Program: Energy Conservation Grant

# Program Background

The Energy Conservation Grant is administered by the North Dakota Department of Commerce and focuses on assisting North Dakota political subdivisions (including tribal governments) with energy efficiency improvements to public buildings.[[1]](#footnote-2) These energy efficiency measures include HVAC and boilers, more efficient lighting, installation of insulation, and other improvements that meet the program’s requirements for a 10-year or less payback period. This program was started in 2013 and to date, approximately 245 energy efficiency projects have been funded statewide. Commerce will expand this program to provide a greater amount of project funding to support more upgrades, include larger county buildings and schools as eligible applicants, target LIDAC areas with additional points in applications, and provide workforce training opportunities in schools.

# Summary of GHG Emission Reduction Results

Table 1 summarizes total GHG emissions reduced associated with expansion of the program. Total cumulative GHG emissions reduced were estimated to be 217,737 MT CO2e from 2025-2030 and 1,221,621 MT CO2e from 2025 to 2050. Results are shown for each separate measure within the program analyzed that, supported by additional funding, would result in GHG emissions reductions. These measures include HVAC upgrades, boiler upgrades, LED lighting installations, insulation installation and window upgrades.

**Table 1. GHG Emission Reductions by Energy Efficiency Measure**

|  |  |  |
| --- | --- | --- |
| MT CO2e | Cumulative  2025-2030 | Cumulative  2025-2050 |
| 1. HVAC Upgrades | 160,957 | 965,745 |
| 2. Boiler Upgrades | 924 | 5,543 |
| 3. LED Lighting Installations | 53,272 | 234,833 |
| 4. Insulation Installations | 2,492 | 14,952 |
| 5. Window Upgrades | 91 | 548 |
| **Program Total** | 217,737 | 1,221,621 |

Emissions reductions from HVAC upgrades make up the largest share of total emission reductions from the program expansion with additional funding over time. LED lighting installations also result in meaningful emissions reductions. Analysis methodology for each measure and the program as a whole is described in the following section. See Table 2 below for more detail on the GHG emissions reductions estimates, including annual savings by measure.

**Table 2. Annual and Cumulative GHG Emissions Reductions (MT CO2e)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Annual by Measure | | | | | Cumulative for Program |
| HVAC Upgrades | Boiler Upgrades | LED  Lighting | Insulation  Installations | Windows  Upgrades |
| **2025** | 8,048 | 46 | 4,728 | 125 | 5 | 12,951 |
| **2026** | 16,096 | 92 | 7,793 | 249 | 9 | 37,190 |
| **2027** | 24,144 | 139 | 10,433 | 374 | 14 | 72,292 |
| **2028** | 32,192 | 185 | 11,444 | 498 | 18 | 116,629 |
| **2029** | 40,239 | 231 | 9,511 | 623 | 23 | 167,256 |
| **2030** | **40,239** | **231** | **9,365** | **623** | **23** | **217,737** |
| **2031** | 40,239 | 231 | 9,005 | 623 | 23 | 267,858 |
| **2032** | 40,239 | 231 | 9,230 | 623 | 23 | 318,204 |
| **2033** | 40,239 | 231 | 9,951 | 623 | 23 | 369,271 |
| **2034** | 40,239 | 231 | 10,017 | 623 | 23 | 420,404 |
| **2035** | 40,239 | 231 | 11,109 | 623 | 23 | 472,630 |
| **2036** | 40,239 | 231 | 11,177 | 623 | 23 | 524,923 |
| **2037** | 40,239 | 231 | 10,969 | 623 | 23 | 577,007 |
| **2038** | 40,239 | 231 | 8,706 | 623 | 23 | 626,830 |
| **2039** | 40,239 | 231 | 9,229 | 623 | 23 | 677,175 |
| **2040** | 40,239 | 231 | 8,625 | 623 | 23 | 726,916 |
| **2041** | 40,239 | 231 | 8,589 | 623 | 23 | 776,621 |
| **2042** | 40,239 | 231 | 8,611 | 623 | 23 | 826,347 |
| **2043** | 40,239 | 231 | 8,377 | 623 | 23 | 875,841 |
| **2044** | 40,239 | 231 | 8,279 | 623 | 23 | 925,236 |
| **2045** | 40,239 | 231 | 8,364 | 623 | 23 | 974,716 |
| **2046** | 40,239 | 231 | 8,267 | 623 | 23 | 1,024,099 |
| **2047** | 40,239 | 231 | 8,271 | 623 | 23 | 1,073,486 |
| **2048** | 40,239 | 231 | 8,257 | 623 | 23 | 1,122,860 |
| **2049** | 40,239 | 231 | 8,313 | 623 | 23 | 1,172,289 |
| **2050** | **40,239** | **231** | **8,217** | **623** | **23** | **1,221,621** |

# Analysis Methodology

GHG emissions reductions for the program expansion were estimated based on representative data from actual energy efficiency projects that were implemented in recent years due to the program’s existing funding. GHG emissions reductions were estimated separately for each type of energy efficiency measure that may be funded by the expanded program, as listed in Table 3. Data used to inform the analysis from each previous project included grant funds received and estimated annual energy savings. Past project costs were converted to 2023 dollars using the Customer Price Index (CPI) based on the year the project was implemented.[[2]](#footnote-3) See the following subsections for details on the assumptions and approach used to estimate GHG emissions reductions for each representative project implemented by measure.

Total GHG emissions reductions for the program expansion as a whole were estimated based on summing the GHG emissions reductions by each measure for all projects implemented over time, with savings accumulating over time. There are uncertainties around the types of measures that will actually get implemented in the future, therefore past program data were used to inform the types of measures that may be implemented most with the program expansion, based on where funding has previously been dispensed. These data indicated that the majority of funding has been used for projects that result in meaningful GHG emissions reductions, particularly LED lighting installations and HVAC upgrades. This information was used to estimate the available total share of additional funding that each measure may have access to in the future, as detailed in Table 3. Total funding requested for the program expansion is $20 million, which includes $1 million estimated for program administration. The remaining $19 million is assumed to be available for implementation-ready projects that would contribute to GHG emissions reductions.

**Table 3. Assumed Total Funds Available by Implementation-Ready Measure**

|  |  |  |
| --- | --- | --- |
|  | Share of Funding for Projects  (%) | Funds for Projects  ($) |
| 1. HVAC Upgrades | 35% | $6,650,000 |
| 2. Boiler Upgrades | 2% | $380,000 |
| 3. LED Lighting Installations | 60% | $11,400,000 |
| 4. Insulation Installations | 2% | $380,000 |
| 5. Window Upgrades | 1% | $190,000 |
| **Program Total** | **100%** | **$19,000,000** |

Each type of energy efficiency measure is implementation-ready and has been supported by the program in the past. The program is ready to dispense more funds to these kinds of projects beginning in 2025. The analysis assumes all funding would be dispensed before 2030, with 20% (i.e., $3.8 million) of available funds spent based on the split by measure as noted in Table 3, in each year from 2025-2029. The total number of projects by measure implemented in each year of this 5-year period was based on the average cost assumed per representative project and up to the 20% share of funding assumed to be spent in that year.

All projects were assumed to have at least a 25-year lifespan, thus projects implemented in 2025 were assumed to maintain GHG emissions reductions compared to baseline throughout the time horizon of the analysis. In reality, the lifespan of a measure is uncertain and could vary by location, use, technology, and other factors.

GHG emissions reductions estimated from avoided fuel use only account for emissions from avoided fuel combustion. There would also be additional avoided emissions upstream of this fuel use due to avoided well to pump activities, such as production and transport of the fuel. These are assumed to be insignificant emissions and de minimis to this analysis as combustion accounts for the vast majority of emissions from fuel.[[3]](#footnote-4)

The following subsections describe how GHG emissions reductions were estimated for each energy efficiency measure to estimate GHG emission reductions for the program expansion.

## Measure 1: HVAC Upgrades

Upgrades and replacements of HVAC systems to newer models can improve efficiency, reduce fuel usage, and result in lower operational costs as well as reduced GHG emissions. For the HVAC upgrades, representative project data was used for a natural gas HVAC replacement based on the past Cooperstown City Hall Fire and Ambulance Departments project implemented using the Energy Conservation Grant program funds in 2020. Annual fuel savings for the upgrade was calculated based on comparing the old system’s fuel usage to the improved projected fuel usage after the project was completed. These data and project cost were provided by the grant recipient based on engineering estimates for the upgraded HVAC unit and are included in Table 4. In reality, HVAC system cost, size, efficiency, and fuel savings compared to older models will all vary by project, though this example was used as a representative average for the analysis.

To estimate annual GHG emissions reductions, this representative project’s estimated fuel savings was multiplied by the emission factor of CO2e per MMBtu for natural gas from the EPA’s Center for Corporate Climate Leadership, also shown in Table 4.[[4]](#footnote-5)

**Table 4. HVAC Upgrades – Representative Project Information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Grant Funding Received  ($) | Annual Fuel Savings  (MMBtu) | Emission  Factor  (MT CO2e/MMBtu) | Annual GHG Savings  (MT CO2e) |
| Project | $34,194 | 3,896 | 0.05311 | 206.9 |

Based on the representative project’s grant funding received and the $6,650,000 share of total program expansion funds assumed to be allocated for HVAC upgrades, up to 195 similar projects were assumed to be implemented, with 20% added in each year from 2025-2029. The roughly 39 projects added in each year save over 8,000 MT CO2e in the year implemented and each year thereafter. Total cumulative GHG emissions reductions for this measure contributing to the expanded program’s total impact are shown in Table 1, with annual reductions detailed in Table 2.

## Measure 2: Boiler Upgrades

Similar to HVAC upgrades, upgrades and replacements of boiler systems to newer models can improve efficiency, reduce fuel usage, and result in lower operation costs as well as reduced GHG emissions. For the boiler upgrades, representative project data was used for a fuel oil boiler replacement based on the past Midkota School District project implemented using program funds in 2023. Based on information provided by this grant recipient, the new boiler would be 33% more fuel efficient than the existing 62-year-old boiler. Fuel consumption for the existing boiler was estimated by the school district at 1,000 MMBtu/yr, while the new boiler would use 611 MMBtu/yr, resulting in a reduction of 389 MMBtu/yr of fuel oil combustion, shown in Table 5, along with the funding received by this representative project. In reality, boiler costs, size, efficiency, and fuel savings compared to older models will all vary by project, though this example was used as a representative average for the analysis.

To estimate annual GHG emissions reductions, this representative project’s estimated fuel savings was multiplied by the emission factor of CO2e per MMBtu for fuel oil from the EPA’s Center for Corporate Climate Leadership, also shown in Table 5.[[5]](#footnote-6)

**Table 5. Boiler Replacement – Representative Project Information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Grant Funding Received  ($) | Annual Fuel Savings  (MMBtu) | Emission  Factor  (MT CO2e/MMBtu) | Annual GHG Savings  (MT CO2e) |
| Project | $47,448 | 389 | 0.07420 | 28.8 |

Based on the representative project’s grant funding received and the $380,000 share of total program expansion funds assumed to be allocated for boiler upgrades, up to 8 similar projects were assumed to be implemented, with 20% added in each year 2025 through 2029. The roughly two projects added in each year save over 46 MT CO2e in the year implemented and each year thereafter. Total cumulative GHG emissions reductions for this measure contributing to the Program’s total impact are shown in Table 1, with annual reductions detailed in Table 2.

## Measure 3: LED Lighting Installations

LED lightbulbs use less electricity and are longer lasting than incandescent or fluorescent lightbulbs, while maintaining the same brightness. For the LED lighting upgrades, GHG emissions reductions were estimated based on the amount of electricity consumption saved by installing more efficient LED lights in place of existing incandescent and fluorescent lights. Cooperstown City Hall completed the replacement of 81 existing incandescent and fluorescent with LED lighting throughout the building in 2020. The grant recipient indicated that the old incandescent and fluorescent lights used 8,536 watts while new LEDs after the project implementation would use 3,991 watts. Assuming 3,000 hours of lighting operation per year, as estimated by the City of Cooperstown, this reduction in wattage amounts to a savings of 13,635 kilowatt-hours (kWh) per year of electricity. In reality, lighting changes, costs, and electricity savings will all vary by project, though this example was used as a representative average for the analysis.

To determine annual GHG reductions from the annual electricity savings, first change over time of the GHG emissions rate for associated electricity generation was estimated. The Energy Conservation Grant program expansion funding can support projects anywhere throughout the state of North Dakota. Without knowing where future projects may be implemented, projections of North Dakota’s state-wide average electricity grid mix were estimated and then used to inform an average grid GHG emission rate applied to the electricity savings from lighting replacement over time.

EIA’s Annual Energy Outlook (AEO) 2023 Reference Case was used to inform the projected state grid mix.[[6]](#footnote-7) EIA provides electric power projections by Electricity Market Module Regions in Tables 54.01 to 54.25. These regions broadly do not align with state boundaries.[[7]](#footnote-8) The electricity generation by resource type projections for the regions in which North Dakota is located were used to inform an estimate of the state’s projected grid mix. A weighting of 95% was given to the projected grid mix of the Southwest Power Pool/North (SPPN) Region as this covers the vast majority of the state. The remainder weights the projected grid mix of the Midcontinent ISO/West (MISW). The resulting estimated grid mix for the state of North Dakota informed by EIA AEO2023 is shown below in Figure 1, depicting a significant increase in zero-emitting resources over the next decade with a decline in fossil fuel-fired generation. This is in-line with broad findings from EIA, driven by increasing clean energy investments due to incentives from the Inflation Reduction Act of 2022 as well as accounting for planned changes, such as Xcel Energy’s commitment to coal retirements and wind expansion across the central U.S.

**Figure 1. North Dakota Estimated Electricity Grid Mix**

A graph showing the amount of electricity per grid

Description automatically generated

An average electricity grid emission rate was calculated for each year based on the above electricity generation mix and average emission factors for end use of natural gas, coal, and zero-emitting electricity. Zero emitting electricity generation sources do not have any GHG emissions associated with them. Average U.S. natural gas combined cycle facility and coal-fired electricity generation emission factors of carbon dioxide(CO2), methane (CH4), and nitrous oxide (N2O) for electricity generation were taken from GREET, a life cycle analysis model created by the Department of Energy’s Argonne National Laboratory.[[8]](#footnote-9) For the GHG emission rate for each fuel in grams of CO2e per kilowatt hour (kWh), global warming potentials for the 100-year time horizon from IPCC 5th Assessment Report were used.[[9]](#footnote-10) The emissions factors used by resource type are shown in Table 6.

**Table 6. Emission Rates for Electricity Generation**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Electricity Generating Resource Type | Emission Rates (grams of pollutant per kWh) | | | |
| CO2 | CH4 | N2O | CO2e |
| Zero-Emitting | 0 | 0 | 0 | 0 |
| Natural Gas | 450 | 0.89 | 0.01 | 477 |
| Coal | 1,050 | 1.70 | 0.02 | 1,104 |

These resulting GHG emission rates in grams of CO2e per kWh were applied to the associated resource type’s estimated share of electricity generation for a given year to estimate the state average electricity grid GHG emission rate, as shown in Figure 2.

**Figure 2. North Dakota Estimated Average Electricity Grid GHG Emission Rate**

A graph showing the amount of electricity in the united states

Description automatically generated

The above emission rate was then multiplied by the electricity savings to calculate the GHG emissions reduction due to more efficient LED lighting. Standard conversion factors were used to align units from grams to metric tons and kWh to MWh. GHG emissions reductions were calculated for each year from 2025-2050 based on the electricity savings for this representative project.

**Table 7. LED Lighting Installations – Representative Project Information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Grant Funding Received  ($) | Annual Elec. Savings  (kWh) | Emission  Factor  (MT CO2e/MMBtu) | Annual GHG Savings  (MT CO2e) |
| Project | $2,359 | 13,635 | See Table 6 | 4.9 |

Based on the representative project’s grant funding received and the $11,400,000 share of total program expansion funds assumed to be allocated for LED projects, more than 4,832 similar projects were assumed to be implemented, with 20% added in each year from 2025-2029. The roughly 966 projects added in each year save over 4,727 MT CO2e in the year implemented and each year thereafter. Total cumulative GHG emissions reductions for this measure contributing to the expanded program’s total impact are shown in Table 1, with annual reductions detailed in Table 2.

## Measure 4: Insulation Installations

GHG emissions reductions from the installation of insulation are achieved through the reduction in the amount of heating and cooling air lost through the building’s envelope. Estimates were based on the past insulation installation project for the Nelson County Highway Department shop and storage building in 2023. The grant recipient provided the R-value of the existing insulation and the anticipated improved R-value of the new insulation. The higher the R-value, the better insulation, allowing better temperature regulation, resulting in reduced fuel use for heating and cooling. The building is heated by propane and fuel oil and the improvements allow the heating system to operate less as the after-project insulation allows the building to stay warmer longer, thus reducing fuel consumption, costs, and GHG emissions. The grant recipient provided the heat loss saved, as well as project cost, shown in Table 8. In reality, insulation upgrade costs, amount, efficiency, and fuel savings will all vary by project, though this example was used as a representative average for the analysis.

**Table 8. Insulation Installations – Representative Project Information**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Grant Funding Received  ($) | Hourly Fuel Loss    (Btu/hr) | Operating  Hours  Per Year  (hours) | Annual Fuel Loss  (MMBtu) | Emission  Factor  (MT CO2e/ MMBtu) | Annual GHG Savings  (MT CO2e) |
| Before | - | -296,338 | 2,913 | -863 | - | - |
| After | - | -158,341 | 1,987 | -315 | - | - |
| **Project** | **$23,395** | **-** | **-** | **549**  **saved** | **0.06195** (LP Gas)  **0.07420** (Fuel Oil) | **38.4** |

Annual savings in fuel usage was calculated using annual fuel loss values for before and after the project implementation. It was indicated that the representative project’s building is heated by a mixture of fuels; roughly 35% LP gas and 65% fuel oil. The reduced fuel loss (i.e., saved) per project implemented assumed this same split to estimate annual GHG emissions reductions for reduced consumption of each fuel. Emission factors of CO2e per MMBtu for each fuel were used from the EPA’s Center for Corporate Climate Leadership and are shown in Table 8.[[10]](#footnote-11)

Based on the representative project’s grant funding received and the $380,000 share of total Program funds assumed to be allocated for insulation installations, more than 16 similar projects were assumed to be implemented, with 20% added in each year from 2025-2029. The roughly three projects added in each year save nearly 125 MT CO2e in the year implemented and each year thereafter. Total cumulative GHG emissions reductions for this measure contributing to the Program’s total impact are shown in Table 1, with annual reductions detailed in Table 2.

## Measure 5: Window Upgrades

In addition to the representative projects for HVAC upgrades and LED lighting installations described above, the Cooperstown City Hall also received grant funding to upgrade six existing windows to new windows providing better insulation in 2020. The grant recipient provided the R-value of the existing windows and the anticipated improved R-value of the new windows. The higher the R-value, the better insulation from the windows, allowing better temperature regulation, resulting in reduced fuel use for heating and cooling. Window upgrades also result in infiltration improvements, which reduce the amount of air that can pass through the windows. The grant recipient provided the heat loss saved for both the R-value and infiltration condition improvements, as well as project cost, as shown below in Table 9. In reality, window upgrade costs, size, efficiency, and fuel savings compared to older models will all vary by project, though this example was used as a representative average for the analysis.

To estimate annual GHG emissions reductions, this representative project’s estimated fuel savings was multiplied by the emission factor of CO2e per MMBtu for natural gas from the EPA’s Center for Corporate Climate Leadership, shown in Table 9.[[11]](#footnote-12)

**Table 9. Window Upgrades – Representative Project Information**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Grant Funding Received  ($) | Before Project | After Project | Annual Fuel Savings  (MMBtu) | Emission  Factor  (MT CO2e/ MMBtu) | Annual GHG Savings  (MT CO2e) |
| R-value Improvement | - | 1.00 | 3.00 | 23.13 | - | - |
| Infiltration Condition Improvement | - | 0.25 | 0.01 | 8.99 | - | - |
| **Project** | **$14,204** | **-** | **-** | **32.12** | **0.05311** | **1.7** |

Based on the representative project’s grant funding received and the $190,000 share of total program funds assumed to be allocated for window upgrades, more than 13 similar projects were assumed to be implemented, with 20% added in each year from 2025-2029. The nearly three projects added in each year save over 4.5 MT CO2e in the year implemented and each year thereafter. Total cumulative GHG emissions reductions for this measure contributing to the expanded program’s total impact are shown in Table 1, with annual reductions detailed in Table 2.

# Cost-Effectiveness of GHG Emissions Reductions

Table 10 below includes information regarding the cost effectiveness of the program’s GHG reductions. These dollar per MT CO2e values were calculated based on the additional funds requested divided by the cumulative GHG emissions reduced from 2025-2030 and 2025-2050.

**Table 10. Cost Effectiveness**

|  |  |  |
| --- | --- | --- |
| Funds Requested | $/MT CO2e for  GHG Reductions  2025-2030 | $/MT CO2e for  GHG Reductions  2025-2050 |
| Program Total ($20,000,000) | $92 | $16 |
| For GHG Reduction Measures ($19,000,000) | $87 | $16 |

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11. US EPA Center for Corporate Climate Leadership. 12 September 2023. “Emission Factors for Greenhouse Gas Inventories.” Accessed March 2024. Retrieved from: <https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf> [↑](#footnote-ref-12)