MADISON METROPOLITAN SCHOOL DISTRICT

COMPREHENSIVE ENERGY PLAN

FINAL REPORT

October 20, 2022

PLUNKETT RAYSICH ARCHITECTS, LLP

DESIGN ENGINEERS

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EXECUTIVE SUMMARY

All four scenarios achieve the same final result (100% renewable energy, zero GHG emissions), but differ in the metrics, timelines and capital costs. The four scenarios examined include:

- Scenario 1: 100% Renewable Energy by 2040
- Scenario 2: Zero Greenhouse Gas (GHG) Emissions by 2040
- Scenario 3A: Zero GHG Emissions by 2050 (constant rate of reduction)
- Scenario 3B: Zero GHG Emissions by 2050 (constant rate of capital investment)

Comparison of Scenarios	Current Path	Scenario 1	Scenario 2	Scenario 3A	Scenario 3B
Total GHG Emissions Reduction (Metric Tons CO2e)	-	390,000	300,000	140,000	160,000
Capital Investment					
Start Construction in year		2024	2024	2034	2024
Complete Construction in year		2039	2039	2049	2049
Peak Rate of Capital Expenditures ($/yr)		$ 75,000,000	$ 33,000,000	$ 40,000,000	$ 20,000,000
Total Capital Investment		**$510,000,000**	**$510,000,000**	**$510,000,000**	**$510,000,000**
Energy Operating Costs					
2050 Annual Operating Cost	$ 4,900,000	$ 2,700,000	$ 2,700,000	$ 2,700,000	$ 2,700,000
Ave Annual Energy Operating Cost (2025-2050)	$ 4,900,000	$ 3,200,000	$ 3,500,000	$ 4,100,000	$ 3,900,000
Ave Annual Renewable Energy Premium (2025-2050)	$ -	$ 240,000	$ 180,000	$ -	$ -
Total Energy Operating Cost	**$155,400,000**	**$111,100,000**	**$119,900,000**	**$134,000,000**	**$128,900,000**
Total Capital & Operating Cost through 2050	**NA**	**$621,100,000**	**$629,900,000**	**$644,000,000**	**$638,900,000**

COMMENTARY

- GHG Emissions: Scenarios 1 & 2 have the highest total GHG reductions due to completing most of the upgrades early in the analysis period.
- Capital Investment:
  - Scenario 1 requires a massive investment in the years 2025 – 2030 ($75M/yr). This may not be realistic since not only does it require more funding up front, the type of construction required is complex (work in existing buildings requiring phasing to minimize impact on operations).
  - Scenario 3B has the most realistic construction timeline since it distributes the work evenly over the analysis period.
- Energy Operating Costs: Similar to GHG emissions, Scenarios 1 & 2 have the lowest total operating costs due to their accelerated timelines.

CONCLUSION

While Scenario 1 has the greatest reduction in GHG emissions and lowest total operating costs, the timeline for implementation is very challenging and may not be possible. Scenario 3B has the most viable implementation timeline and has the additional advantage of aligning with both the IPCC and with Madison Gas & Electric's timelines for climate change mitigation.

INTRODUCTION

In April 2019 the Madison Metropolitan School District Board of Education adopted a resolution to meet 50% of the district's operations energy needs with renewable energy by 2030, 75% by 2035 and 100% by 2040. This study was commissioned to develop a comprehensive plan to achieve these goals.

The first progress report defined the current state of energy use and sources as well as projections for energy use based on current plans for expansion, energy efficiency and renewable energy sourcing. It identified Greenhouse Gas (GHG) emissions as an alternative metric that better aligns with the Intergovernmental Panel on Climate Change's mitigation goals.

The second progress report outlined strategies needed to achieve the goal of 100% renewable energy and zero greenhouse gas emissions and examined four scenarios for implementing these strategies.

This third progress report refines and updates the building system strategies previously identified and adds an analysis of operating costs for each scenario.

The final report represents

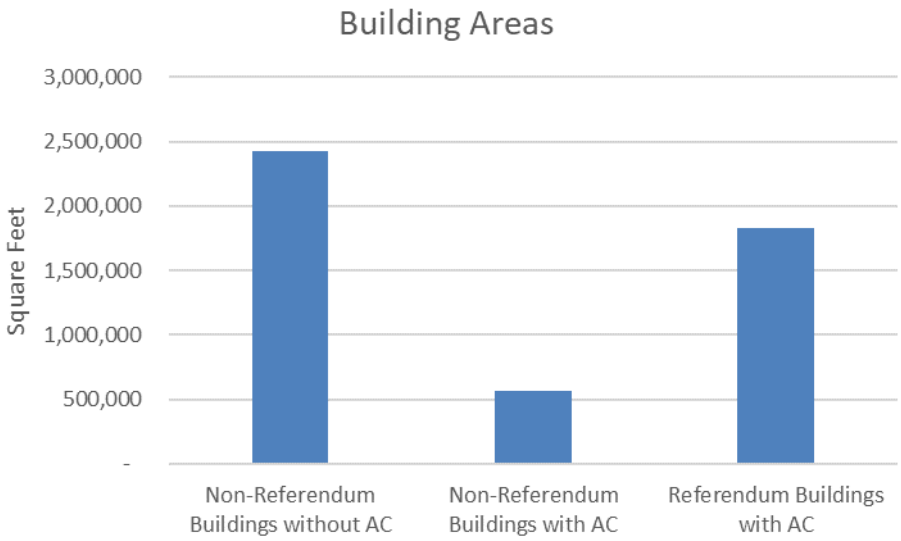
BUILDING IMPROVEMENTS

CONVERT BUILDING HEATING SYSTEMS TO ELECTRIC AND IMPROVE ENERGY EFFICIENCY

Since current building heating systems account for 73% of energy use, converting this use to renewable energy is the most impactful strategy for meeting the district's energy needs from renewable sources. Since the district's heating systems are overwhelmingly powered by natural gas and since no renewable sources of natural gas are available to the district, the building heating systems must be converted to be powered by electricity which can be provided from renewable sources.

In addition to converting natural gas heating systems to electric, improving the energy efficiency of the existing buildings will contribute to the goal of reducing the climate impact of district operations. Since installing new HVAC systems constitutes a significant construction undertaking, there is an inherent economy of scale to including other energy efficiency upgrades at the same time.

The district's buildings fall into three priorities. The first priority is buildings which are currently not air conditioned. A second priority is buildings which are currently air conditioned, but not part of the most recent referendum. Finally, the buildings included in the most recent referendum will be fully air conditioned when completed in 2024 and will have heating systems with the most remaining life, so it is logical to electrify those systems last. The following graph illustrates the total square footage for these three categories.



This analysis assumes the following building system improvements are included in projects to implement electrification of building heating systems for each of the above categories.

Non-Referendum Buildings without Air Conditioning

- New geothermal heating and cooling system including all new distribution piping terminal units and ductwork as well as new electric service to power the heat pumps. The extensive nature of

this work will also require installation of new ceilings and fire suppression throughout as well as miscellaneous chases and soffits.
- New energy recovery ventilation including distribution ductwork
- New LED lighting
- New fire suppression system
- New windows
- New roofing with increased insulation
- Total project cost estimated at $161/sf

Non-Referendum Buildings with Air Conditioning

- New geothermal heating plant and distribution piping. Replacing existing heating coils to work with low temperature hot water. Assumes existing terminal units and ductwork will be reused. Assumes new ceilings in corridors and minimal chases and soffits due to less extensive modifications required than for buildings without air conditioning.
- New LED lighting
- New windows
- New roofing with increased insulation
- Total project cost estimated at $86/sf

Referendum Buildings:

- Replace existing gas-fired boilers with geothermal heat pumps. Since the heating distribution systems have been designed for low temperature hot water (130 F), the existing piping and coils can be reused. This means no ceiling work or chases will be required.
- Since these buildings are currently being fully renovated, other efficiency upgrades are not required
- Total project cost estimated at $32/sf

INSTALL SOLAR ELECTRICITY GENERATION

Once fossil fuel uses have been converted to electric, the next step to carbon free energy is to obtain electricity from renewable sources. This can be done by purchasing renewable electricity and/or generating it directly. The most practical method for the district to install renewable electricity generation is rooftop photovoltaics (PV).

Since a detailed analysis of how much solar power can be installed at each school is beyond the scope of this study, and since a review of Madison Gas & Electric's rate structure revealed a more favorable rate structure if systems are limited to 100 kW per building, the analysis assumes that each of the non-referendum buildings includes installation of 100 kW of rooftop PV. Since the referendum projects will include photovoltaic installations, no additional PV is included for those buildings.

It is further assumed that the photovoltaic installations will be combined with other upgrades to capture the economy of scale and efficiency of incorporating it into a larger project. Based on this, the additional

total project cost for adding PV to the HVAC Upgrades is estimated at $2,420/kW. Based on an estimate of annual solar production and M G&E's rate structure, it is anticipated the annual savings generated will be approximately $126/yr per KW installed. This results in a simple payback of 19.2 years. Note however, that this does not take into account any escalation of utility rates. At an escalation rate of 3%, the payback is just under 15 years.

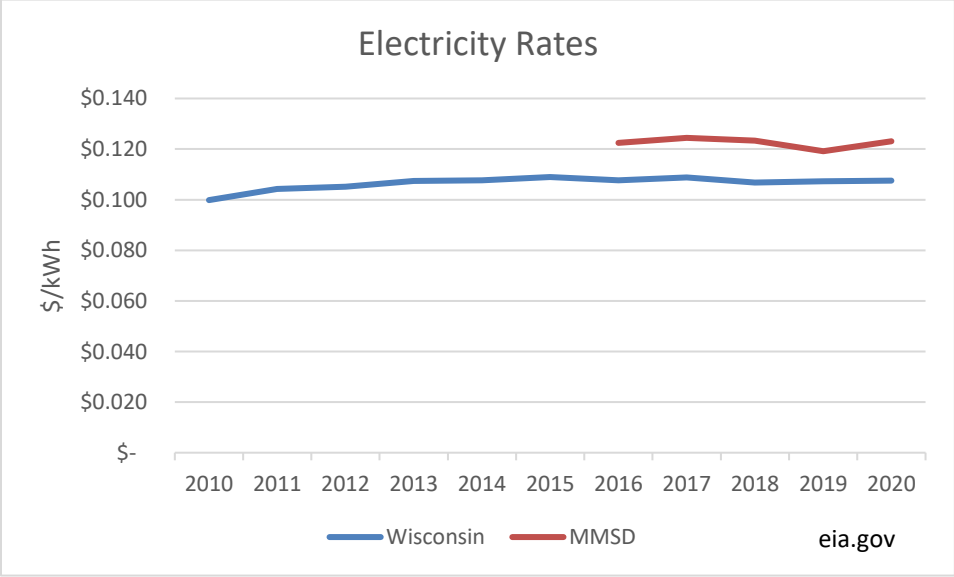
CAPITAL INVESTMENT ESTIMATES

For the purpose of this analysis, all costs will be presented in 2022 dollars. Escalation and financing costs are not included to facilitate a direct comparison of capital costs of the various alternatives to highlight the basic differences without the distraction of varying assumptions of escalation factors and finance costs. However, when planning actual budgets based on the selected strategies, escalation and financing costs will need to be added. For construction costs, total project costs have been estimated to include 10% contingency and 20% soft costs.

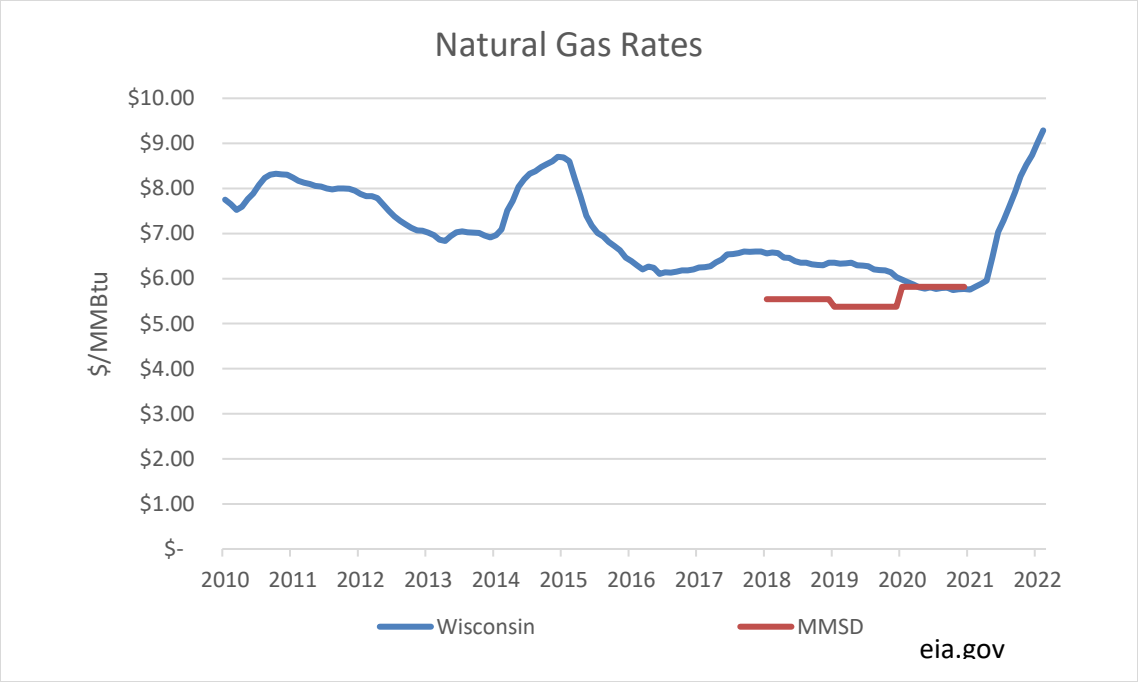
OPERATING COST ESTIMATES

Similarly, operating costs are presented based on 2022 rates. While these rates will certainly escalate, the rate of escalation and in particular, the relative escalation of gas and electricity rates, is unknown and historically highly variable. Including escalation rates could obscure some of the underlying dynamics. However, when budgeting for these future expenses, it will be necessary to include some escalation factor and update estimates regularly.

For reference, the following charts illustrate recent trends in gas and electric rates for both Wisconsin averages and MMSD actuals.

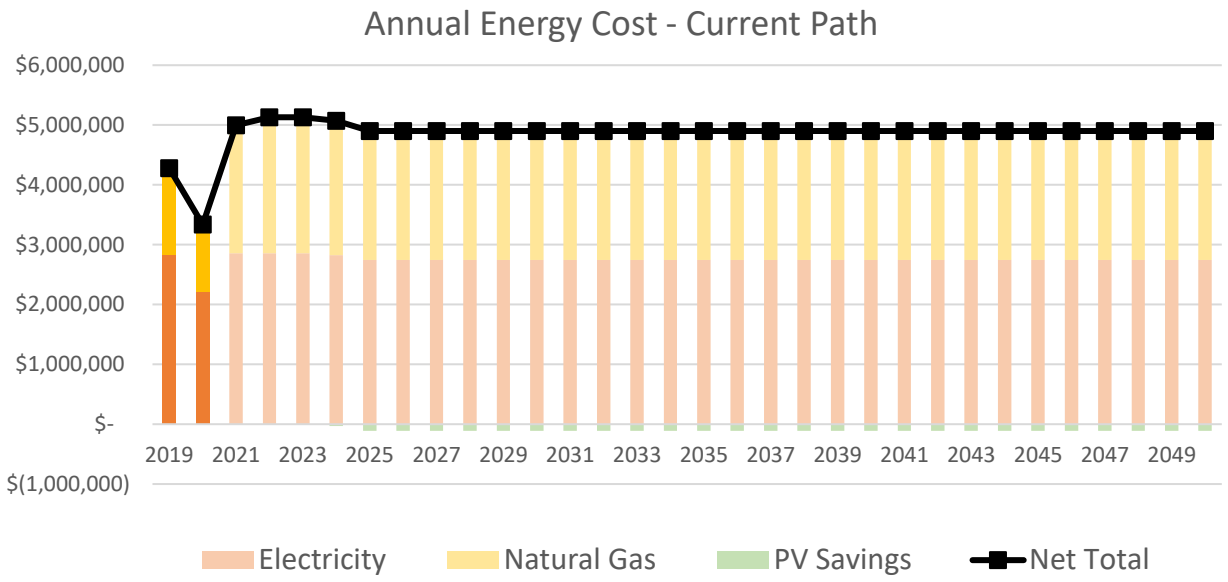


As shown in this graph, Wisconsin electricity rates have been fairly stable. The same cannot be said for natural gas rates which have varied significantly.



CURRENT PATH OPERATING COST ESTIMATE

Since the current path does not involve any specific changes to energy systems after the referendum projects are complete, total energy costs remain constant at approximately $5M/yr (in 2022 dollars) after 2025.



SCENARIO 1: 100% RENEWABLE BY 2040

Scenario 1 is based on the timeline needed to meet the goals as stated in the Board of Education Resolution. In other words, it addresses the type and pace of implementation needed to modify the district's energy usage such that 50% of the total energy used comes from renewable energy by 2030, 75% by 2035 and 100% by 2040. This section of the report outlines the timeline and associated capital budgets to achieve these goals.

STRATEGIES & CAPITAL COSTS

To meet the goals in this scenario, strategies were selected to produce a uniform increase in % renewable energy between 2025 and 2040. This approach also ensures meeting the interim goals for 2030 and 2035.

Work in Non-Referendum Buildings (2024– 2029): $75.2M/yr

- Upgrade HVAC and implement energy efficiency improvements in buildings without AC at the rate of approximately 400,000 sf per year. $65.3M/yr
- Electrify heating and implement energy efficiency upgrades in buildings with AC at the rate of 90,000 sf per year. $8.1M/yr
- Install photovoltaic electricity generation on these building's roofs at approximately 750 kW/yr. $1.8M/yr

Work in Referendum Buildings (2030 – 2039)

- Electrify heating at the rate of 180,000 sf per year. $5.9M/yr.

Other Measures (2030-2039)

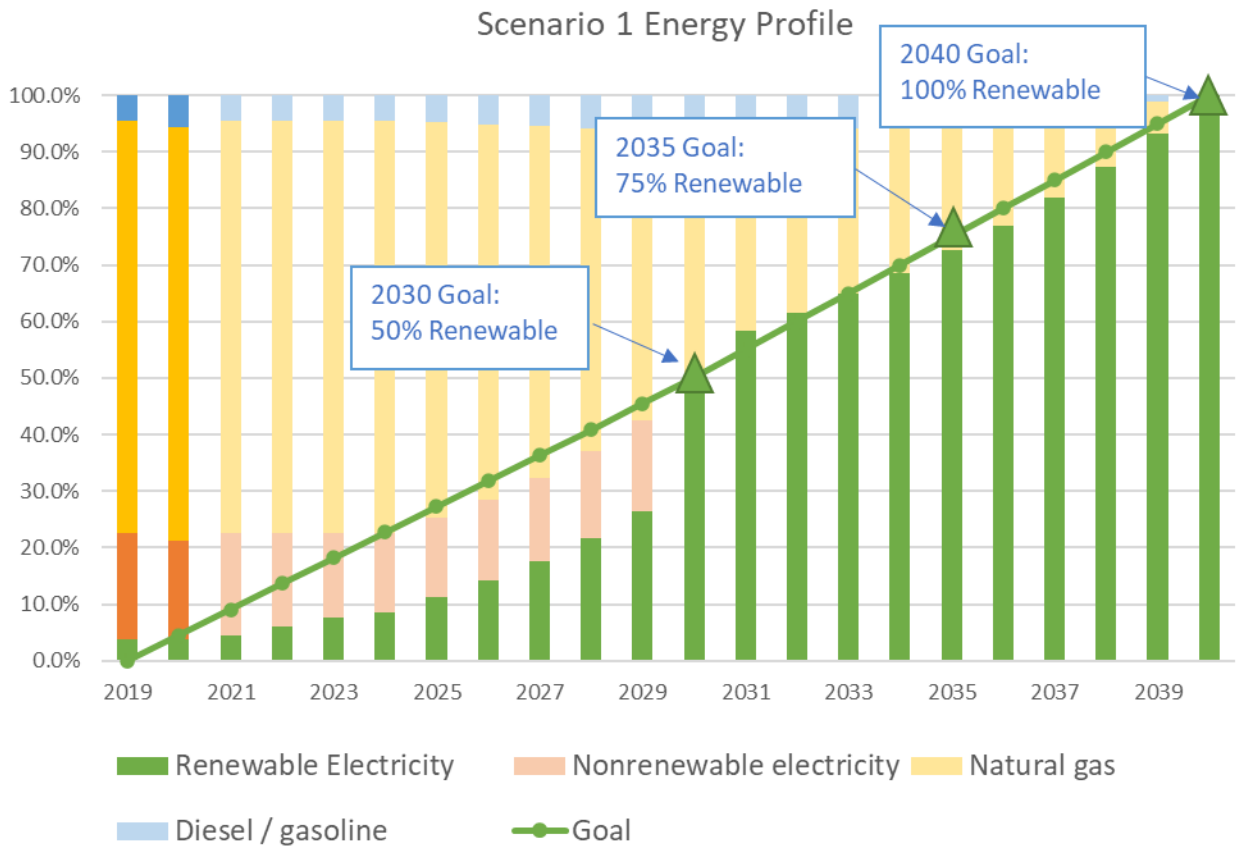
- Purchase all electricity from renewable sources while the remainder of natural gas heating systems are converted to electric. This is possible through Madison Gas & Electric's Green Tomorrow program by which the customer pays an additional fee of $0.01/kWh in order to secure electricity that comes from renewable sources.
- Convert district-owned vehicles and contracted buses to electric (2024-2039)

Total Capital Investment: $510M

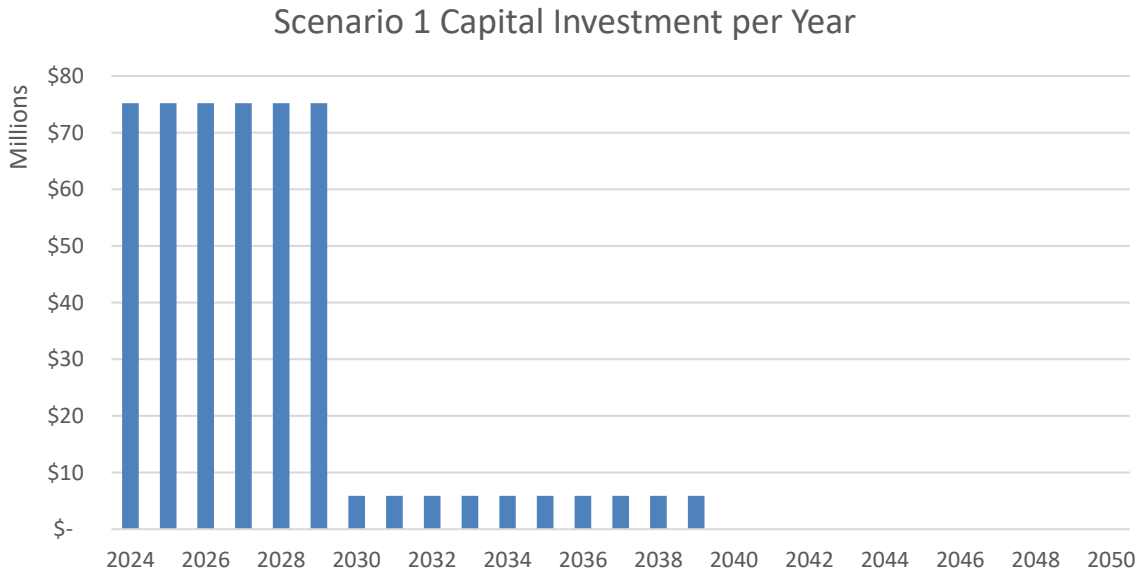
Note that starting in 2030, 100% of the district's electricity must come from renewable sources to meet the goal of having 50% of the district's total energy come from renewable energy. This remains the case as the district's fossil fuel use is phased out from 2030 to 2040. Although it is theoretically possible to meet the 2030 goal by converting all fossil fuel use to electricity and procuring only 50% of electricity from renewable sources, that is not practical since it would involve converting all of the district's buildings and vehicles to electric in that time. Similarly, while it would be possible to meet the goal with installing more photovoltaics and reducing the need to pay a premium for purchased electricity to come from renewable sources, that would involve transitioning to a less favorable electric rate as well as finding additional sites for photovoltaics which may not be possible.

Implementing these strategies on these timelines results in the following energy profile

SCENARIO 1: 100% RENEWABLE BY 2040



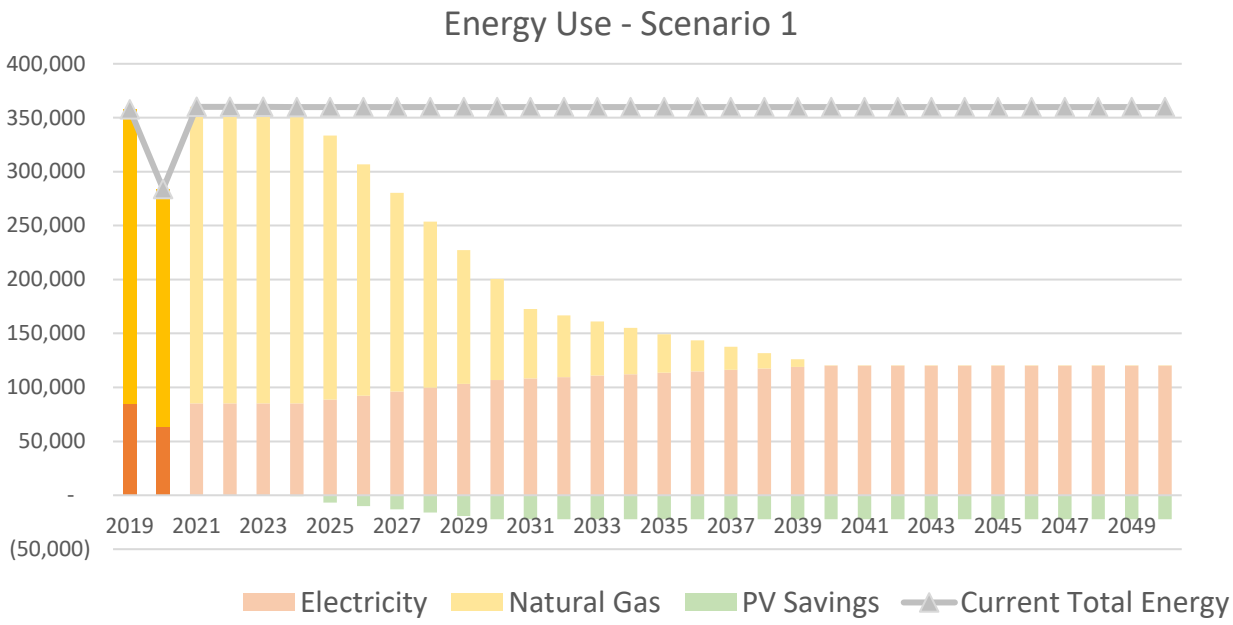
As illustrated by the following graph, meeting the target of 50% renewable energy by 2030 requires the vast majority of funds to be used in the first 6 years.



SCENARIO 1: 100% RENEWABLE BY 2040

ENERGY CONSUMPTION & OPERATING COSTS

Although the HVAC improvements involve adding the new load of air conditioning to many buildings, this is more than offset by efficiency improvements. The following graph shows total energy use of this scenario compared to the current path.

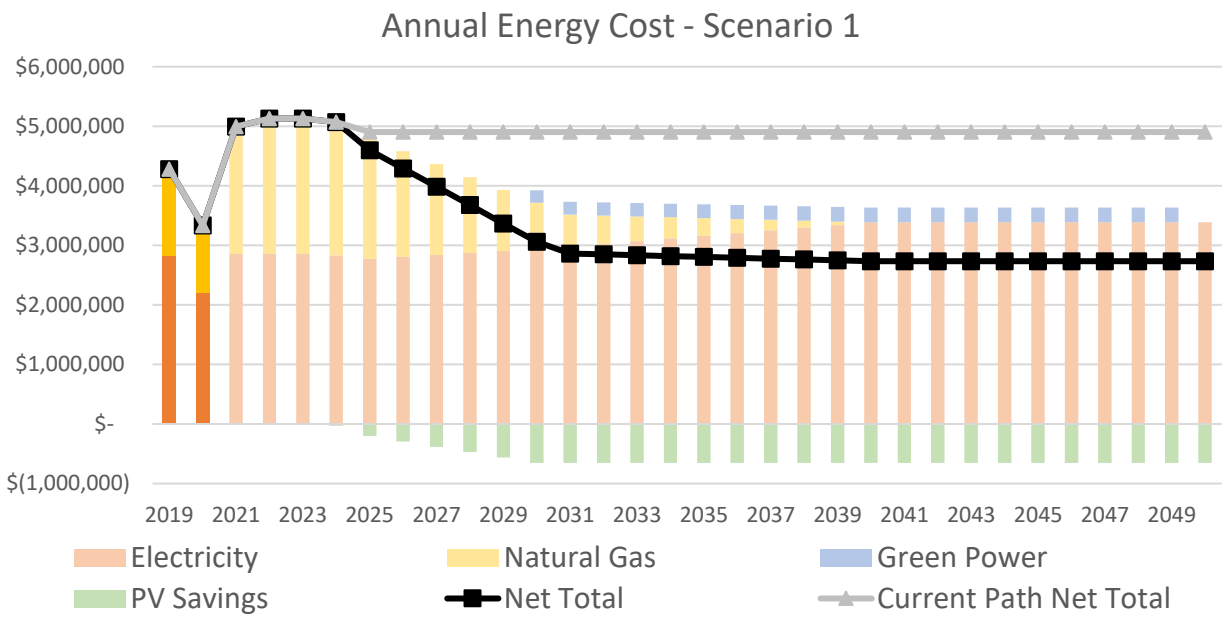


The dramatic reduction in energy use (67%) is due largely to two factors.

- The largest improvement is due to the conversion from 80% (at best) efficient gas boilers to 300-400% "efficient" geothermal heating. This is because for every unit of electrical energy used to operate the heat pump, 2-3 additional units of heating energy are extracted from the ground.
- The other significant efficiency improvement is from ventilation air energy recovery which transfers heat and moisture from exhaust air to preheat / precool ventilation air.

Although the overall reduction in operating cost is not as dramatic as the reduction in energy (since the cost of electricity per unit energy is significantly higher than that of natural gas), the savings is still significant (44%). Due to the rapid upgrades required, the operating costs reduce quickly in Scenario 1. The net operating cost of this scenario levels out just below $3,000,000/yr, compared to ~ $5,000,000/yr for the current path. The savings is due to a combination of efficiency improvements (see discussion above) and savings due to on site photovoltaic electricity generation. The total energy operating over the period is $106M.

SCENARIO 1: 100% RENEWABLE BY 2040



SCENARIO 2: ZERO GHG EMISSIONS BY 2040

Scenario 2 is based on the timeline needed to meet a goal of zero Greenhouse Gas Emissions (GHG) associated with the district's energy use on the same timeline as stated in the Board of Education Resolution. In other words, it addresses the type and pace of implementation needed to modify the district's energy usage such that GHG emissions are reduced by 50% by 2030, 75% by 2035 and 100% by 2040. This section of the report outlines the timeline and associated capital budgets to achieve these goals.

The rationale for applying the metric of % reduction of GHG emissions vs % renewable energy is that it relates more directly to the cause of climate change and is aligned with the metric used by the UN's Intergovernmental Panel on Climate Change (IPCC), the most widely recognized authority on global climate change. The IPCC has concluded that eliminating GHG emissions by 2050 will limit global warming to 1.5 deg C which is considered to be a level of warming that avoids the most catastrophic effects of climate change, while still being achievable[1]. Unlike the metric of renewable energy, the metric of GHG emissions recognizes the differences in climate impact between various non-renewable sources. For example, reducing coal usage has a greater impact than reducing natural gas usage.

STRATEGIES & CAPITAL COSTS

To meet the goals in this scenario, strategies were selected to produce a uniform rate of reduction in GHG emissions between 2025 and 2040. This approach also ensures meeting the interim goals for 2030 and 2035.

The capital investment required for the above timeline is as follows.

Work in Non-Referendum Buildings (2024– 2039)

- Upgrade HVAC and implement energy efficiency upgrades in buildings currently without AC: $32.6M/yr (2024-2035)
- Electrify heating and implement energy efficiency upgrades in buildings currently with AC: $12M/yr (2036-2039)
- Install photovoltaic systems: 300 kW & $700,000 / yr

Work in Referendum Buildings (2036– 2039)

- Electrify heating systems: $26.9M/yr

Other Measures (2024 – 2039)

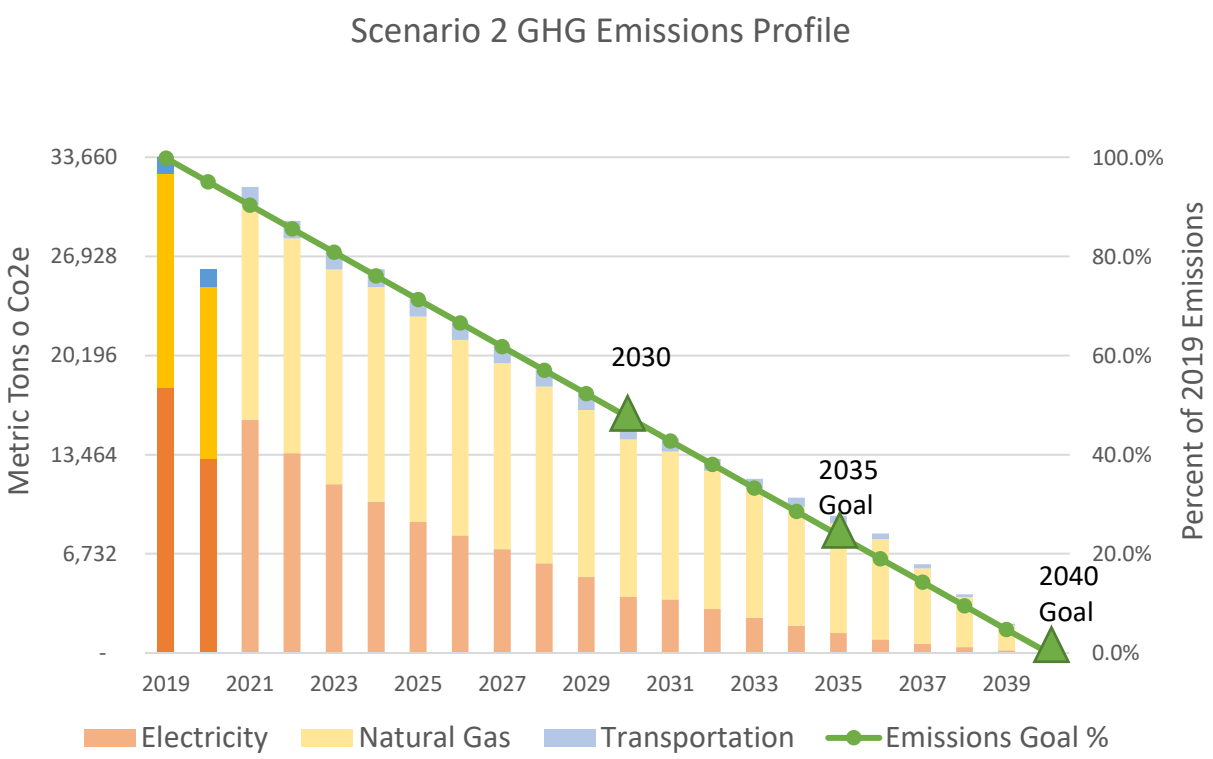
- Convert the district-owned vehicles to electric
- Convert buses to electric (purchased as service)

Total Capital Investment: $510M

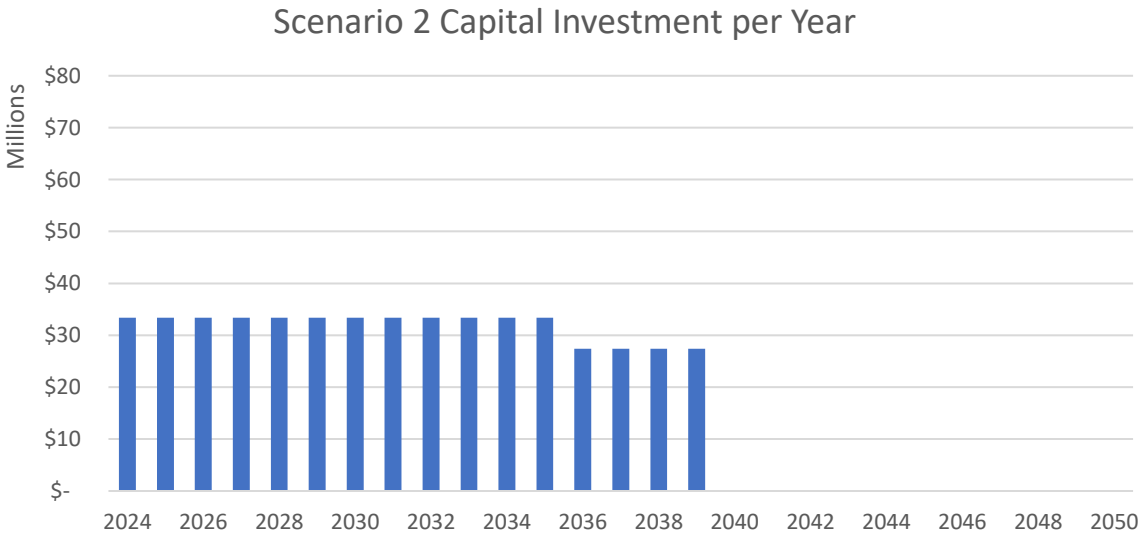
Implementing these strategies on these timelines results in the following GHG emissions profile.

[1] Intergovernmental Panel on Climate Change Summary for Policy Makers - 10/8/2018

SCENARIO 2: ZERO GHG EMISSIONS BY 2040



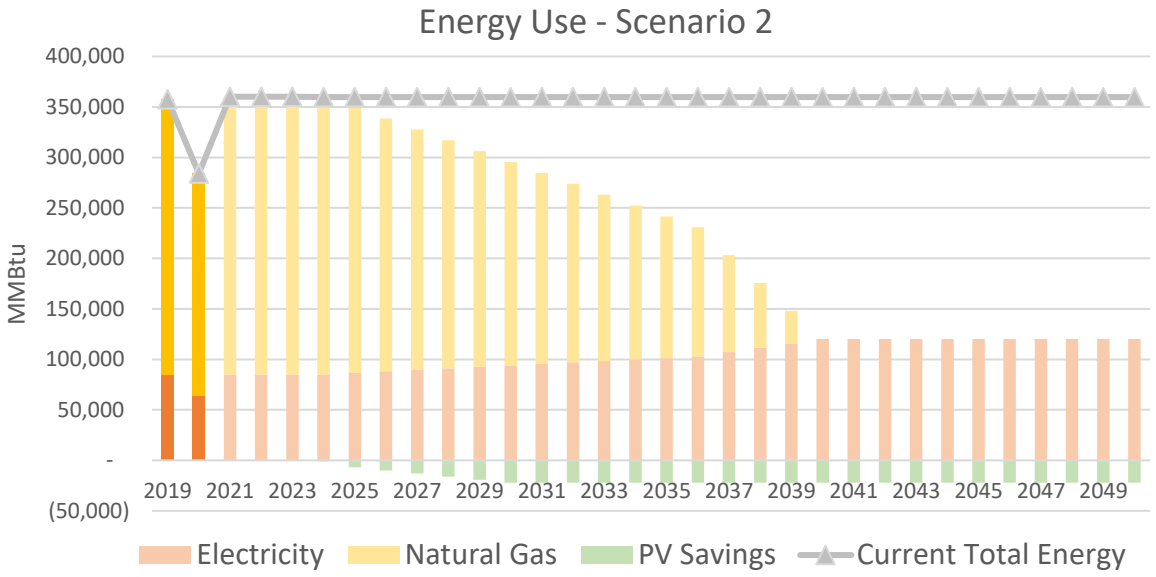
As illustrated by the following graph, the rate of capital investment is more evenly distributed in Scenario 2 than Scenario 1, but still more heavily weighted in the years 2024-2031.



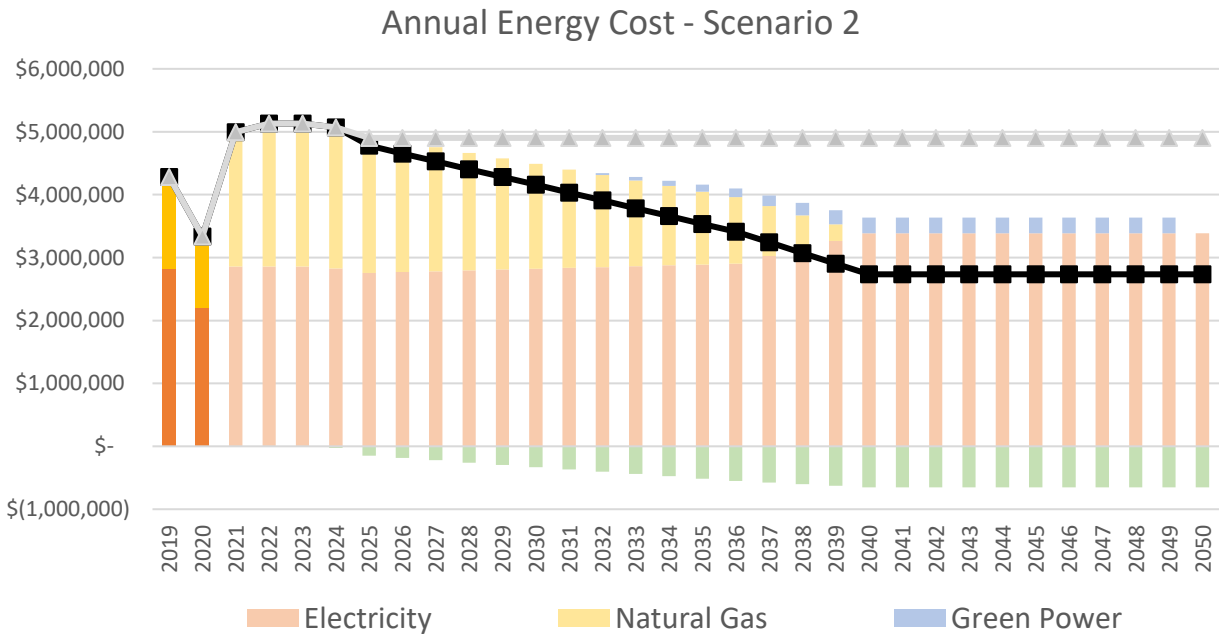
SCENARIO 2: ZERO GHG EMISSIONS BY 2040

ENERGY CONSUMPTION & OPERATING COSTS

The following graph shows total energy use of this scenario compared to that of the current path. The ultimate reduction in energy is the same as scenario 1, but the rate of reduction is less. This is due to the fact that the building improvements are spread over a longer period of time.



Similarly, the energy cost graph ends with the same annual operating cost as Scenario 1 (~$3M/yr), but takes longer to reach the minimum due to the slower rate of implementation. Total operating cost over the period is $116M.



SCENARIO 3: ZERO GHG EMISSIONS BY 2050 (IPCC TIMELINE)

Scenario 3 is based on meeting a goal of zero Greenhouse Gas Emissions (GHG) associated with the district's energy use by 2050 instead of 2040. This scenario follows the same timeline as the IPCC and has the advantage not only of aligning with the most widely recognized authority on climate change mitigation, but also takes advantage of synergy with the efforts of other parties operating on the same timeline. Specifically, MG&E, the district's electricity provider, has established the goal of providing 100% renewable electricity to their customers by 2050. Aligning with this goal means that the district can focus their efforts on converting all fossil fuel use to electric without the need to install and operate their own renewable electricity generation. While it may still be advantageous to install some photovoltaic generation, this can be done to achieve financial return and / or public relations goals rather than being required to achieve climate mitigation goals.

This scenario will be explored using two different rates of implementation of strategies. The first (Scenario 3A) is based on a constant rate of GHG emissions reductions from 2025 to 2050. Interim goals are established for 2030 (33% reduction) and 2040 (71% reduction) based on that trajectory. The second (3B) is based on a constant rate of capital investment over the period with interim goals similarly established.

SCENARIO 3A STRATEGIES & CAPITAL COSTS

To meet the goals in Scenario 3A, the following strategies were selected to produce a uniform rate of reduction in GHG emissions between 2019 and 2050.

Work in Non-Referendum Buildings (2033– 2045)

- Upgrade HVAC and implement energy efficiency upgrades in buildings currently without AC at the rate of 190,000 sf/yr in 2033-2042. $39M/yr
- Electrify heating and implement energy efficiency upgrades in buildings currently with AC at the rate of 180,000 sf/yr in 2043-2045. $16M/yr
- Install photovoltaic systems: 360 kW & $900,000 / yr

Work in Referendum Buildings (2040– 2049)

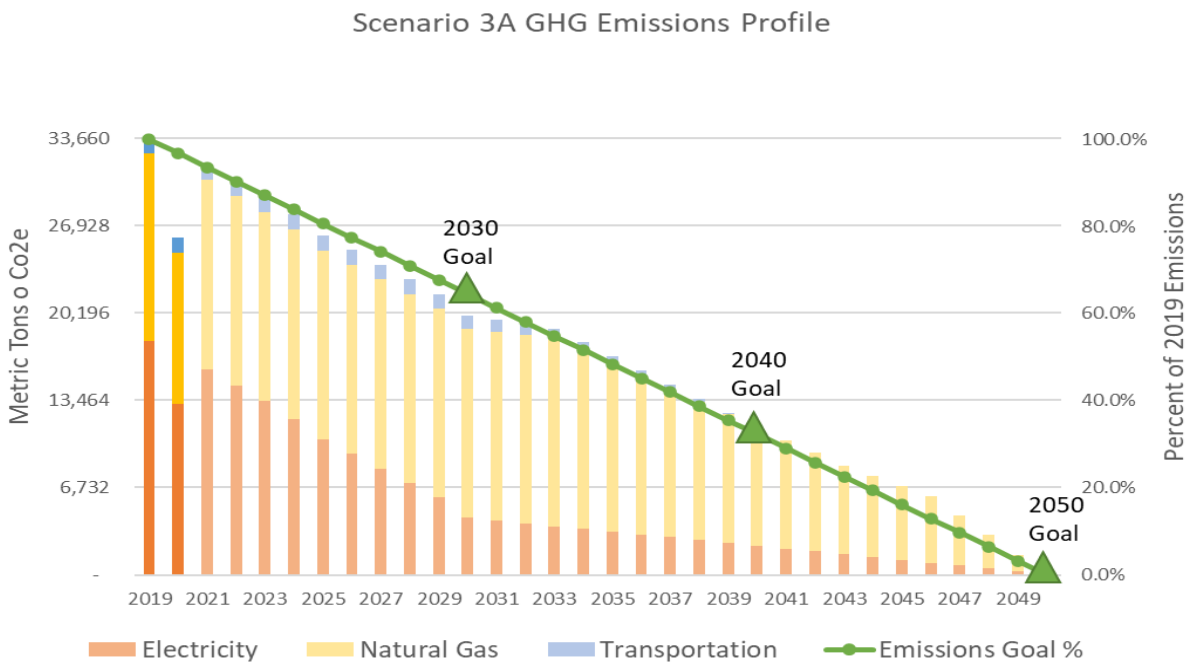
- Electrify heating systems. $15M/yr
- No photovoltaic installation is required in this scenario

Other Measures

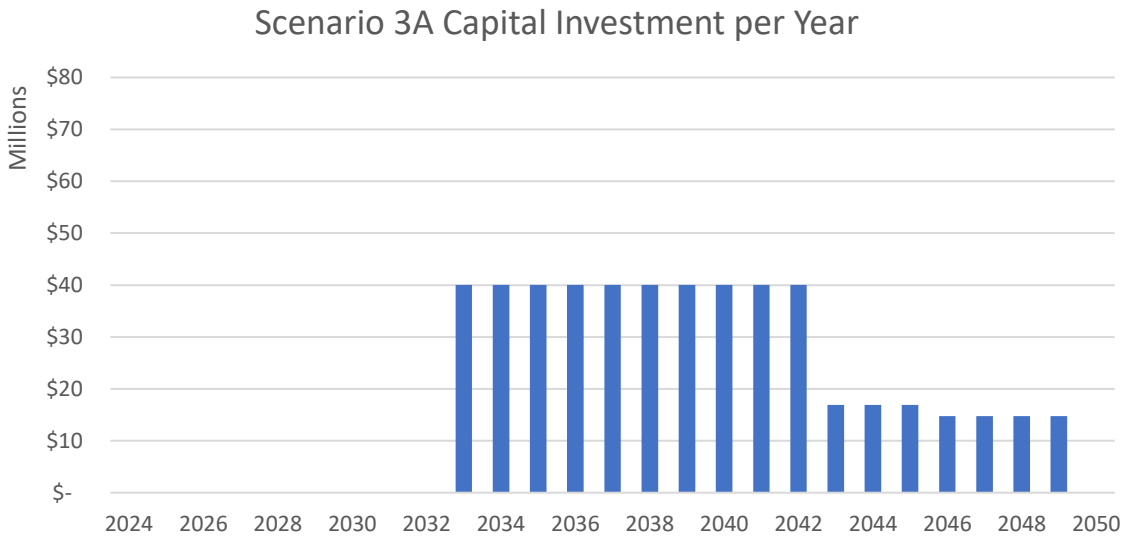
- Convert the district-owned vehicles to electric
- Convert buses to electric (purchased as service)
- No purchase of renewable energy credits is required in this scenario

Total Capital Investment: $510M

SCENARIO 3: ZERO GHG EMISSIONS BY 2050 (IPCC TIMELINE)



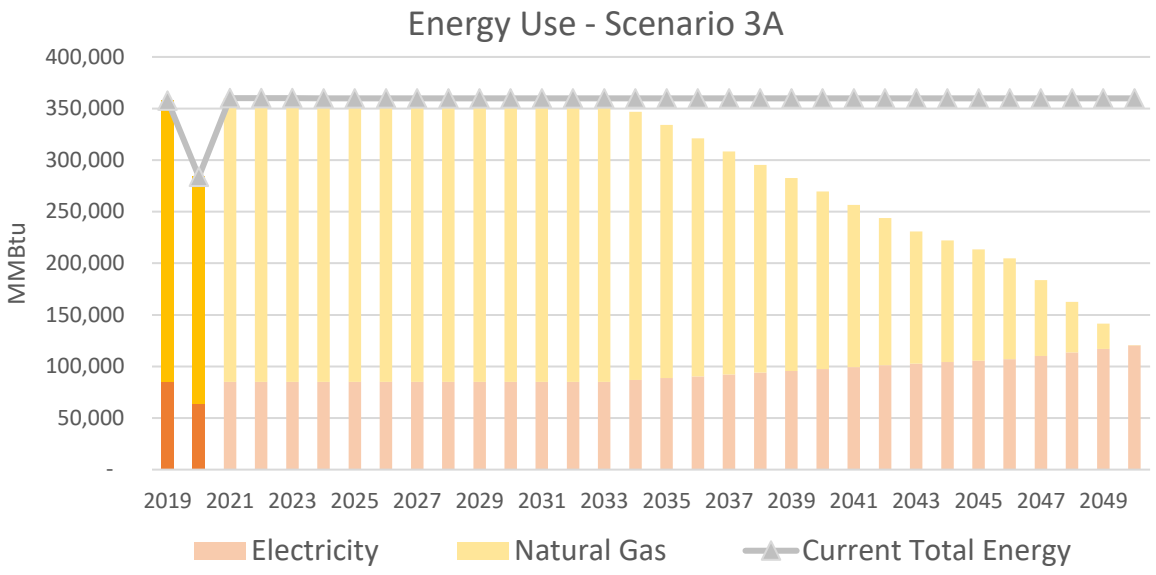
In this scenario, GHG emissions reductions by the district's electricity provider are sufficient to follow the straight-line reduction without the need for district improvements until 2033. As illustrated by the following graph, the rate of capital investment is more evenly distributed in Scenario 3 than Scenario 1 .



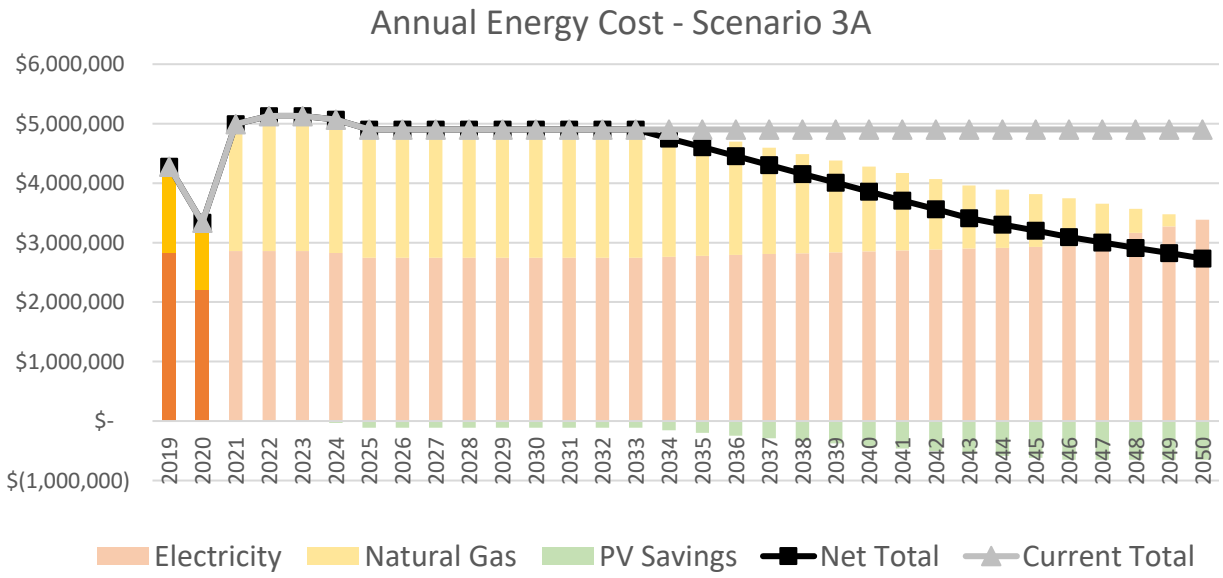
SCENARIO 3A ENERGY CONSUMPTION & OPERATING COSTS

The following graph shows total energy use of Scenario 3A compared to that of the current path. The ultimate reduction in energy is the same as Scenarios 1 &2, but the reduction starts later. This is due to the fact that the building improvements do not begin until 2033.

SCENARIO 3: ZERO GHG EMISSIONS BY 2050 (IPCC TIMELINE)



Similarly, the energy cost graph ends with the same annual operating cost as Scenarios 1&2 (~$3M/yr), but takes longer to reach the minimum due to the later beginning of implementation. The total operating cost over the period is $134M.



SCENARIO 3B STRATEGIES & CAPITAL INVESTMENT

For Scenario 3B, the following strategies and timelines were selected based on a uniform rate of capital investment between 2024 and 2049. In this scenario, the reduction in GHG emissions is not uniform, but rather begins more slowly and accelerates toward the end of the period.

SCENARIO 3: ZERO GHG EMISSIONS BY 2050 (IPCC TIMELINE)

Work in Non-Referendum Buildings (2024– 2046)

- Upgrade HVAC and implement energy efficiency upgrades in buildings currently without AC at the rate of 120,000 sf/yr in 2024-2043: $19.2M/yr
- Electrify heating and implement energy efficiency upgrades in buildings currently with AC at the rate of 200,000 sf/yr in 2044-2046: $19.2M/yr
- Install photovoltaic systems: 180 kW & $400,000 / yr

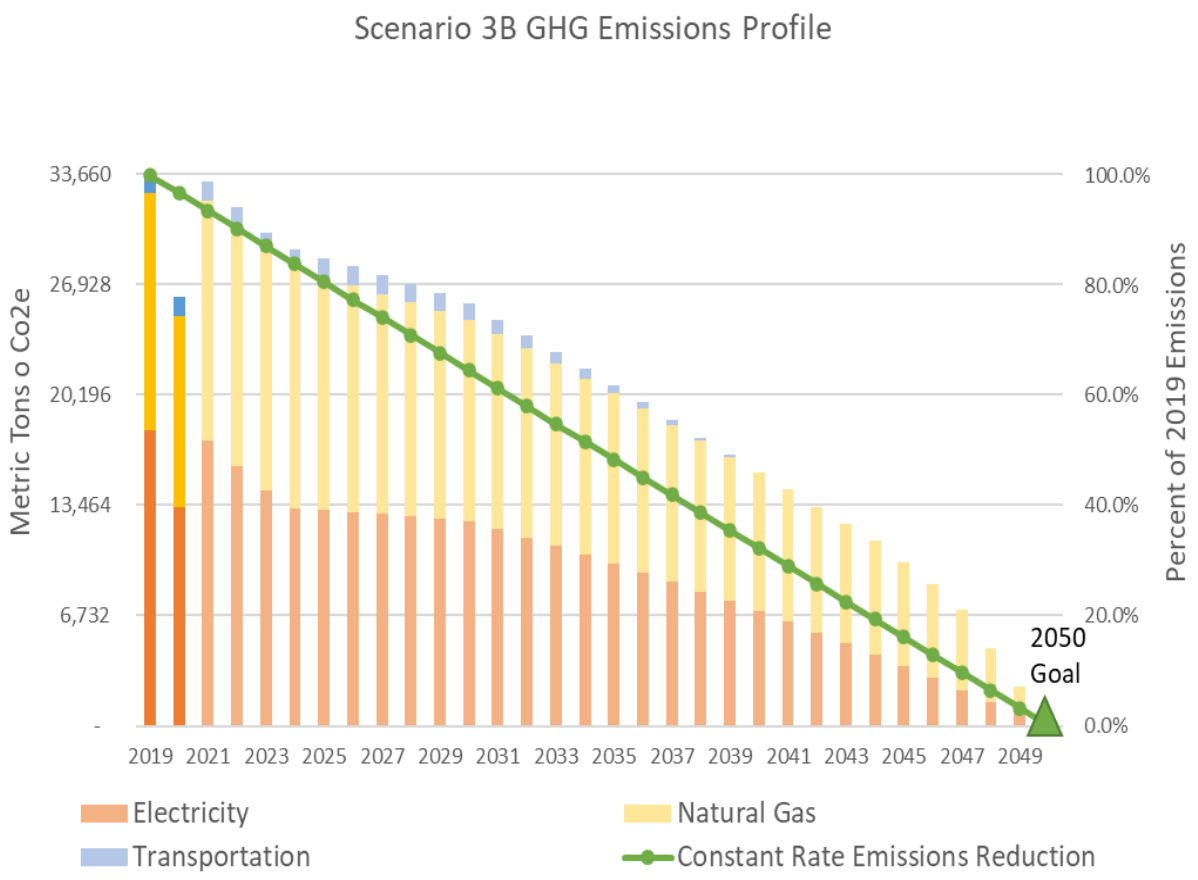
Work in Referendum Buildings (2047– 2049)

- Electrify heating at the rate of 600,000 sf per year: $19.5M/yr
- No photovoltaic installation is required in this scenario

Other Measures

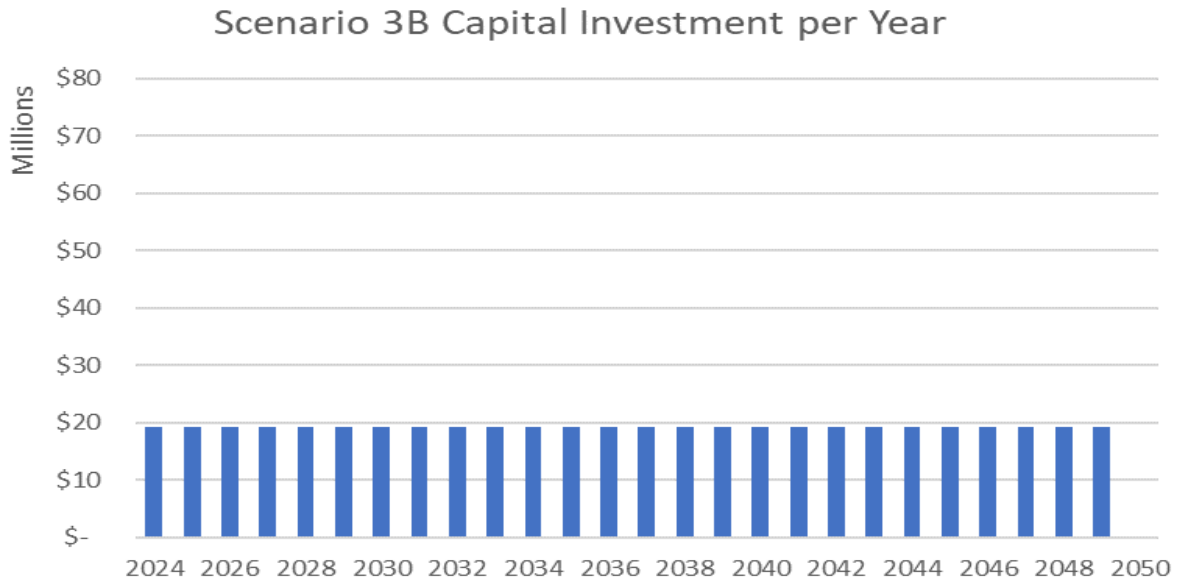
- Convert the district-owned vehicles to electric
- Convert buses to electric (purchased as service)
- No purchase of renewable energy credits is required in this scenario

Total Capital Investment: $510M



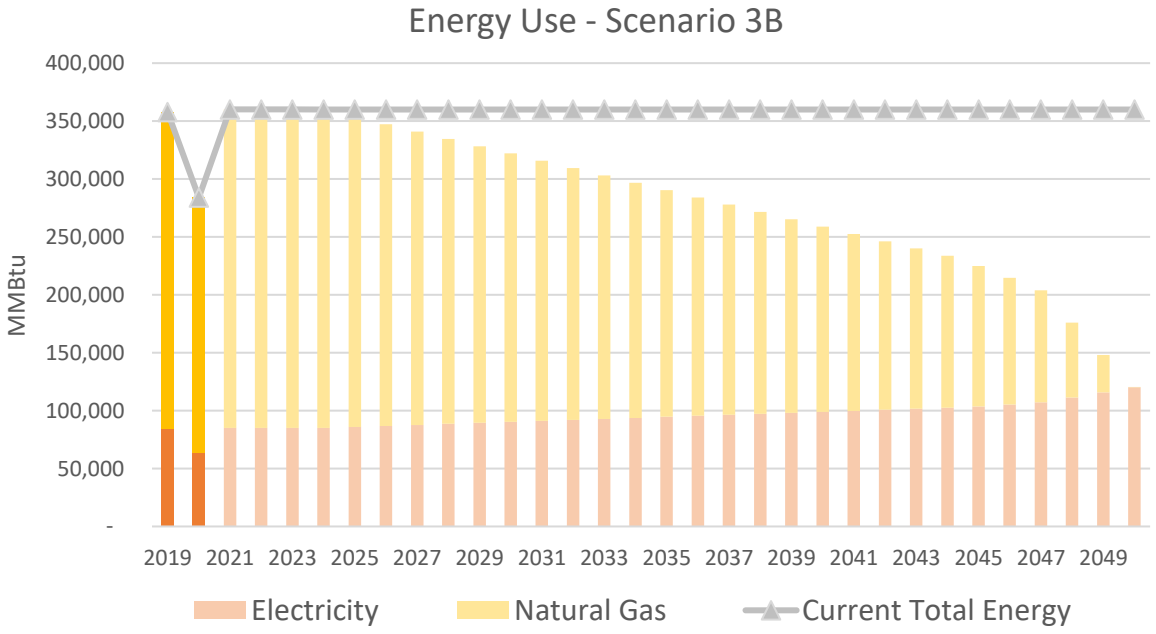
SCENARIO 3: ZERO GHG EMISSIONS BY 2050 (IPCC TIMELINE)

This scenario has the most uniform rate of capital investment.



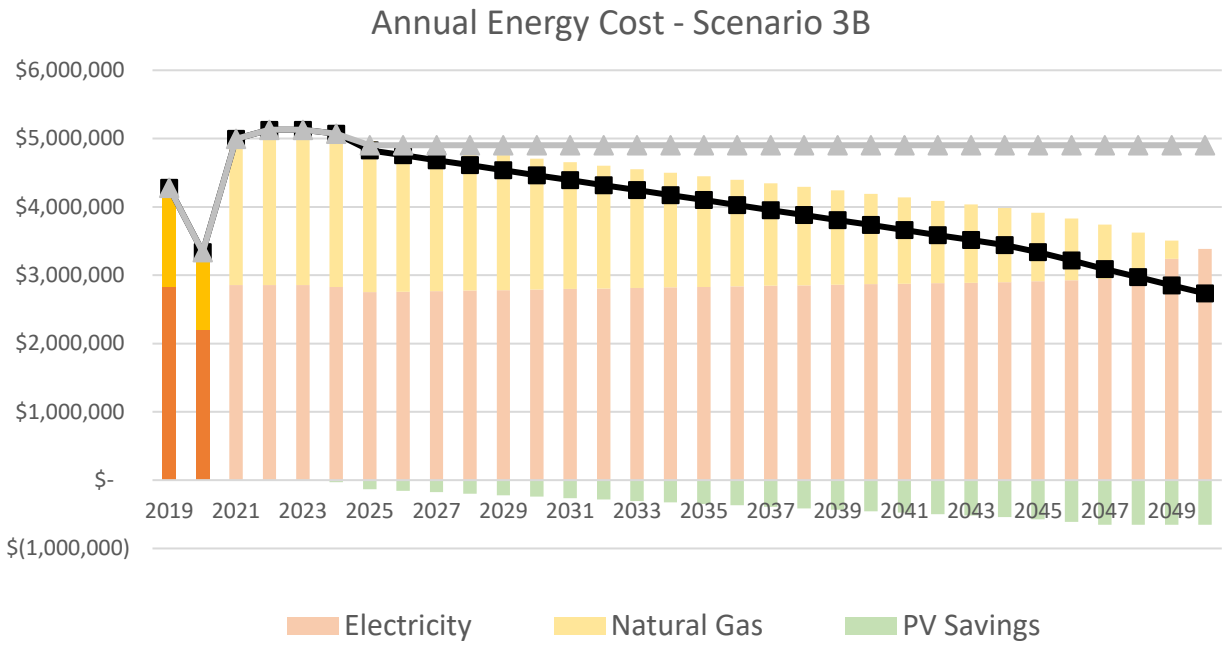
SCENARIO 3B ENERGY CONSUMPTION & OPERATING COSTS

The following graph shows total energy use of Scenario 3B compared to that of the current path. The ultimate reduction in energy is the same as the other scenarios, but is the most gradual.

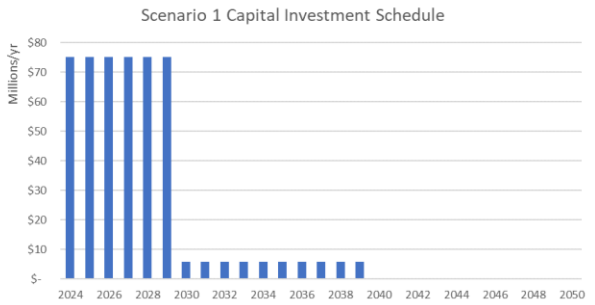


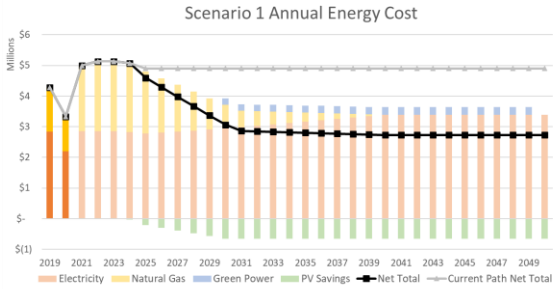
SCENARIO 3: ZERO GHG EMISSIONS BY 2050 (IPCC TIMELINE)

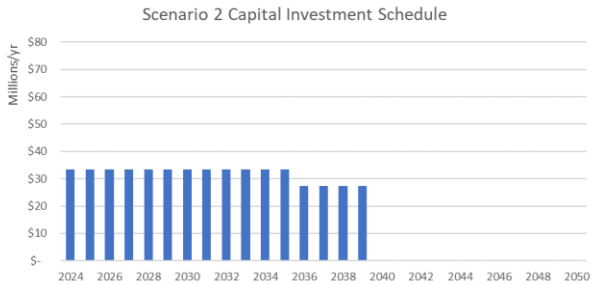
Again, the energy cost graph ends with the same annual operating cost as the other scenarios (~$3M/yr), but in this case fall in between the others with respect to the rate of reduction. The total operating cost over the period is $128.9M.

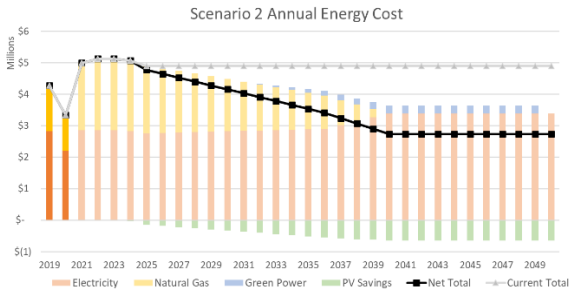


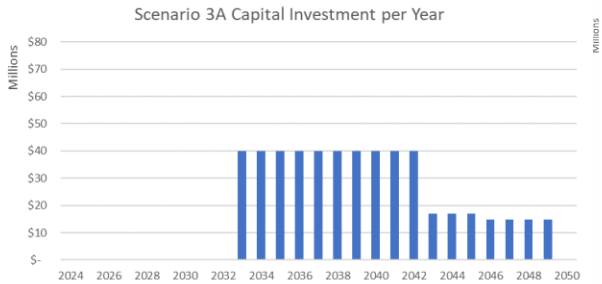
All four scenarios ultimately result in both 100% renewable energy and zero greenhouse gas emissions. The four scenarios are also similar in terms of the total capital investment required ($510M) and final annual operating cost ($2.7M). The primary difference is in how the capital investment and operating cost savings is distributed over time. Scenario 1 requires 85% of the total capital investment in the first 6 years of implementation with the remaining 15% spread over the following 10 years. On the other end of the spectrum, Scenario 3B spreads the investment evenly over 26 years at 3.8% per year. The following graphs illustrate the differences in rates of capital investment and annual operating costs.

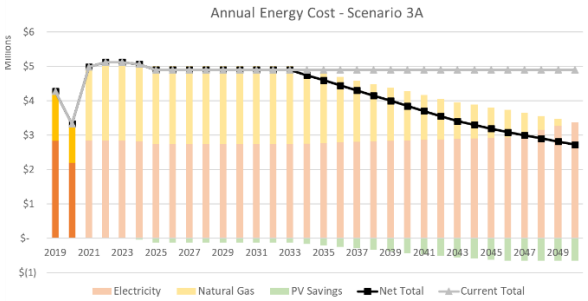


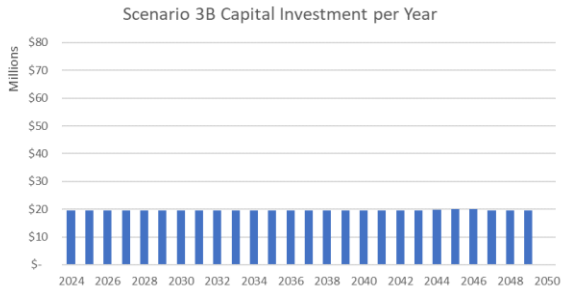


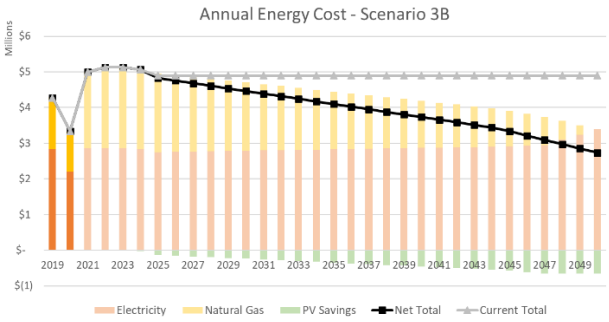












Comparison of Scenarios	Current Path	Scenario 1	Scenario 2	Scenario 3A	Scenario 3B
Total GHG Emissions Reduction (Metric Tons CO2e)	-	390,000	300,000	140,000	160,000
Capital Investment in Non-Referendum Buildings					
Start Constrution in year	NA	2024	2024	2033	2024
Complete Construction in year		2029	2039	2045	2046
Upgrade HVAC & Electrify Heating (sf/yr)		500,000	140,000 - 200,000	190,000 - 240,000	120,000 - 200,000
Upgrade HVAC & Electrify Heating ($/yr)		$73,400,000	$32,600,000 (2024-2035); $12,000,000 (2036-2039)	$39,000,000 (2033-2042); $16,000,000 (2043-2045)	$19,200,000
Add PV Generation (kW/yr)		750	300	360	180
Capital Cost to Install PV ($/yr)		$ 1,800,000	$ 700,000	$ 900,000	$ 400,000
Capital Investment in Referendum Buildings					
Start Constrution in year	NA	2030	2036	2046	2047
Complete Construction in year		2039	2039	2049	2049
Electrify Heating Systems (sf/yr)		180,000	600,000	460,000	590,000
Capital Cost to Electrify Heating Systems ($/yr)		$ 5,900,000	$ 26,900,000	$ 15,000,000	$ 19,200,000
Total Capital Investment	**$ -**	**$510,000,000**	**$510,000,000**	**$510,000,000**	**$510,000,000**
Energy Operating Costs					
2050 Annual Operating Cost	$ 4,900,000	$ 2,700,000	$ 2,700,000	$ 2,700,000	$ 2,700,000
Ave Annual Energy Operating Cost (2025-2050)	$ 4,900,000	$ 3,200,000	$ 3,500,000	$ 4,100,000	$ 3,900,000
Ave Annual Renewable Energy Premium (2025-2050)	$ -	$ 240,000	$ 180,000	$ -	$ -
Total Energy Operating Cost	**$155,400,000**	**$111,100,000**	**$119,900,000**	**$134,000,000**	**$128,900,000**
Total Capital & Operating Cost through 2050	**NA**	**$621,100,000**	**$629,900,000**	**$644,000,000**	**$638,900,000**

COMMENTARY

- GHG Emissions: Scenarios 1 & 2 have the highest total GHG reductions due to completing most of the upgrades early in the analysis period.
- Capital Investment:
  - The capital investment accomplishes more than just mitigating greenhouse gas emissions. The recommended measures strategically combine eliminating fossil fuel use and improving energy efficiency with improving the learning environment (adding air conditioning), addressing deferred maintenance (replacing windows and roofs) and reducing operating costs.
  - Revisions to referendum buildings: Scenario 1 requires beginning to replace the heating systems in 2030 where as Scenario 3A does not require this work to start until 2040 and Scenario 3B not until 2047 when these new systems will have been in operation for 20 years.
  - Scenario 1 requires a massive investment in the years 2025 – 2030 ($75M/yr). This may not be realistic since not only does it require more funding up front, the type of construction required is complex (work in existing buildings requiring phasing to minimize impact on operations).

  - Scenario 3B has the most realistic construction timeline since it distributes the work evenly over the analysis period.
- Energy Operating Costs: Similar to GHG emissions, Scenarios 1 & 2 have the lowest total operating costs due to their accelerated timelines.

CONCLUSION

While Scenario 1 has the greatest reduction in GHG emissions and lowest total operating costs, the timeline for implementation is very challenging and may not be possible. Scenario 3B has the most viable implementation timeline and has the additional advantage of aligning with both the IPCC and with Madison Gas & Electric's timelines for climate change mitigation.