjustments.[21,22] RD is a better fit for Evanston's fleet needs if it can be accessed in the market, however B100 has been included in this assessment because it may be a necessary low-carbon fuel for Evanston if RD is not available.

Hydrogen

Fuel cell electric vehicles (FCEVs) contain an electrochemical reactor to convert hydrogen and an oxidant to energy. FCEVs create no tailpipe GHG or criteria air pollutant emissions; the chemical byproduct is water vapor and warm air.[23,24] While hydrogen production has the potential to be low or zero carbon if produced with renewable

---

[15] Jonathan Leonard and Patrick Couch, "The Potential – and Challenges – of Renewable Diesel Fuel for Heavy-Duty Vehicles," GNA, January 10, 2017, https://www.gladstein.org/the-potential-and-challenges-of-renewable-diesel-fuel-for-heavy-duty-vehicles/

[16] Shelley Ernst, "Is Renewable Diesel Still a 'Miracle Fuel'?," Government Fleet, January 8, 2020, https://www.government-fleet.com/348069/is-renewable-diesel-still-a-miracle-fuel

[17] "$400 Million Renewable Biodiesel Plant to Be Built in Illinois," Renewable Energy Magazine, May 21, 2020, https://www.renewableenergymagazine.com/biofuels/400-million-renewable-biodiesel-plant-to-20200521.

[18] Richard W. Corey and Tom Howard, "Renewable Diesel Should Be Treated the Same as Conventional Diesel" (State of California, July 31, 2013), https://ww2.arb.ca.gov/sites/default/files/2018-08/Renewable_Diesel_Joint_Statement_7-31-13.pdf "4 Things To Know About Renewable Diesel," Puget Sound Clean Air Agency, WA, January 10, 2017, https://pscleanair.gov/469/4-Things-To-Know-About-Renewable-Diesel.

[19] Leonard and Couch, "The Potential – and Challenges – of Renewable Diesel Fuel for Heavy-Duty Vehicles."

[20] https://afdc.energy.gov/fuels/emerging_hydrocarbon.html

[21] "Biodiesel in Winter Time," Triangle Biofuels Industries, February 24, 2015, https://www.trianglebiofuels.com/biodiesel-in-winter-time/

[22] "Biodiesel Cold Flow Basics: Information for Petroleum Distributors, Blenders, and End-Users on Issues Affecting Biodiesel in the Winter Months" (National Biodiesel Board, 2014), https://www.biodiesel.org/docs/default-source/fact-sheets/cold-flow-basics.ppt?sfvrsn=3a918a6c_5#:~:text=Biodiesel%20Cold%20Flow%20Basics&text=Operability%20is%20defined%20as%20the,of%20the%20fuel%20delivery%20system.&text=Diesel%20fuels%20composition%20and%20cold,greatly%20across%20the%20United%20States

[23] Notably, San Francisco includes hydrogen fuel cells to be part of its electric vehicle pathway. Electric Mobility Subcommittee, "Electric Vehicle Roadmap for San Francisco" (The Mayor's Electric Vehicle Working Group (EVWG), June 2019), https://static1.squarespace.com/static/5489e34ce4b0a7bfc8ca7a0d/t/5d671018e683a900013a4953/1567035419028/EV+Roadmap_Final.pdf

[24] U.S. Department of Energy, "Alternative Fuels Data Center: Fuel Cell Electric Vehicles," Government, Energy Efficiency & Renewable Energy, accessed August 13, 2020, https://afdc.energy.gov/vehicles/fuel_cell.html

electricity, today it is typically produced from natural gas and therefore has a fairly high lifecycle GHG footprint (see appendix).[25]

Hydrogen can be produced on-site or procured from an off-site source, but requires a significant fueling infrastructure investment.[26, 27] Currently, FCEVs are 40% to 90% more expensive than conventional vehicles due to lack of economies of scale and fuel cell technology. Projected wide-use applications of fuel cells include heavy duty trucks, logistic vehicles, forklifts, buses, and passenger vehicles.[28,29] However, for example, only four transit agencies in the country use this technology in buses at this time.[30]

The Evanston carbon neutral fleet scenarios do not include hydrogen in the 2035 fleet, but it is recommended that Evanston stay apprised of developments in this market and reassess this option in 2 to 3 years, especially if federal or state grants become available for the capital costs associated with hydrogen.

Fossil Fuel

All the climate neutral fleet scenarios for Evanston include some amount of fossil fuel use in 2035, because more special use vehicle types may require it, but under the most transformative scenario it would be 5% of today's use. RD, if viable, would be 22% of today's fuel volume under that scenario. At this time, Evanston operates a fossil fuel fueling station that is being considered for an upgrade. It is recommended to analyze the option of procuring diesel and gasoline offsite, as it may be more aligned with Evanston's carbon neutral goals to pursue development of alternative fueling infrastructure.

Vehicles

SEDANS AND MOTORCYCLES

Beginning in 2021, it is recommended that every sedan the City purchases is electric. The electric sedan market is well-established, and performance will meet Evanston's needs in terms of driving range between charges. These vehicles are most efficient at mid-range speeds so they work well for urban settings at speeds below 45 mph.[31] BEVs can be useful for vehicles on fixed routes within the city which drive a limited range.[32] Current light-duty BEVs

---

[25] Argonne National Laboratory, GREET 2020 Model, September 2020. https://greet.es.anl.gov/

[26] SunLine Transit Agency in California has invested at least $27 million in electric hydrogen production technology and fuel cell buses. https://www.nytimes.com/2020/11/11/business/hydrogen-fuel-california.html A 2013 study found a cost of at $2.65 million for state of the art hydrogen fueling stations. https://www.nrel.gov/docs/fy13osti/56412.pdf

[27] "AC Transit Zero-Emissions Bus Rollout Plan: Alameda Contra Cost Transit District Oakland, CA," Zero Emissions Future (Oakland, CA: AC Transit, June 10, 2020), http://www.actransit.org/wp-content/uploads/AC-Transit-ZEB-Rollout-Plan_06102020.pdf

[28] Alan MacCharles et al., "Fueling the Future of Mobility Hydrogen and Fuel Cell Solutions for Transportation," White Paper (China: Deloitte and Ballard, January 7, 2020), https://info.ballard.com/hubfs/Other%20Reports/Deloitte%20Volume%201%20Powering%20the%20Future%20of%20Mobility.pdf?hsCtaTracking=5de5914f-7cb0-42a5-b9d0-8248b33f03ae%7Ccc91e1e5-d73e-4bea-b2a0-82c826394bf3

[29] Alan MacCharles et al., "Fueling the Future of Mobility Hydrogen and Fuel Cell Solutions for Transportation," White Paper (China: Deloitte and Ballard, January 7, 2020), https://info.ballard.com/hubfs/Other%20Reports/Deloitte%20Volume%201%20Powering%20the%20Future%20of%20Mobility.pdf?hsCtaTracking=5de5914f-7cb0-42a5-b9d0-8248b33f03ae%7Ccc91e1e5-d73e-4bea-b2a0-82c826394bf3, 20.

[30] National Transit Database

[31] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide," Guide (Washington (DC): National Association of Regional Councils, 2016), https://static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/5c3e30734ae237da7d84cf2c/1547579509097/Electric%2BVehicle%2BProcurement%2BBest%2BPractices%2BGuide%2BFinal.pdf

[32] Gordon Feller, "Rotterdam's Municipal EV Fleet: Lessons for Utilities and Cities," T&D World, December 9, 2019, https://www.tdworld.com/electrification/article/21112387/rotterdams-municipal-ev-fleet-lessons-for-utilities-and-cities

range from 110 to 373 miles per charge.[33] Evanston also has several motorcycles in its fleet that could become electric by 2035.

Evanston should install at least 3 to 5 electric charging stations in locations these sedans are to be parked by early 2021. This will support the procurement of EVs to begin while planning continues for more fleet-wide electrification infrastructure.

The City of Cambridge, MA was contacted and provided information about the electric vehicles in their fleet, which faces similar use conditions as Evanston.[34] Table 2 shows the usage, charging time and energy use data for five Nissan Leafs acquired for their fleet in July 2020. Cambridge also has older Chevy Volt electric vehicles in their fleet and stated the battery efficiency of those models has declined with disuse (of note, many electric vehicles are sold with an 8-year/100,000 mile warranty for the battery). At an average of 29.6 kWh per 100 miles, the Leafs are achieving typical fuel economy for current electric sedans. At approximately 3 minutes of charging time per mile, the Nissan Leafs would easily charge during off hours for the average 3,185 annual miles of use of the current sedans in Evanston's fleet.

Table 3. Cambridge, MA 2020 Nissan Leaf Usage, Charging Time, and Energy use

	Odometer when registered	Odometer now	Odometer date	Charging time	Miles driven	Sum of Energy	Miles per kWh	kWh / 100 miles	Miles Per Gallon Gasoline Equivalent
Nissan 1	25	5,991	12/9/2020	299:27:59	5,966	1,710.3	3.5	28.7	117.6
Nissan 2	31	2,584	12/4/2020	150:30:03	2,553	863.0	3.0	33.8	99.7
Nissan 3	32	246	12/8/2020	9:06:18	214	49.3	4.3	23.1	146.2
Nissan 4	8	2,422	12/8/2020	155:05:31	2,414	734.5	3.3	30.4	110.8
Nissan 5	9	5,690	12/7/2020	274:51:31	5,681	1,620.1	3.5	28.5	118.2

As a point of comparison, the list price for a 2020 Nissan Leaf was $31,600-$38,200, which is approximately $6,000 more than the list price of a 2021 Chevrolet Malibu gasoline vehicle. Driven 10,000 miles per year in Evanston, the Nissan Leaf would use $217 per in electricity, while the Chevrolet Malibu would use $691 per year in gasoline. Consumer Reports estimates the average maintenance cost of an electric vehicle at $0.02 per mile for the first 100,000 miles and an internal combustion vehicle at $0.044 per mile.[35] At those rates, the annualized cost of ownership over 10 years of the Nissan Leaf is $3,907 in today's dollars, as compared to $3,999 for the Chevrolet Malibu. At 2018 GHG rates for grid-connected electricity the Nissan Leaf's carbon footprint would be 1.6 $MTCO_2e$ and the Chevrolet Malibu's would be 2.7 $MTCO_2e$. The Nissan Leaf's carbon footprint is expected to decrease as the grid electricity decarbonizes and on-site solar electric generation could offset the emissions of a given electric vehicle entirely. A table comparing cost and performance of several other models is in the Appendix.

The City of New York has found the maintenance cost of their battery electric vehicles is "dramatically less" than that of gasoline or hybrid models; a factor which increases the lifecycle savings of electric vehicles even more. New

---

[33] Dave Vanderwerp, "EV Range: Everything You Need to Know," Car and Driver, May 22, 2020, https://www.caranddriver.com/shopping-advice/a32603216/ev-range-explained/

[34] Personal Communication Sidorenko, Irina, Energy and Sustainability Analyst at *City of* Cambridge, MA, December 2020. (isidorenko@cambridgema.gov)

[35] Harto, Chris, Adam Winer, and David Friedman. "Electric Vehicle Owners Spending Half as Much on Maintenance Compared to Gas-Powered Vehicle Owners, Finds New CR Analysis." Consumer Reports, September 24, 2020. https://advocacy.consumerreports.org/press_release/electric-vehicle-owners-spending-half-as-much-on-maintenance-compared-to-gas-powered-vehicle-owners-finds-new-cr-analysis

York's 2018 average annual maintenance costs by vehicle model ranged from $205 to $386 for electric sedans, while hybrid and gasoline models ranged from $496 to $1,805.[36]

SUVS

Evanston's climate neutral fleet scenarios anticipate the SUVs in the fleet will be electric by 2035 and some SUVs will be downsized to sedans. There are several electric SUVs on the market today, so Evanston should explore procuring 1-3 electric SUVs in 2021 to begin integrating them into the fleet. Given the rapid change of this technology it may suit Evanston to lease these SUVs with the intention of upgrading them in 2-3 years as battery life and other technology improvements are deployed. Evanston should plan to no longer purchase fossil fuel SUVs by the year 2025. If Evanston finds it necessary to purchase fossil fuel powered SUVs between 2021 and 2024 it should aim for those to be hybrid electric models with high fuel economy. A table comparing cost and performance of several models is in the Appendix.

PICKUP TRUCKS AND VANS

It is expected that Ford will release an electric version of its F150 truck in 2022 and there are several other electric pickup truck makes coming on the market. [37] The F150 is a smaller truck and Evanston only has 3 of this size in its current fleet. It is recommended to downsize some of the larger truck models in the fleet, if detailed usage analysis shows downsizing as a possibility. This will allow Evanston's pickup truck fleet to electrify (and decarbonize) more quickly.

Evanston's carbon neutral fleet scenarios anticipate a mix of fuel technologies among its pickup trucks in 2035. Where possible, electric is preferred, and up to 90% of the pickup trucks in the fleet could become electric under the most transformative scenario. The technology trajectory is somewhat uncertain, so the more moderate carbon neutral scenarios assume 24-31 pickups continue to be fossil fuel (likely diesel) powered in 2035. The remaining trucks should be biofuel (or hydrogen) powered. The best fuel economy possible should be chosen when purchasing fossil fuel and biofuel vehicles.

Vans in the fleet should follow a similar pattern—90% could be electric if the technology enables that; 10-12 may continue to be fossil fuel powered under the more moderate scenarios, if needed for performance reasons; and the remainder should be biofuel powered. Ford has announced an electric version of its Transit van for the 2022 model year.[38]

Other Medium and Heavy-Duty Vehicles

Evanston's fleet includes many medium- and heavy-duty vehicles that provide critical services. Vehicles of these type are at least 30% of the fleet. The market is much smaller for these vehicles, with limited supply chains, vehicle availability, and use.[39] The most transformative carbon neutral fleet scenario recommends Evanston's heavy trucks, construction trucks, fire trucks, garbage trucks, specialty trucks, landscape vehicles, ambulances, buses, watercraft, and street sweepers as a whole become 39% electric, 42% biodiesel and 19% fossil fuel by 2035. If the technology is slower to become available, the more fossil fuel dependent scenario would include 11% electric and 8% biofuel vehicles among these types.

---

[36] City of New York, "Reducing Maintenance Costs with Electric Vehicles," NYC Fleet Newsletter, March 8, 2019. https://www1.nyc.gov/assets/dcas/downloads/pdf/fleet/NYC-Fleet-Newsletter-255-March-8-2019-Reducing-Maintenance-Costs-With-Electric-Vehicles.pdf

[37] "2023 Ford F-150 Electric: What We Know So Far," Car and Driver, October 15, 2020, https://www.caranddriver.com/ford/f-150-electric

[38] "Ford to Offer All-Electric Transit; U.S.-Made, Zero-Emissions Van to Join All-Electric Mustang Mach-E and F-150 in Lineup," Ford Media Center, March 3, 2020, https://media.ford.com/content/fordmedia/fna/us/en/news/2020/03/03/ford-to-offer-all-electric-transit.html

[39] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide"; Northwest Regional Planning Commission, "Regional Energy Plan" (2017), https://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Act_174/NRPC/NRPC%20Energy%20Plan.pdf

Working in partnership with other cities will be an essential part of Evanston's carbon neutral strategies for these vehicle types. A multi-city request for information (RFI) came out in 2017 for a quick market survey of medium and heavy-duty vehicle development to signal to manufacturers that there is demand for zero-emission medium and heavy-duty vehicles.[40] Several cities (Chicago; Seneca, SC; King County, WA; Twin Rivers, CA) have begun electrification of their buses first.[41] Los Angeles has announced that it will fully electrify its garbage trucks by 2035.[42] The image below from Fleets for the Future displays BEV applications for medium and heavy-duty trucks, including one plugin hybrid electric vehicle (PHEV), as well as where they are used.[43]



	Transit Buses	Step Van	Cab Chassis
Category	BEV	BEV	BEV
Battery Size	135-395 kWh	60-125 kWh	145-207 kWh
All-Electric Range	140-160 miles	90-150 miles	100-155 miles
Example Fleet	City of Denver	UPS FedEx	Frito Lay



	Terminal Trucks	Refuse	Bucket Trucks
Category	BEV	BEV	PHEV[9]
Battery Size	200 kWh	210 kWh	14.2-28.4 kWh
All-Electric Range	30-60 miles	50-85 miles	40 miles
Example Fleet	Port of Los Angeles	City of Chicago	Pacific Gas and Electric (PG&E)

Figure 0-A. Battery Electric Vehicle (BEV) Medium and Heavy-Duty Truck Examples[44]

Some cities have requested vehicles that do not exist yet, such as electric fire engines and heavy-duty trucks. In late 2019, the US Department of Energy "listed 61 all-electric truck models: 36 buses, 10 vocational trucks, 9 vans and step vans, 3 tractors, 2 street sweepers, and 1 refuse truck."[45] Current models have range limitations and high cost differentials to internal combustion engine models, which is why the carbon neutral fleet scenarios anticipate

---

[40] Joe Ryan, "Cities Shop for $10 Billion of Electric Cars to Defy Trump - Bloomberg," March 14, 2017, https://www.bloomberg.com/news/articles/2017-03-14/cities-shop-for-10-billion-of-electric-vehicles-to-defy-trump
[41] Matt Casale, Morgan Folger, and James Horrox, "Electric Buses in America | U.S. PIRG," U.S. PIRG, October 10, 2019, https://uspirg.org/feature/usp/electric-buses-america
[42] "LA Sanitation Announces Public Commitment to 100% Electric Refuse Truck Fleet as Los Angeles Leaders Discuss Zero-Emissions Plans," LA County Electric Bus and Truck Coalition, accessed December 8, 2020, https://laelectrictruckandbus.org/press-releases-1/2020/1/23/la-sanitation-announces-public-commitment-to-100-electric-refuse-truck-fleet-as-los-angeles-leaders-discuss-zero-emissions-plans
[43] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide."
[44] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide."
[45] Nadel and Junga, "Electrifying Trucks: From Delivery Vans to Buses to 18-Wheelers," 7.

later adoption for these vehicle types. The California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP) website includes a catalogue of heavy-duty vehicles that are available in the market.[46]

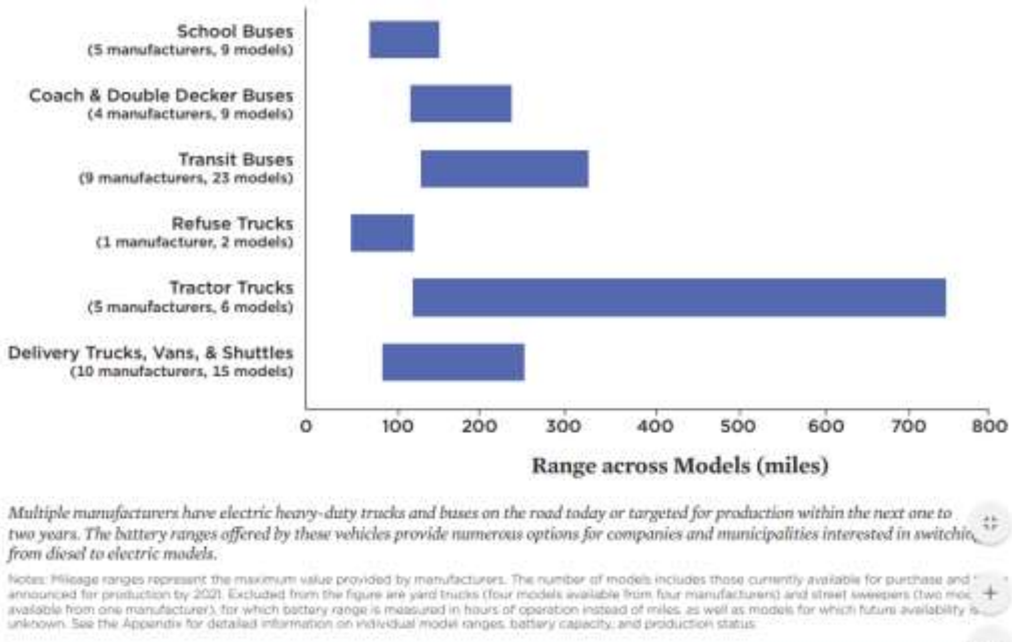

Figure 0-B. Current Electric Truck and Bus Ranges[47]

While the market continues to grow, there are other ways that municipalities can work towards zero-emissions in their medium and heavy-duty vehicles. Two options include installing auxiliary power units and converting the drivetrain. Some of these vehicles experience many hours idling. During this time, diesel powers auxiliary services within the vehicle. Vehicles with electric auxiliary power units (APUs) could replace diesel-only vehicles so that when the truck is idling for accessory use, power switches to electric instead of using diesel.[48] The APU is charged when the vehicle is running on diesel,[49] so it could be used as a transition to a zero-emission fleet. Additionally, municipalities can consider converting to an electric drivetrain to make vehicle movement electric.[50] An electric drivetrain is optimal in congested areas where fossil fuel engines are least efficient.[51] U.S. EPA Certified installers, often smaller companies, are required to make the conversion.[52]

---

[46] "How to Participate," California HVIP, March 2020, https://www.californiahvip.org/how-to-participate/

[47] "Ready for Work"; Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide."

[48] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide"; "Idle Reduction Technology," Idle-Free California, accessed July 17, 2020, http://idlefreecalifornia.org/idle-reduction-technology.html

[49] Tyler Fussner, "Engine Idle Reduction Systems and Solutions," *Vehicle Service Pros* (blog), July 7, 2020, https://www.vehicleservicepros.com/vehicles/powertrain/emissions-fuel-efficiency/engine-idling-devices-idle-control-systems/article/21142636/engine-idle-reduction-systems-and-solutions

[50] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide."

[51] "Advanced Clean Trucks: Accelerating Zero-Emission Truck Markets" (California Air Resources Board, June 25, 2020), https://ww2.arb.ca.gov/sites/default/files/2020-06/200625factsheet_ADA.pdf

[52] "Ready for Work"; Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide."

Fleet Management and Rightsizing

Rightsizing

The current Evanston fleet includes many vehicles with low annual mileage, even excluding the lowest mileage values, which may not have miles recorded or may be equipment hours of usage—201 vehicles recorded between 1,000 and 10,000 miles in 2018. The median mileage was just 4,233 miles, as compared to the U.S. average of 11,800.[53,54] This presents an opportunity for combining vehicle uses and rightsizing the fleet. For example, the City of Seattle has instituted a policy to eliminate fleet vehicles used less than 2,400 miles per year (200 miles per month).[55]

Hours, days, and purposes of vehicle usage should be tracked to identify cases where one new vehicle could serve the same utility of two or more existing vehicles. The reasons for rightsizing include 1) the higher up-front cost of alternative fuel vehicles make them a more effective investment if they are used more;[56] 2) induced demand has shown when a vehicle is available individuals tend to find reasons to use it instead of seeking alternatives; 3) encouraging only essential vehicle use will reduce fuel consumption and greenhouse gas (GHG) emissions; and 4) freeing up space now used for vehicle parking will support installation of zero carbon infrastructure, green stormwater infrastructure, or other sustainability and resilience actions.

The scenarios for Evanston's carbon neutral fleet include a significant reduction in the number of vehicles—from 467 in 2018 to 342-380 by 2035. The avoided purchase of these vehicles could save $4 to $7 million. These vehicles should be replaced by reduced travel, alternative transportation modes, and more efficient use of vehicles including shared vehicles across departments. Identifying these opportunities will require a survey of vehicle users or travel diary[57] in addition to the existing fleet tracking, but such data would be useful for assessing VMT reduction potential as well.

---

[53] This analysis of fuel economy and 2018 mileage excludes vehicles that were indicated as sold, or 2019 and later model years, as well as those with 0 or negative or other significant outlier data points for fuel or mileage. Exclusions are intended to allow for a full-year's analysis of typical fleet activity as of 2018.

[54] "Annual Vehicle Distance Traveled in Miles and Related Data - 2018 (1) by Highway Category and Vehicle Type," Federal Highway Administration, November 2019, https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm.

[55] City of Seattle, "Green Fleet Action Plan: An Updated Action Plan for the City of Seattle," 2019. https://www.seattle.gov/Documents/Departments/FAS/FleetManagement/2019-Green-Fleet-Action-Plan.pdf

[56] Best practice is 10,000 to 12,000 miles annually, but that may be an unrealistically high target for Evanston's needs. Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide," Guide (Washington (DC): National Association of Regional Councils, 2016), https://static1.squarespace.com/static/57a0a284d2b857f883096ab0/t/5c3e30734ae237da7d84cf2c/1547579509097/Electric%2BVehicle%2BProcurement%2BBest%2BPractices%2BGuide%2BFinal.pdf

[57] A travel diary can be a physical or virtual "log book", in which every vehicle user fills out their trip purpose, passengers, and other information that is not otherwise in the vehicle tracking system. This level of detailed data collection should only occur for a short time, enough to learn a typical pattern of activity.

Fuel Economy

The fuel economy of new vehicle purchases should be increased 42%-50% from 2018 levels by 2035. The overall fuel economy of vehicles for sale in the market is improving, so much of this change will occur naturally with fleet turnover, but procurement with a focus on fuel economy should be a priority.[58] Additionally, smaller, lighter vehicles should be chosen when they can meet City needs. The typical passenger vehicle in the current fleet is a sports utility vehicle (SUV) or pickup truck. Replacing some of these vehicles with sedans would save energy, emissions, fuel cost and purchase cost. In the case of electric vehicles, choosing smaller vehicles can reduce charging times and increase driving range. The electronic traction control in electric vehicles can help even smaller models handle snow and ice well.[59]

Staff members should be encouraged and enabled to use vehicles efficiently to support the city's climate goals. There are information tools that can give drivers feedback on the efficiency of their vehicle usage and trainings available on "eco-driving" that can teach best practices for achieving fuel economy.[60] Enforcement of the City's existing anti-idling policy could reduce fuel usage.

Tracking

Improvements in data quality control with Evanston's existing fleet and fuel tracking systems will enable closer management of vehicle activity and emissions. An assessment of fleet data found gaps that should be amended, including mileage data that was not recorded during fueling and lack of differentiation in reports between hours and miles of vehicle activity. A new data management structure will be needed to better represent the fleet's energy and performance data as electric vehicles are adopted. Specifics include, "energy consumed (kWh), vehicle state of charge (SOC) before, during, and after trips, charge times and duration."[61] Additionally, Evanston may consider including real time data collection within zero-emission vehicles to give drivers and fleet managers more insight into usage and performance.[62]

Procurement

Procurement goals can ensure the decarbonization of the fleet happens in a timely manner. The decisions made in the next 5 years will shape Evanston's 2035 fleet. The City of Los Angeles set a goal of 50% electric light duty vehicles by 2017 and now is working toward 100% zero-emissions sedans by 2021. Additionally, their procurement process dictates considering zero-emission vehicles first for all procurement of new equipment.[63] As vehicle technologies are changing rapidly, leasing may be a good option to increase fleet turnover. [64] The Climate Mayors Electric Vehicle Purchasing Collaborative has information on electric vehicle purchasing and leasing.[65] Early

---

[58] U.S. Department of Energy, Energy Information Administration, "Annual Energy Outlook," (2018). Light duty vehicles are projected to improve fuel efficiency 40% by 2035, commercial light trucks 21%, and freight trucks 25%. https://www.eia.gov/outlooks/aeo/pdf/appa.pdf

[59] Jukka Kukkonen, Fresh Energy, "Electric vehicles are great winter cars," February 11, 2019. https://fresh-energy.org/electric-vehicles-are-great-winter-cars/#

[60] "Eco Driving Tools," Energypedia, November 7, 2014, https://energypedia.info/wiki/Eco_Driving_Tools

[61] Fleets for the Future, "Electric Vehicle Procurement Best Practices Guide," 13.

[62] "AC Transit Zero-Emissions Bus Rollout Plan: Alameda Contra Cost Transit District Oakland, CA."

[63] Michael Samulon, Update on LA Municipal Fleet Zero Emissions Goals, Phone, August 19, 2020.

[64] "Electric Vehicles and the City of New Bedford" (Massachusetts Department of Environmental Protection, October 9, 2018), https://www.mass.gov/files/documents/2018/10/09/massevip-newbedford.pdf.

[65] Climate Mayors Electric Vehicle Purchasing Collaborative https://driveevfleets.org/

decommissioning of fossil fuel fleet vehicles and ending the practice of transferring older vehicles between departments may help Evanston meet its climate targets sooner.

Funding and financing for low-carbon technology continues to evolve. Large providers of the necessary infrastructure technology may offer financing themselves and service models exist in the sustainable infrastructure realm wherein capital cost is borne by private implementers. Outreach to venders, vehicle manufacturers, and the electric utility may identify additional funding and financing incentives. In 2017, for example, San Francisco Bay Area municipalities partnered with an auto dealership to allow the dealership to receive the federal tax incentive for electric vehicle purchases in place of the non-taxed public agencies and the dealership lowered the vehicle sales prices as a result.[66]

A variety of federal energy and transportation funds have been used for electric vehicles and infrastructure purchases.[67] The U.S. has recommitted to GHG reduction by rejoining the Paris Agreement, which may make federal funds for climate neutral fleets and infrastructure more available in coming years.

Maintenance

Maintenance is another important aspect of fleet management that is crucial to GHG savings. Performance of vehicles depends on regular maintenance.[68] Transitioning the fleet to more electric vehicles is likely to save maintenance costs, as electric vehicles do not have the fluids and moving parts of internal combustion engines and have much fewer manufacturer recommended maintenance tasks.[69] However, the transition will require maintenance staff training and time for learning the new technologies to enable maintenance staff to safely keep the fleet at top performance levels.

An important GHG to track and manage in the future is the purchase of refrigerant gas used in most automobile air conditioning systems, which has a high global warming potential. However, this may be less of an issue going forward as these gases are phased out of vehicles.

Vehicle Miles Traveled (VMT) Reduction

City of Evanston vehicles logged at least 1.5 million miles in 2018. A balanced portfolio of emissions reduction action requires that the vehicle miles traveled for city business decrease 20-30% by 2035. That is much easier to envision now than it might have been even a year ago, as the COVID-19 pandemic has forced new ways of working.

---

[66] Georgetown Climate Center, "Capturing the Federal EV Tax Credit for Public Fleets: A Case Study of a Multi-Jurisdictional Electric Vehicle Fleet Procurement in Alameda County, California," April 2017. https://www.georgetownclimate.org/files/report/Capturing-the-Federal-EV-Tax-Credit-for-Public-Fleets%20-%20Case%20Study.pdf

[67] U.S. Department of Energy and U.S. Department of Transportation, Guide to Federal Funding, Financing, and Technical Assistance for Plug-in Electric Vehicles and Charging Stations, July 2016. https://www.energy.gov/sites/prod/files/2016/07/f33/Guide%20to%20Federal%20Funding%20and%20Financing%20for%20PEVs%20and%20PEV%20Charging.pdf

[68] Oak Ridge National Laboratory, "Keeping Your Vehicle in Shape," Fuel Economy.Gov, accessed December 8, 2020, //www.fueleconomy.gov/feg/maintain.jsp.

[69] Harto, Chris, et al "Electric Vehicle Owners Spending Half as Much on Maintenance Compared to Gas-Powered Vehicle Owners, Finds New CR Analysis."

Policies and strategies to achieve VMT reduction can include trip reduction, travel efficiency, and use of alternative modes.

Trip Reduction

Ensuring staff have the tools and resources they need to avoid traveling will be the most cost-effective fleet strategy. Departments should be given clear data on their vehicle use with associated targets for reduction. Additional technology for online meetings and conferences should be provided where needed to reduce travel.

Some of trip reduction is a cultural shift—if leadership shows a preference for virtual meetings or avoiding travel it will set the tone. Trip reduction can also be made fun through a competition between departments. Consider also if the locations of staff and activities can be shifted to reduce travel needs between facilities.

Out of town business travel is not yet recorded in Evanston's municipal operations GHG inventory but tracking of it should begin and targets should be set to limit its use to essential needs.

Travel Efficiency

When travel in Evanston fleet vehicles is necessary it should be done efficiently. Routes for vehicles such as garbage trucks should be analyzed for efficiency—fuel savings may be possible by changing routes or adjusting vehicle overnight parking locations. Carpooling among all staff for City business should be expected and rewarded. A staff survey or travel diary may identify ways in which trips for multiple purposes can be combined to save mileage, as well.

Alternative Modes

Evanston is a multi-modal city and City operations should take advantage of that. Staff should be encouraged, expected, and rewarded for traveling to meetings virtually, by bicycle, on foot, or by public transit. Current vehicle uses should be analyzed to determine use purposes that could be replaced by other modes. The City conducting its operations on foot, by bicycle, or on transit makes its commitment to carbon-neutrality visually present in the community. Some of these alternative modes may be weather-dependent, so the city may want to provide a limited number of taxi vouchers or other back up transportation options to staff (these should be carefully tracked as they would be part of the city's operational carbon footprint).

Staff Commutes

Staff commutes are outside of the scope of Evanston's municipal operations GHG inventory, however best practice for climate action would encourage staff to reduce the GHG emissions associated with their commute. The strategies listed in this VMT Reduction section can be applied to commutes as well. Policies such as parking cash out, subsidized transit passes, or payments for staff who walk, bike or carpool are all also supportive of reducing staff commute emissions. The location of City facilities should be prioritized for location efficiency and access by transit and other non-auto transportation modes. Electric charging stations could be made available to staff who commute or carpool by personal vehicle to encourage clean vehicle use.

Cost Impacts

A high-level cost estimate was created for each of the scenarios as shown in Table 4. Implementation and operational choices made in the process of decarbonizing the fleet can greatly impact costs, so these values should be considered as indicators of the scale of cost involved rather than as forecasts.

Scenario 1 creates total savings over the period from 2021-2035 of $12 million. This scenario has the highest costs for infrastructure and vehicle purchases over business as usual, but it also generates the most savings in annual fuel and maintenance costs. Scenario 1 includes a large reduction in the number of fleet vehicles and vehicle miles traveled, which both generate cost savings against business as usual.

Scenario 2 has the lowest total savings at $5 million from 2021-2035. Both Scenarios 2 and 3 have lower investment needs as less of the fleet is transformed to zero carbon fuels, but both achieve lower annual fuel and maintenance savings as a result.

The bulk of the infrastructure investment in each scenario needs to occur in the early to mid-point of the scenario period to support the fleet as it transforms. In 2021 and 2022 investment needed will include electric vehicle charging stations for smaller fleet vehicles. As charging needs grow in future years a significant electrical system upgrade is likely required and those costs are estimated in the scenarios. The on-site solar investment could be spread out over time, but earlier installation is encouraged to capture the electricity cost savings it will generate and its GHG benefits.

Table 4. Estimated Cost Impacts by Scenario

2035	Scenario 1	Scenario 2	Scenario 3
Annual Fuel Cost Reduction from Business as Usual in 2035[70]	$(400,000)	$(300,000)	$(220,000)
Annual Maintenance Cost Reduction from Business as Usual in 2035[71]	$(3,200,000)	$(1,700,000)	$(1,500,000)
Estimated Change in Fleet Vehicle Purchase Costs (Total 2021-2035)[72]	$670,000	$(600,000)	$(1,300,000)
Estimated Infrastructure Cost (Total 2021-2035)[73]	$16 million	$12 million	$8.2 million
Total Estimated Savings from 2021-2035[74]	$(12,000,000)	$(5,400,000)	$(6,800,000)

[70] Fuel savings include increased fuel economy, reduced vehicle miles traveled, cost savings from self-generating electricity with on-site solar and the cost savings of grid electricity over other transportation fuels. Annual value. All cost values in today's dollars.
[71] Maintenance savings is an estimate based on Evanston's reported 2018 fleet maintenance costs per mile, maintenance cost differentials reported for New York City's electric fleet, and reductions in vehicle miles traveled in each scenario. Annual value.
[72] Net fleet purchase costs include the added cost of electric vehicles over business as usual and the savings from fewer vehicle purchases with rightsizing.
[73] Infrastructure costs include the total estimated costs for electric vehicle chargers, on-site solar installation, and electrical system upgrades. These costs may vary significantly with infrastructure system design.
[74] Total estimated savings are infrastructure costs + change in fleet costs + annual fuel and maintenance savings assuming an adoption rate of new vehicles and technology of 7% of the fleet per year + offset purchases in 2035 to achieve carbon neutrality.

Appendix 1: Fuel Lifecycle Emissions Comparison[75]

While Evanston's municipal operations GHG inventory does not include lifecycle emissions, Evanston should take these into consideration when making choices about fuels or infrastructure investments. Argonne National Laboratory's GREET calculator provides in-depth information on fuel and vehicle lifecycle impacts. The fuel module estimates GHG emissions from "Pump to Wheels" (PTW, the direct emissions in the GHG inventory), as well as "Well to Pump" (WTP, indirect Scope 2 and upstream Scope 3 emissions). The figure below provides these values in terms of grams of CO_2e per gallon of gasoline equivalent (GGE).

The GREET model shows two zero carbon fuels on the current market—renewable electricity and hydrogen from distributed solar. This is indicated by the black dot, which is the sum of WTP and PTW impacts, including negative carbon values from fuel sources that take carbon out of the atmosphere, such as when soybeans are growing.

Biofuels, such as biodiesel, ethanol and renewable diesel, produce carbon emissions upon combustion, but those emissions are considered biogenic carbon that are part of the existing carbon cycle, which is tracked separately and considered a lower impact than anthropogenic carbon. Thus, they can be considered nearly carbon neutral fuels, despite showing significant tailpipe carbon emissions, if they are sustainably produced and their upstream emission are not large.

[75] Energy Systems, "GREET 2019 WTW Calculator," Argonne National Laboratory, 2019, https://public.tableau.com/views/GREET2019_WTWCalculator/GHG_Dashboard?:embed=y&:showVizHome=no&:host_url=https%3A%2F%2Fpublic.tableau.com%2F&:embed_code_version=3&:tabs=no&:toolbar=yes&:animate_transition=yes&:display_static_image=no&:display_spinner=no&:display_overlay=yes&:display_count=yes&publish=yes&:loadOrderID=0.

Figure A- 1 Lifecycle Emissions of Transportation Fuels (gCO2e/gallons of gasoline equivalent) (Pump-to-Wheels and Well-to-Pump) [76]

---

[76] Energy Systems, "GREET 2019 WTW Calculator," Argonne National Laboratory, 2019, https://public.tableau.com/views/GREET2019_WTWCalculator/GHG_Dashboard?:embed=y&:showVizHome=no&:host_url=https%3A%2F%2Fpublic.tableau.com%2F&:embed_code_version=3&:tabs=no&:toolbar=yes&:animate_transition=yes&:display_static_image=no&:display_spinner=no&:display_overlay=yes&:display_count=yes&publish=yes&:loadOrderID=0.

The following figure models the same data on a per mile basis, which considers typical vehicle efficiencies. In this approach, the efficiency gains and greater carbon emissions advantages of electric and fuel cell vehicles is more apparent than in the figure above.

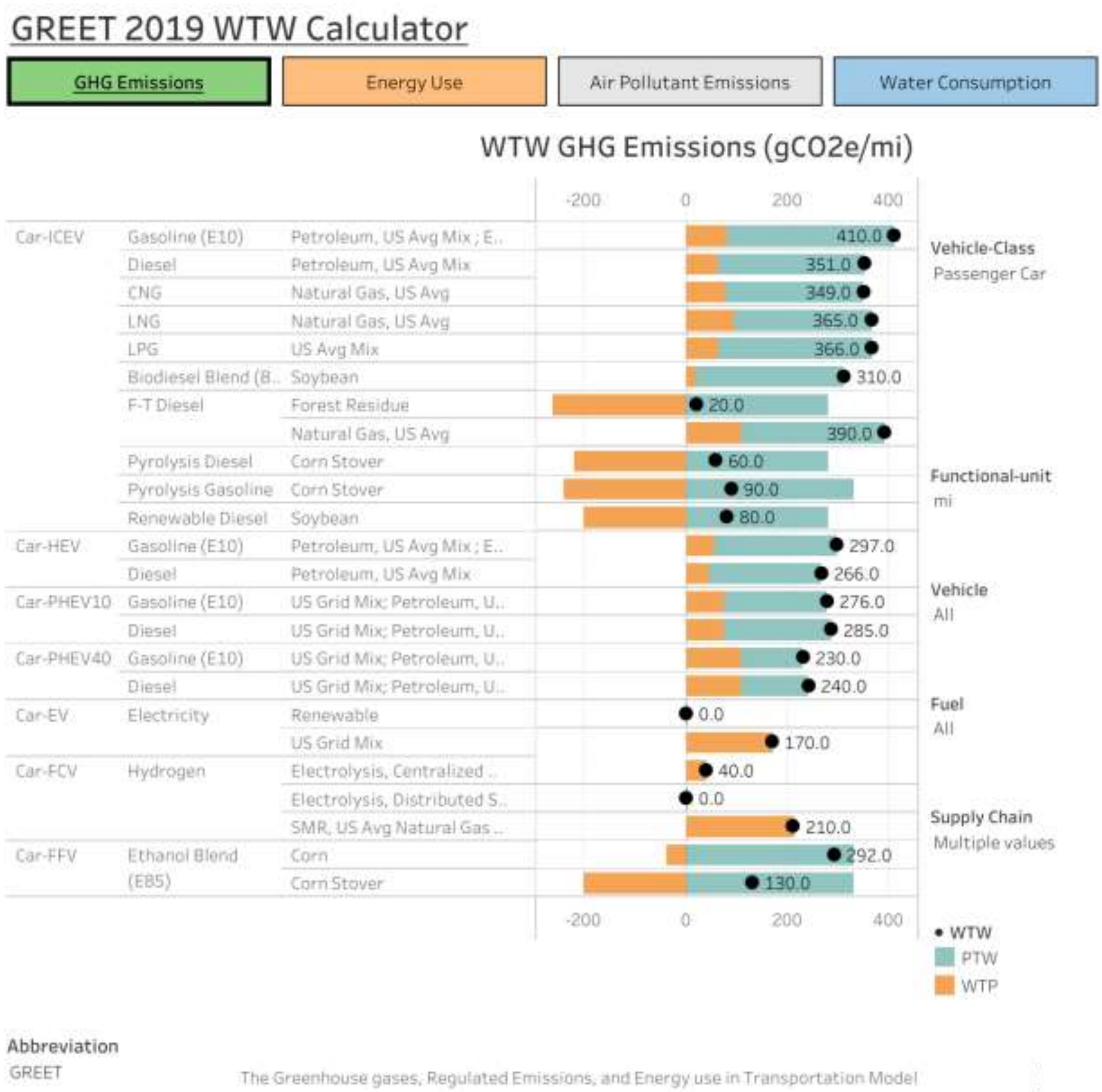

Figure A- 2. Lifecycle Emissions of Transportation Fuels per Mile in a Passenger Car (gCO2e/mile) (Pump-to-Wheels and Well-to-Pump) [77]

[77] Energy Systems, "GREET 2019 WTW Calculator," Argonne National Laboratory, 2019.

Table B-1. Model Year 2020 & 2021 Vehicle Examples

Vehicle Make & Model	Model Year	Fuel	Efficiency	Efficiency Units	Range (miles on one full tank / battery)	MSRP Cost Low	MSRP Cost High	Time to Charge Battery	Car and Driver Rating	Cost Analysis Annual Miles	Annual Fuel Use	Fuel Units	Annual Fuel Cost	Annual Maintenance Cost	Total 10-Year Annualized Cost	Annual GHG MTCO2e
Sedans																
Hyundai Ioniq	2020	Electric	25	kWh/100 mi	170	$33,045	$38,615	5.8 hrs at 240V	8	10,000	2,500	kWh	$181	$200	$3,964	1.3
Chevrolet Bolt EV	2020	Electric	29	kWh/100 mi	259	$37,495	$41,895	10 hrs at 240V	8	10,000	2,900	kWh	$209	$200	$4,379	1.5
Nissan Leaf	2020	Electric	30	kWh/100 mi	226	$31,600	$38,200	8 or 11 hrs at 240V	6.5	10,000	3,000	kWh	$217	$200	$3,907	1.6
Chevrolet Malibu	2021	Gasoline	32	mpg	506	$23,065	$34,295	N/A	7	10,000	313	Gallons	$691	$440	$3,999	2.7
Ford Fusion Hybrid FWD	2020	Gasoline	42	mpg	588	$28,000	$34,595	N/A	6	10,000	238	Gallons	$526	$440	$4,096	2.1
Ford Fusion Energi Plug-in Hybrid	2020	Gasoline	42	mpg	610	$37,000	$37,000	2.6 hrs at 240V		10,000	238	Gallons	$526	$440	$4,666	2.1
SUVs																
Hyundai Kona	2020	Electric	27	kWh/100 mi	258	$37,190	$45,400	9 hrs at 240V	9	10,000	2,700	kWh	$195	$200	$4,524	1.4
Kia Niro	2020	Electric	30	kWh/100 mi	239	$39,090	$44,590	9.5 hrs at 240V	8.5	10,000	3,000	kWh	$217	$200	$4,601	1.6
Volvo XC40 AWD BEV	2021	Electric	43	kWh/100 mi	208	$54,985	$54,985	8 hrs at 240V		10,000	4,300	kWh	$310	$200	$6,009	2.3
Ford Explorer AWD HEV	2021	Gasoline	25	mpg	465	$49,855	$51,855	N/A	7.5	10,000	400	Gallons	$884	$440	$6,410	3.5
Ford Explorer RWD	2021	Gasoline	24	mpg	446	$32,225	$44,710	N/A	7.5	10,000	417	Gallons	$921	$440	$5,208	3.7
Ford Explorer RWD HEV	2020	Gasoline	28	mpg	540	$52,280	$52,280	N/A	7.5	10,000	357	Gallons	$789	$440	$6,457	3.1
Ford Explorer RWD	2020	Gasoline	24	mpg	461	$36,675	$48,310	N/A	7.5	10,000	417	Gallons	$921	$440	$5,610	3.7
Vans																
Ford E-Transit Connect	2022	Electric	unknown		126	$24,285	$45,000	10 miles / hr @240V, or 15 miles / hr @240V-48A	8.5	10,000						

Ford Transit Connect	2021	Gasoline	26	mpg	411	$24,665	$28,795	N/A		10,000	385	Gallons	$850	$440	$3,963	3.4
Ford Transit Connect	2021	Ethanol	19	mpg	300	$24,665	$28,795	N/A		10,000	526	Gallons	$1,316	$440	$4,429	0.0
Pickup Trucks																
Ford F-150	2023	Electric	unknown		Hoping 300	$70,000	$70,000			10,000						
Ford PowerBoost Hybrid F-150	2021	Gasoline	23	mpg						10,000	435	Gallons	$961	$440		3.8
Ford F-150	2020	Ethanol	16	mpg	368	$28,745	$55,820	N/A	9	10,000	625	Gallons	$1,563	$440	$6,231	0.0
Ford F450 4x4	2021	Gasoline	15	mpg	435	$55,415	$55,415			10,000	667	Gallons	$1,473	$440	$7,455	5.9

Ethanol vehicles would also emit 3.0-3.6 $MTCO_2$(b) biogenic emissions.
Sources: U.S. DOE and U.S. EPA "Fuel Economy.gov" https://www.fueleconomy.gov/
Car and Driver https://www.caranddriver.com
City of Evanston Fuel Cost Data
U.S. EPA GHG Emissions Factors
Consumer Reports, "Electric Vehicle Ownership Costs," October 2020. https://advocacy.consumerreports.org/wp-content/uploads/2020/10/EV-Ownership-Cost-Final-Report-1.pdf

Appendix 4.
Technical Assumptions

Baseline Greenhouse Gas Assumptions

Fuel consumption, electricity and natural gas usage and renewable energy (solar) onsite production were obtained from the 2018 Municipal Greenhouse Gas Inventory and assumed to be correct. In addition, part of the larger project was to review this inventory for its reporting accuracy.

Building Energy Savings Potential and Associated Costs

Energy Savings. The kilowatt hours and therms savings potential for energy consumption-related strategies were estimated based in part first on energy assessments across three municipal buildings. Using that information, an estimated high/low range of electricity and natural gas savings were calculated per square foot, then attributed across other buildings.

Cost Savings. Operational savings due to reduced energy consumption were used by taking an average cost per kilowatt hour and therms for the three assessed buildings, and applying that average cost per energy unit to the electricity and natural gas savings associated with the energy efficiency and electrification strategies. The cost of additional electricity consumption due to electrification was also calculated using an average estimated cost per kilowatt hour.

Construction/Installation Costs. The one-time cost for construction and installation of energy efficiency, renewable energy and electrification strategies can differ depending on type of materials, building type and other factors. The team applied a dollar amount per square footage for each municipal building.

Onsite Solar Capacity Potential. The rooftop solar capacity was analyzed for Evanston's municipal buildings using a formula that identified roof area, a cover ratio factor for solar modules, site orientation and other factors. This model provides reasonable estimates but does not replace individual onsite assessments for each building prepared by a certified professional.

Onsite and Offsite Solar Costs. Using inputs on estimated solar capacity and remaining electricity consumption after all other strategies have been implemented, a cost per installed kilowatt hour was applied for onsite solar development and installation ($2.14 per installed watt), and a cost per kilowatt hour for the development of new, offsite solar generation ($1.90 per installed watt). These cost estimates do not replace site-specific assessments conducted by a certified professional.

Cost Assumptions for Renewable Energy Credits and other Offsets. The cost per megawatt hour (MWh) for new solar generation was estimated at $6. Offsets for any remaining natural gas consumption were calculated using an estimate of $10 per MMBTU. This value assumption is based on 2021 industry numbers and may differ over time.

Streetlight Energy Savings Potential and Associated Costs

Energy Savings. Electricity kilowatt hour savings were assumed using the 2018 Evanston Street Light Master Plan, and a review of an analysis for streetlight efficiency upgrades via the local electricity utility.

Cost Savings. Using the estimated kilowatt hours savings, the team applied an estimated cost per kilowatt hour to arrive at an estimated total cost savings.

Installation Costs. Based on information supplied by the 2018 Evanston Streetlight Master Plan, the installation costs include total pole replacement of 1/3 of all Tallmadge lights, with 2/3 fixture replacement only, and all Cobra heads with fixture replacement only. Labor and installation costs, per the plan, assumed the following: Tallmadge with pole replacement: $5760; Tallmadge without pole replacement: $2060 without poles; Cobra-head fixtures: $659.

Fleet Fuel Savings Potential and Associated Costs

Fuel Savings. The strategies result in a reduction in fuel consumption (gasoline and diesel, primarily) and therefore result in overall fuel savings. The dollar amount for fuel savings were achieved by multiplying the total gasoline and diesel savings against the dollar amount per gallon, based on the 2021 fuel costs, per City of Evanston fleet maintenance records.

Maintenance Cost Savings. For the bulk of Evanston's vehicles that use unleaded gasoline, B20 diesel and diesel, the maintenance costs were calculated by examining fleet assessment data with vehicles over 1000 miles annually and those with over 1000 lifetime miles, arriving at an average lifetime maintenance cost per mile. For electric vehicles and renewable biodiesel, maintenance costs were researched across several sources to arrive at an average lifetime maintenance cost per mile. Maintenance cost per mile assumptions were as follows: Unleaded gasoline $1.24; B20 Diesel $6.82; Diesel $5.11; Electric $0.62; Renewable Diesel/Other Biofuels $5.11.

Infrastructure and other One-Time Costs. Estimates for the cost of new infrastructure includes vehicle charges, onsite solar and electrical system upgrades, and vehicle purchase costs, including the differential costs from transitioning from traditional vehicles to more electric vehicles, among other purchasing habit changes. Costs for each are based on industry standard pricing in 2021. Implementation and operational choices made in the process of decarbonizing the fleet can greatly impact costs, so the values noted in the ZES should be considered as indicators of the scale of cost, rather than forecasts.

Emissions Calculations

Electricity Consumption in Buildings and Streetlights. Electricity emissions calculations utilize location based accounting of electricity greenhouse gas emissions, which applies a specific factor that is supplied by the U.S. Environmental Protection Agency – in this case it is the eGrid subregion RFC West emissions factor. (MTCO2e/kWh: .00036516)

Evanston intends to use offsite renewable energy to make its operations fully carbon neutral. The RFC West emissions factor stays relevant even in that scenario, because GHG accounting protocols typically require "location-based" accounting of electricity GHGs, which would entail applying the RFC West emissions factor to all grid-connected electricity use. The purchase of renewable energy toward the goal of carbon neutrality is accounted for with a second "market-based" emissions accounting approach, and both location-based and market-based GHG emissions must be reported. A full explanation of these dual accounting approaches is provided in the *GHG Protocol Scope 2 Guidance*.[1] Strategies to reduce grid-sourced electricity use, such as through demand reduction and on-site renewable electricity production, will reduce GHG emissions for both reporting approaches.

Natural Gas Combustion in Buildings. Natural gas emissions applied the standard factor supplied by the U.S. Environmental Protection Agency. (MTCO2e/therms: .00531)

Fleet/Fuel Consumption. Emissions factors are applied for the various types of fuel consumption, per gallon, as well as added electricity consumption related to the increase in electric vehicles. (MTCO2e/gasoline gallon: .008789395; MTCO2e/diesel gallon: .010213978; MTCO2e/electric: .00036516; MTCO2e/Biodiesel gallon: 2.41336E -05)

[1] World Resources Institute, "GHG Protocol Scope 2 Guidance: An Amendment to the GHG Protocol Corporate Standard," 2015. https://ghgprotocol.org/sites/default/files/standards/Scope%202%20Guidance_Final_Sept26.pdf The *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories* includes similar guidance.