**Appendix: GHG Reduction Analysis**

This Appendix describes the GHG emissions reduction analyses for the measures in CIRDA’s grant application; see accompanying Supplemental Spreadsheet “CIRDA\_GHGanalysis\_AppendixSpreadsheet” for more detail.

# #1: Regional Building and Asset Modernization Program

## Program Analysis by Project Type

GHG emissions reductions were estimated for each project type supported by the program and summed for program total. There are uncertainties around the actual projects that will be implemented; therefore, the split of funds by project type in Table 1 was informed by factors such as seven known pilot projects and three example project costs, difficulty and practicality of implementation, and popularity. The total funding requested for the program is $275 million, including $33.6 million for administration. The remaining $241.4 million is assumed to be available for emissions reducing projects.

##### Table 1. Measure 1 Program Fund Allocation by Project Type

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Project Type | Share of Funds | Total  Funds | Average Cost per Project | Average  Ann. GHGs Reduced per Project | Estimated Counts Supported |
| Buildings: Solar | 14% | $33.3 M | $3.3 M | 462 MT | 20 projects |
| Buildings: LED Lighting Efficiency | 10% | $25.0 M | $4.6 M | 17 MT | 6 buildings |
| Buildings: HVAC Efficiency | 7% | $16.7 M | $2.1 M | 6 MT | 8 systems |
| Buildings: Window Efficiency | 3% | $8.3 M | $6.4 M | 4 MT | 1+ buildings |
| Energy Insights Program: Electricity | 4% | $9.0 M | $0.06 M | 33 MT | 160 facilities |
| Energy Insights Program: Natural Gas | 0.4% | $1.0 M | $0.005 M | 18 MT | 200 facilities |
| Industrial: Energy Efficiency | 29% | $69.4 M | $0.49 M | 641 MT | 143 facilities |
| Industrial: Solar | 10% | $23.1 M | $13.8 M | 3,982 MT | 1+ projects |
| Transportation: EV charging | 12% | $27.8 M | $0.12 M | 5 MT | 232 ports |
| Transportation: Mobility | 4% | $9.0 M | $1.5 M | 120 MT | 6 projects |
| Transportation: Public Transit | 8% | $18.8 M | $18.8 M | 87 MT | 22 hybrid buses |
| Program Total | **100%** | **$241.4 M** |  |  |  |

To estimate program-wide impacts, the pilot projects were assumed to be implemented with resulting GHG emissions reductions contributing to program total. Then average costs and reductions from pilots of the same project type were used to inform program-wide reductions, up to the available funds in Table 1. The average cost was used to determine a count of more projects that could be implemented for that project type given remaining available funds. The count was then multiplied by average annual GHG emissions reductions to estimate the benefits. It was assumed that 30% of remaining funds were disbursed for Tranche 2, with new projects online by 2027, and all remaining funds disbursed for Tranche 3, with all projects online by 2029. See Table M1 for annual and cumulative GHG emissions reduction results. The estimated cost-effectiveness (in dollar per MT CO2e reduced) listed in the grant application for each measure was calculated by dividing the total funds requested by the cumulative GHG emissions reduced.

## Project Analyses

The following subsections describe the methodology for each pilot project and example project for which there is no known pilot proposed at this time but which the program funds could support. This methodology informs the above analysis by project type to estimate program wide GHG reductions.

### #1a: City of Indianapolis Solar Updates

The 10 buildings estimate collective 2,845 MWh of zero-emitting generation from the new solar arrays which, beginning in 2026, are assumed to offset average state grid emissions each year. See “Electricity Grid Emissions” section below for how the base grid emission rate was estimated. This pilot was used to inform averages for the “Buildings: Solar” project type.

### #1b: McCordsville Town Hall Energy Efficiency Upgrades

This project estimates base annual HVAC energy consumption of 60.5 MWh would be reduced to 38.3 MWh with a new, more efficient system assumed to be installed in 2026, reducing emissions from the state’s average grid each year due to reduced consumption. See “Electricity Grid Emissions” section below for how the grid emission rate was estimated. This pilot was used to inform averages for the “Buildings: HVAC” project type.

### #1c: Energy Insights Program (EIP)

EIP expansion would offer energy audits and planning support for industrial facilities to then install energy efficiency measures for both electricity and natural gas usages.

The program found average electricity usage per participant to be 2,400 MWh, which could be reduced by 10% at each of the 100 pilot participants, reducing emissions from the state’s average grid each year due to reduced consumption during a project’s 10-year life funded beginning in 2026. See “Electricity Grid Emissions” section below for how the grid emission rate was estimated. This pilot was used to inform averages for the EIP “Electricity” project type.

CIRDA’s GHG inventory data was used to inform reductions for the EIP’s gas usage measures. Total consumption of 35,855,303 MMBtu across 1,606 non-waste industrial facilities averages to 22,326 MMBtu of gas consumption per facility. This average usage was assumed to be reduced by 4% after implementing behavioral changes[[1]](#footnote-2) at each of the 100 pilot participants in 2026 for a 10-year measure life. This may be considered conservative as up to 12% savings may be achieved and measure life could be longer than 10 years. GHG emissions reductions from reduced gas combustion were estimated using EPA’s emission factor.[[2]](#footnote-3) This pilot was used to inform averages for the EIP “Natural Gas” project type.

### #1d: Rolls Royce HVAC Optimization & Submetering

The project estimates that an annual average of 900 MWh of electricity consumption would be avoided, which is assumed here to offset average state grid emissions. See “Electricity Grid Emissions” section below for how the base grid emission rate was estimated. The project also estimates these measures would avoid 6,977 MMBtu of gas consumed, resulting in reduced emissions from less gas combustion, estimated using EPA’s emission factor.2 It was assumed these measures would be implemented by 2026 and this pilot was used to inform averages for the “Industrial: Energy Efficiency” project type.

### #1e: Rolls Royce Solar PV

The project estimates 14,488 MWh of zero-emitting generation from new on-site solar, which is assumed to be operational in 2029, offsetting average state grid emissions each year thereafter. See “Electricity Grid Emissions” section below for how the base grid emission rate was estimated. Emissions from construction are assumed to be insignificant/not included. This pilot was used to inform averages for the “Industrial: Solar” project type.

### #1f: Crispus Attucks High School Energy Efficiency Renovations

This pilot would implement three separate upgrades with resulting avoided emissions for each described here then summed for the pilot project’s total. See “Base Building Energy Consumption” section below for how the base natural gas and electricity consumptions for the building were estimated.

An HVAC system upgrade would lower the building’s natural gas consumption of 2,249 MMBtu by roughly 5% when a newer, more efficient system[[3]](#footnote-4) is installed in 2026. GHG emissions reductions from reduced gas combustion were estimated using EPA’s emission factor.2 This pilot was used to inform averages for the “Buildings: HVAC” project type.

The pilot would also replace windows, improving building envelope sealing and thus gas-fueled heating/cooling efficiency. To avoid double counting, it was assumed that first the new HVAC system would be installed and the new, lower gas consumption was used to inform the window improvement analysis. It was assumed that 25%,[[4]](#footnote-5) or 531 MMBtu of this gas consumption is related to losses due to inefficient windows. New windows installed in 2026 were assumed to improve this by 13%,[[5]](#footnote-6) consuming roughly 462 MMBtu per year, reducing emissions from gas combustion, estimated using EPA’s emission factor.2 This pilot was used to inform averages for the “Buildings: Window” project type.

The pilot would also replace lighting with more efficient LEDs. It was estimated that 9%,[[6]](#footnote-7) or nearly 99 MWh of the building’s base electricity consumption is due to current lighting. New LEDs installed in 2026 were assumed to reduce this by 60%,[[7]](#footnote-8) consuming less than 40 MWh per year, reducing emissions from the state’s average grid each year. See “Electricity Grid Emissions” section below for how the grid emission rate was estimated. This pilot was used to inform averages for the “Buildings: LED” project type.

### #1g: Indianapolis Arts Center Upgrades

The project estimates 223 MWh of zero-emitting generation from a new solar array, which beginning in 2026 is assumed to offset average state grid emissions each year. See “Electricity Grid Emissions” section below for how the base grid emission rate was estimated. This pilot was used to inform averages for the “Buildings: Solar” project type.

This pilot also includes HVAC system upgrade, where base building consumption of 1,958 MMBtu of gas is assumed to be reduced by roughly 5% when a newer, more efficient system3 is installed in 2026. See “Base Building Energy Consumption” section below for how the base was estimated. GHG emissions reductions from reduced gas combustion were estimated using EPA’s emission factor.2 This was used to inform averages for the “Buildings: HVAC” project type.

### Example: EV charging infrastructure

An estimated cost of $120,000 for purchase and installation[[8]](#footnote-9) of one EV charger was used to inform the “EV charging” project type analysis. It was assumed this one workplace charger is assumed to support the full charging needs of two EVs each year, avoiding two internal combustion engine (ICE) vehicles that may have otherwise been on the road. For estimating emissions due to EV charging, it was assumed each EV consumes 4.9 MWh each year,[[9]](#footnote-10) multiplied by the average state grid emission rate described in the “Electricity Grid Emissions” section below. For estimating avoided emissions from these not being ICE vehicles, an average annual drive of 11,106 miles per vehicle was assumed,[[10]](#footnote-11) multiplied by the Gasoline LDV Fleet average CO2 emission factor for 2026.[[11]](#footnote-12) The net of these calculations result in the avoided emissions used for the program analysis.

### Example: Mobility

Informed by draft projects considered in the CIRDA region, an estimated average cost of $1.5 million for a 240-bicycle bike share project, operational by 2026, was used to inform the “Mobility” project type analysis. Due to uncertainties, it was assumed that half these bikes would be regularly used any given commute day (235 days per year assumed[[12]](#footnote-13)) to avoid single occupancy ICE vehicles. Mean trip distance of 7.52 miles was assumed,[[13]](#footnote-14) and doubled to account for a to-and-from commute. The total annual avoided vehicle miles (3,534.4 per vehicle x 120 bikes in use) were multiplied by the Gasoline LDV Fleet average CO2 emission factor for the same year11 to estimate avoided emissions.

### Example: Public Transit

Informed by draft projects considered in the CIRDA region, an estimated cost of $18.8 million could support[[14]](#footnote-15) 22 hybrid diesel buses operational by 2027, used to inform the “Public Transit” project type analysis. Due to uncertainties, it was assumed each bus would have five regular riders any given commute day (235 days per year assumed12) that would have otherwise used single occupancy ICE vehicles (22 x 5 = 110 ICE vehicle commutes avoided).

For estimating emissions due to initial route construction in 2025 and 2026, it was assumed 4 regular work vehicles would each drive 4,950 miles over each year in the course of the work, consuming total 3,300 gallons of diesel,[[15]](#footnote-16) with emissions from fuel combustion estimated using EPA’s diesel fuel and non-road equipment emission factors2 and global warming potentials (GWPs) for the 100-year time horizon from IPCC 5th Assessment Report for pollutant conversions to CO2e.[[16]](#footnote-17)

Emissions for the hybrid bus operations beginning in 2027 were estimated assuming mean trip distance of 7.52 miles,13 and doubled to account for a to-and-from commute. The total annual hybrid bus miles (3,534.4 per vehicle x 22 buses) were multiplied by the Diesel Bus Fleet average CO2 emission factor for 202711 to estimate emissions, though the emission factor was reduced by 75%[[17]](#footnote-18) to account for lower emissions of hybrid diesel buses.

For estimating avoided emissions from buses avoiding ICE vehicle use, the annual commute miles (3,534.4 miles x 110 LDVs) were multiplied by the Gasoline LDV Fleet average CO2 emission factor for 2027.11

The annual net of the above calculations resulted in avoided emissions for the program analysis.

## Table M1. Measure #1 GHG Emissions Reductions (MT CO2e)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1a | | 1b | | 1c | | 1d | | 1e | | 1f | | 1g | | Measure #1 | |
| Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul |
| 2025 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | -35 | -35 |
| 2026 | 1,656 | 1,656 | 13 | 13 | 13,969 | 13,969 | 894 | 894 | - | - | 45 | 45 | 135 | 135 | 16,819 | 16,785 |
| 2027 | 1,344 | 3,001 | 10 | 23 | 16,073 | 30,043 | 795 | 1,689 | - | - | 38 | 83 | 111 | 246 | 49,551 | 66,336 |
| 2028 | 1,227 | 4,227 | 10 | 33 | 15,082 | 45,125 | 758 | 2,447 | - | - | 36 | 119 | 102 | 348 | 48,391 | 114,727 |
| 2029 | 1,067 | 5,294 | 8 | 41 | 13,731 | 58,856 | 707 | 3,154 | 5,430 | 5,430 | 33 | 151 | 89 | 438 | 124,437 | 239,164 |
| 2030 | 892 | 6,185 | 7 | 48 | 12,255 | 71,110 | 652 | 3,806 | 4,539 | 9,970 | 29 | 180 | 76 | 513 | 121,820 | 360,984 |
| 2031 | 857 | 7,042 | 7 | 55 | 11,960 | 83,071 | 641 | 4,447 | 4,362 | 14,331 | 28 | 208 | 73 | 586 | 121,297 | 482,281 |
| 2032 | 803 | 7,845 | 6 | 61 | 11,509 | 94,580 | 624 | 5,071 | 4,089 | 18,421 | 27 | 236 | 69 | 655 | 120,496 | 602,777 |
| 2033 | 786 | 8,631 | 6 | 67 | 11,363 | 105,943 | 618 | 5,689 | 4,001 | 22,421 | 27 | 262 | 67 | 722 | 120,234 | 723,012 |
| 2034 | 742 | 9,373 | 6 | 73 | 10,993 | 116,936 | 605 | 6,294 | 3,778 | 26,199 | 26 | 288 | 64 | 786 | 119,578 | 842,590 |
| 2035 | 734 | 10,107 | 6 | 79 | 10,927 | 127,863 | 602 | 6,896 | 3,738 | 29,937 | 26 | 313 | 63 | 849 | 119,460 | 962,050 |
| 2036 | 773 | 10,880 | 6 | 85 | 4,735 | 132,598 | 614 | 7,510 | 3,937 | 33,874 | 26 | 340 | 66 | 915 | 113,520 | 1,075,570 |
| 2037 | 794 | 11,674 | 6 | 91 | 0 | 132,598 | 621 | 8,131 | 4,040 | 37,915 | 27 | 367 | 68 | 983 | 108,916 | 1,184,486 |
| 2038 | 807 | 12,481 | 6 | 97 | 0 | 132,598 | 625 | 8,756 | 4,108 | 42,022 | 27 | 394 | 69 | 1,052 | 109,000 | 1,293,486 |
| 2039 | 783 | 13,264 | 6 | 104 | 0 | 132,598 | 618 | 9,374 | 3,989 | 46,011 | 27 | 420 | 67 | 1,119 | 108,847 | 1,402,333 |
| 2040 | 774 | 14,038 | 6 | 110 | 0 | 132,598 | 615 | 9,988 | 3,940 | 49,952 | 26 | 447 | 66 | 1,186 | 108,783 | 1,511,117 |
| 2041 | 784 | 14,822 | 6 | 116 | 0 | 132,598 | 618 | 10,606 | 3,992 | 53,943 | 27 | 473 | 67 | 1,253 | 108,848 | 1,619,964 |
| 2042 | 786 | 15,608 | 6 | 122 | 0 | 132,598 | 619 | 11,225 | 4,004 | 57,947 | 27 | 500 | 67 | 1,320 | 108,861 | 1,728,825 |
| 2043 | 780 | 16,388 | 6 | 128 | 0 | 132,598 | 617 | 11,841 | 3,971 | 61,918 | 27 | 527 | 67 | 1,387 | 108,818 | 1,837,643 |
| 2044 | 782 | 17,170 | 6 | 134 | 0 | 132,598 | 617 | 12,459 | 3,980 | 65,898 | 27 | 553 | 67 | 1,454 | 108,828 | 1,946,472 |
| 2045 | 744 | 17,914 | 6 | 140 | 0 | 132,598 | 605 | 13,064 | 3,788 | 69,686 | 26 | 579 | 64 | 1,518 | 108,581 | 2,055,052 |
| 2046 | 717 | 18,631 | 6 | 145 | 0 | 132,598 | 597 | 13,660 | 3,651 | 73,337 | 25 | 604 | 62 | 1,580 | 108,405 | 2,163,457 |
| 2047 | 721 | 19,352 | 6 | 151 | 0 | 132,598 | 598 | 14,258 | 3,670 | 77,007 | 25 | 630 | 62 | 1,642 | 108,428 | 2,271,885 |
| 2048 | 712 | 20,064 | 6 | 157 | 0 | 132,598 | 595 | 14,853 | 3,625 | 80,633 | 25 | 655 | 62 | 1,704 | 108,369 | 2,380,254 |
| 2049 | 703 | 20,767 | 5 | 162 | 0 | 132,598 | 592 | 15,446 | 3,578 | 84,210 | 25 | 680 | 61 | 1,765 | 108,307 | 2,488,560 |
| 2050 | 667 | 21,434 | 5 | 167 | 0 | 132,598 | 581 | 16,027 | 3,398 | 87,608 | 24 | 704 | 58 | 1,823 | 108,075 | 2,596,636 |

Note: negative reductions in above table indicate added emissions. Results of example projects not included separately in table but are embedded in program-level analysis results.

# #2: Regional Open Space Revitalization and Connectivity Program

GHG emissions reductions were estimated for each project type supported by the program and summed for the program total. There are uncertainties regarding the actual projects that will be implemented; therefore, the split of funds by project type in Table 2 was informed by factors such as the five known pilot project and the one example project costs, difficulty and practicality of implementation, and popularity. The total funding requested for the program is $199 million, including $25 million for administration. The remaining $174 million is assumed to be available for emissions reducing projects.

##### Table 2. Measure 2 Program Fund Allocation by Project Type

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Project Type | Share of Funds | Total  Funds | Average Cost per Project | Average  Ann. GHGs Reduced per Project | Estimated Counts  Supported |
| Brownfield: Solar | 20% | $35 M | $24.5 M | 6,575 MT | 1+ projects |
| Brownfield: Tree Planting | 20% | $35 M | $1 M | 54 MT | 1,521 acres |
| Walking/Biking Trails | 30% | $52 M | $7.5 M | 17 MT | 7 projects |
| Wetlands | 20% | $35 M | $1.8 M | 22 MT | 1,507 acres |
| Reforestation | 10% | $17 M | $4.3 M | 132 MT | 447 acres |
| Program Total | **100%** | **$174 M** |  |  |  |

To estimate program-wide impacts, the pilot projects were assumed to be implemented with resulting GHG emissions reductions contributing to program total. Then average costs and reductions from pilots of the same project type were used to inform program-wide reductions, up to the available funds in Table 2. The average cost was used to determine a count of more projects that could be implemented for that project type given remaining available funds. The count was then multiplied by average annual GHG emissions reductions to estimate the benefits. It was assumed that 30% of remaining funds were disbursed for Tranche 2, with new projects online by 2027, and all remaining funds disbursed for Tranche 3, with all projects online by 2029. See Table M2 for annual and cumulative GHG emissions reduction results. The estimated cost-effectiveness (in dollar per MT CO2e reduced) listed in the grant application for each measure was calculated by dividing the total funds requested by the cumulative GHG emissions.

## Project Analyses

The following subsections describe the methodology for each pilot project and example project for which there is no known pilot proposed at this time but for which the program funds could support. This methodology informs the above analysis by project type to estimate program wide GHG reductions.

### #2a: City of Indianapolis Brownfield Julietta Landfill

It was assumed the project will be operational in 2027, and that the roughly 10 MW solar array will have a capacity factor in-line with national averages of around 26% to generate over 22,700 MWh of zero-emitting power each year, offsetting average state grid emissions. Emissions from construction are assumed to be insignificant and are not included. See “Electricity Grid Emissions” section below for how the base grid emission rate was estimated. This pilot was used to inform averages for the “Brownfield: Solar” project type.

### #2b: Nickel Plate Pedestrian Bridge

There are uncertainties on the impacts, but for this analysis it was assumed this new walking bridge may avoid 12 single occupancy vehicles that would otherwise be driven any given commute day (235 days per year assumed12) due to streamlined access to parks, schools, and commutes. A mean one-way trip distance of 7.52 miles avoided was assumed,13 and doubled to account for a to-and-from commute. The total annual avoided vehicle miles (3,534.4 per vehicle x 12 ICE vehicles not in use) were multiplied by the Gasoline LDV Fleet average CO2 emission factor for 202611 to estimate avoided emissions. There are uncertainties for estimating the details of initial construction in 2025, but for this analysis it was assumed 4 regular work vehicles would each drive 270 miles over 6 months of construction work, consuming total 180 gallons of diesel,15 with emissions from fuel combustion estimated using EPA’s diesel fuel and non-road equipment emission factors2 and GWPs from IPCC for pollutant conversions to CO2e.16 The annual net of these calculations resulted in avoided emissions for the pilot and was used to inform averages for the “Walking/Biking Trails” project type.

### #2c: Grassy Creek Trail

It was assumed that this new prime-location multi-mile trail will avoid twenty single occupancy vehicles that would otherwise be driven any given commute day (235 days per year assumed12) due to streamlined access to transit, schools, and commutes. A mean one-way trip distance of 7.52 miles avoided was assumed,13 and doubled to account for a to-and-from commute. The total annual avoided vehicle miles (3,534.4 per vehicle x 20 ICE vehicles not in use) were multiplied by the Gasoline LDV Fleet average CO2 emission factor for 202611 to estimate avoided emissions. There are uncertainties for estimating the details of initial construction in 2026, but for this analysis it was assumed 10 regular work vehicles would each drive 3,420 miles over 10 months of construction work, consuming total 5,700 gallons of diesel,15 with emissions from fuel combustion estimated using EPA’s diesel fuel and non-road equipment emission factors2 and GWPs from IPCC for pollutant conversions to CO2e.16 The annual net of these calculations resulted in avoided emissions for the pilot and was used to inform averages for the “Walking/Biking Trails” project type.

Another feature of this pilot would result in planting 80 acres of trees. Assuming 1.2 MT of CO2 stored for every acre (described below in subsection #2d), this avoided 96 MT each year since planting by 2027, and was also used to inform averages for the “Reforestation” project type.

### #2d: Connor Prairie Reforestation

The project conservatively estimates that 1.2 metric tons of CO2 may be stored each year for every acre of trees.[[18]](#footnote-19) The pilot would support 140 new acres, assumed to be planted by 2026 and capable of storing the resulting 168 MT of CO2 for each successive year. This pilot was used to inform averages for the “Reforestation” project type.

### #2e: Connor Prairie Wetland Enhancement and Fertilizer Education Program

This pilot would enhance 80 acres of wetlands on currently unused land. The Second State of the Carbon Cycle Report finds a mid-estimate of 66.99 grams of CO2 stored per square meter (or 0.27 MT stored per acre) of forested wetlands per year.[[19]](#footnote-20) The pilot’s new wetlands therefore estimated to store nearly 22 MT each year by 2026. There are significant uncertainties regarding carbon storage in wetlands, but it is believed this may be a conservative estimate of avoided emissions.[[20]](#footnote-21)

### Example: Brownfield Site Revitalization

Informed by draft projects considered in the CIRDA region, an estimated average cost of just over $1 million could support tree planting on roughly 45 acres of unused brownfield. Assuming the 1.2 MT of CO2 stored for every acre of trees planted (described above in subsection #2d), this example project avoiding 54 MT each year and was used to inform the “Brownfield: Tree Planting” project type analysis.

## Table M2. Measure #2 GHG Emissions Reductions (MT CO2e)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2a | | 2b | | 2c | | 2d | | 2e | | Measure #2 | |
| Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul | Ann | Cumul |
| 2025 | - | - | -2 | -2 | - | - | - | - | - | - | -2 | -2 |
| 2026 | - | - | 14 | 12 | -60 | -60 | 168 | 168 | 22 | 22 | 198 | 196 |
| 2027 | 10,726 | 10,726 | 14 | 26 | 119 | 59 | 168 | 336 | 22 | 43 | 12,699 | 12,895 |
| 2028 | 9,789 | 20,515 | 14 | 40 | 119 | 179 | 168 | 504 | 22 | 65 | 11,762 | 24,657 |
| 2029 | 8,510 | 29,025 | 14 | 54 | 119 | 298 | 168 | 672 | 22 | 87 | 14,208 | 38,865 |
| 2030 | 7,114 | 36,139 | 14 | 68 | 119 | 417 | 168 | 840 | 22 | 108 | 12,811 | 51,676 |
| 2031 | 6,835 | 42,974 | 14 | 82 | 119 | 536 | 168 | 1,008 | 22 | 130 | 12,533 | 64,210 |
| 2032 | 6,409 | 49,383 | 14 | 96 | 119 | 656 | 168 | 1,176 | 22 | 152 | 12,106 | 76,316 |
| 2033 | 6,270 | 55,652 | 14 | 110 | 119 | 775 | 168 | 1,344 | 22 | 174 | 11,968 | 88,284 |
| 2034 | 5,921 | 61,573 | 14 | 124 | 119 | 894 | 168 | 1,512 | 22 | 195 | 11,618 | 99,902 |
| 2035 | 5,858 | 67,431 | 14 | 138 | 119 | 1,013 | 168 | 1,680 | 22 | 217 | 11,556 | 111,458 |
| 2036 | 6,170 | 73,601 | 14 | 152 | 119 | 1,133 | 168 | 1,848 | 22 | 239 | 11,868 | 123,326 |
| 2037 | 6,332 | 79,933 | 14 | 166 | 119 | 1,252 | 168 | 2,016 | 22 | 260 | 12,030 | 135,355 |
| 2038 | 6,437 | 86,370 | 14 | 180 | 119 | 1,371 | 168 | 2,184 | 22 | 282 | 12,135 | 147,490 |
| 2039 | 6,251 | 92,621 | 14 | 193 | 119 | 1,490 | 168 | 2,352 | 22 | 304 | 11,949 | 159,439 |
| 2040 | 6,175 | 98,796 | 14 | 207 | 119 | 1,610 | 168 | 2,520 | 22 | 325 | 11,873 | 171,312 |
| 2041 | 6,256 | 105,052 | 14 | 221 | 119 | 1,729 | 168 | 2,688 | 22 | 347 | 11,954 | 183,266 |
| 2042 | 6,274 | 111,326 | 14 | 235 | 119 | 1,848 | 168 | 2,856 | 22 | 369 | 11,972 | 195,238 |
| 2043 | 6,223 | 117,549 | 14 | 249 | 119 | 1,967 | 168 | 3,024 | 22 | 390 | 11,921 | 207,159 |
| 2044 | 6,237 | 123,787 | 14 | 263 | 119 | 2,087 | 168 | 3,192 | 22 | 412 | 11,935 | 219,094 |
| 2045 | 5,936 | 129,722 | 14 | 277 | 119 | 2,206 | 168 | 3,360 | 22 | 434 | 11,633 | 230,727 |
| 2046 | 5,722 | 135,444 | 14 | 291 | 119 | 2,325 | 168 | 3,528 | 22 | 455 | 11,420 | 242,147 |
| 2047 | 5,752 | 141,196 | 14 | 305 | 119 | 2,445 | 168 | 3,696 | 22 | 477 | 11,449 | 253,597 |
| 2048 | 5,682 | 146,878 | 14 | 319 | 119 | 2,564 | 168 | 3,864 | 22 | 499 | 11,379 | 264,976 |
| 2049 | 5,607 | 152,484 | 14 | 333 | 119 | 2,683 | 168 | 4,032 | 22 | 521 | 11,304 | 276,281 |
| 2050 | 5,325 | 157,809 | 14 | 347 | 119 | 2,802 | 168 | 4,200 | 22 | 542 | 11,023 | 287,304 |

Note: negative reductions in above table indicate added emissions. Results of example projects not included separately in table but are embedded in program-level analysis results.

# #3: Indianapolis Area Renewable Energy and Waste Reduction

The Indianapolis Motor Speedway (IMS), in partnership with the American Dairy Association, would implement a food waste collection program around the City of Indianapolis to support the production of renewable natural gas (RNG). The Renewable Energy and Waste Reduction Operation would collect food waste from IMS events, grocery stores, and restaurants in Marion County, as well as collect farm animal waste to be transported to an anaerobic digester on a local dairy farm that produces RNG. There were uncertainties around the anticipated digester location, the amount of animal food waste collected, and the digester RNG production potential. Therefore, for this GHG emissions reduction analysis, estimates for two different farm options were calculated and then averaged. There were also uncertainties around the location of participating grocery stores and restaurants and the amount of food waste collected in these locations, therefore, this analysis conservatively assumed the minimum amount of food waste collected will be the amount produced from IMS events. This analysis accounted for emissions reductions from RNG production and avoided fertilizer use, as well as emissions sources from waste transportation and reduced composting. Data on the potential energy consumption of the digester itself was not available, therefore, GHG emissions were not estimated for this. Further, emissions from construction are assumed to be insignificant and are not included.

### GHG Emissions Reductions

GHG emissions reductions were estimated for digester RNG production, assuming this fuel would offset conventional natural gas consumption, by multiplying the anticipated production estimated by IMS (average of 45,600 and 137,000 MMBtu) by EPA’s natural gas emissions factor.[[21]](#footnote-22) Currently, all farm animal waste produced on the farm is applied as fertilizer; therefore, GHG emissions reductions were estimated for the amount of farm animal waste that will no longer be used as fertilizer. Animal farm waste estimated by IMS (average of 4,139 and 12,417 metric tons) was input into EPA’s Local GHG Inventory Tool,[[22]](#footnote-23) which calculated GHG emission reductions from avoided fertilizer use.

### GHG Emissions Sources

Currently, all food waste from IMS events is sent to a composting facility, GreenCycle. GHG emissions from transporting waste were estimated by calculating the difference between the delivery of food waste from IMS to the anticipated digester farm and the baseline delivery of food waste to the closer GreenCycle composting facility. This analysis assumed a refuse truck delivers food waste to GreenCycle operating at 2.53 miles per gallon[[23]](#footnote-24) (MPG) of gasoline and a Class 4-6 Vehicle delivers food waste to the digester farm operating at 8 MPG of gasoline.[[24]](#footnote-25) This analysis conservatively assumed 52 deliveries of food waste per year (one per week). To estimate emissions, the resulting annual vehicle miles traveled were multiplied by the assumed MPG values, EPA’s emission factors for heavy duty gasoline vehicles,2 and global warming potentials from IPCC 5th AR.16 GHG emissions were also calculated for food waste from IMS events that would be diverted from the composting facility by multiplying the minimum amount of food waste produced from IMS events, as estimated by IMS (200 tons), and the EPA emission factor for food waste composting.[[25]](#footnote-26)

### Net GHG Emissions Reductions

The reductions and sources were summed to estimate resulting net reductions included in Table M3.

## Table M3: Measure #3 GHG Emissions Reductions (MT CO2e)

|  |  |  |
| --- | --- | --- |
|  | Measure #3 | |
| Ann | Cumul |
| 2025 | - | - |
| 2026 | - | - |
| 2027 | - | - |
| 2028 | 5,088 | 5,088 |
| 2029 | 5,088 | 10,176 |
| 2030 | 5,088 | 15,264 |
| 2031 | 5,088 | 20,352 |
| 2032 | 5,088 | 25,440 |
| 2033 | 5,088 | 30,528 |
| 2034 | 5,088 | 35,616 |
| 2035 | 5,088 | 40,704 |
| 2036 | 5,088 | 45,792 |
| 2037 | 5,088 | 50,879 |
| 2038 | 5,088 | 55,967 |
| 2039 | 5,088 | 61,055 |
| 2040 | 5,088 | 66,143 |
| 2041 | 5,088 | 71,231 |
| 2042 | 5,088 | 76,319 |
| 2043 | 5,088 | 81,407 |
| 2044 | 5,088 | 86,495 |
| 2045 | 5,088 | 91,583 |
| 2046 | 5,088 | 96,671 |
| 2047 | 5,088 | 101,759 |
| 2048 | 5,088 | 106,847 |
| 2049 | 5,088 | 111,935 |
| 2050 | 5,088 | 117,023 |

# Electricity Grid Emissions

EIA’s Annual Energy Outlook 2023 Reference Case informed projected state grid mix, used as part of estimated GHG reductions from changes to electricity use.[[26]](#footnote-27) Generation results are for Electricity Market Module regions in Tables 54.01 to 54.25, which broadly do not align with state boundaries.[[27]](#footnote-28) The projections for regions in which Indiana is located were used to inform a state-level estimate. A weighting of 70% was given to the projected mix of MISO/Central as this covers the majority of the state. The remainder weighted the projected mix of PJM/West. The resulting estimated mix for the state is shown Figure 1, depicting an 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 the Inflation Reduction Act of 2022 as well as accounting for planned changes, such as AES’s announced coal retirements and solar expansion in the area.

##### Figure 1. Indiana Estimated electricity grid mix



An average grid emission rate was calculated for each year based on the above mix and average emission factors for end use of each resource type shown in Table 3. Zero-emitting generation does not have emissions associated with end use. Average U.S. natural gas combined cycle and coal facility emission factors for CO2, CH4, and N2O were estimated from GREET.[[28]](#footnote-29) GWPs from IPCC were used for pollutant conversions to CO2e.16

##### Table 3. Emission Rates by Electricity Resource Type

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Electricity Generating Resource Type | CO2  (g/kWh) | CH4  (g/kWh) | N2O  (g/kWh) | CO2e  (g/kWh) |
| Zero-Emitting | 0 | 0 | 0 | 0 |
| Natural Gas | 450 | 0.89 | 0.01 | 477 |
| Coal | 1,050 | 1.70 | 0.02 | 1,104 |

The GHG emission rate by type was multiplied by its estimated project share of state generation for a given year to project average Indiana electricity grid emission rate as shown in Figure 2.

The rate for a year was first multiplied by the electricity consumption for baseline and then separately for after a project was implemented to estimate the resulting emissions for each. Then, the (lower) emissions from after the project is implemented were subtracted from the (higher) baseline to estimate avoided emissions due to the project.

Avoided emissions may decline over time though avoided electricity consumption is constant because the average grid emission rate is decarbonizing over time. Additionally, the estimated avoided emissions using this average grid electricity rate may underestimate actual reductions as the programs and measures discussed here may reduce peak usage, which likely relies on less-efficient and higher-emitting generation.

##### Figure 2. Indiana Estimated average electricity grid GHG emission Rate



# Base Building Energy Consumption

Baseline building-specific energy consumption data was not available for Indianapolis Arts Center, McCordsville Town Hall, and Crispus Attucks High School projects. Base electricity and natural gas consumption were estimating using assumptions from EIA’s Commercial Buildings Energy Consumption Survey (CBECS).[[29]](#footnote-30) Average East North Central region commercial building electricity and gas consumption per square foot was estimated by dividing the region’s total building energy consumption[[30]](#footnote-31) by floorspace.[[31]](#footnote-32)

Electricity = 694 trillion Btu / 17,374 million square feet

Natural Gas = 603 trillion Btu / 14,491 million square feet

To estimate baseline energy consumption, these averages were multiplied by the assumed total square footage size of each building for the resulting estimates in Table 4. Building sizes were assumed as follows: Indianapolis Arts Center (40,000 sq ft)[[32]](#footnote-33), McCordsville Town Hall (13,128 sq ft)[[33]](#footnote-34), and Crispus Attucks (45,943 sq ft). Building size for Crispus Attucks was unavailable and was therefore based on the size of an average education facility in the region, estimated by dividing total regional education facility floorspace (2,435 million sq ft)[[34]](#footnote-35) by the count of facilities in the region (53,000).[[35]](#footnote-36)

There are uncertainties for the estimated building size for Crispus Attucks as well as the total average building energy consumption estimates due to basing these on regional averages from 2018 survey data.

##### Table 4. Building Baseline Energy Consumption

|  |  |  |  |
| --- | --- | --- | --- |
| Project | Natural Gas  (MMBtu) | Electricity  (MMBtu) | Total Energy  (MMBtu) |
| Indy Art Center | 1,665 | 1,598 | 3,163 |
| McCordsville | 546 | 524 | 1,038 |
| Crispus Attucks | 1,912 | 1,835 | 3,747 |

1. CEE, Center for Equity and Energy Behavior, <https://cee1.org/index.php/program-insights/center-for-equity-and-energy-behavior/>, accessed February 2024. [↑](#footnote-ref-2)
2. 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>. GHG reduction estimates here are for combustion only and therefore may be uncertain and conservative due to differences in consumption across different facility sizes or timeframes, as well as due to this avoided GHG estimate not accounting for avoided emissions from reduced production or transport of fuel. [↑](#footnote-ref-3)
3. DOE, CCMS, Appliance & Equipment Standards Program, <https://www.regulations.doe.gov/certification-data/CCMS-4-Furnaces.html#q=Product_Group_s%3A%22Furnaces%22>, accessed February 2024. Informed by DOE data, base AFUE of 85 assumed, improved to 90 to represent newer system. [↑](#footnote-ref-4)
4. US DOE, Update or Replace Windows, Energy Saver site, <https://www.energy.gov/energysaver/update-or-replace-windows>. [↑](#footnote-ref-5)
5. US Energy Star, Residential Windows, Doors, Skylights, <https://www.energystar.gov/products/res_windows_doors_skylights>. The site’s finding that new windows may reduce energy bills by 13% was used as a proxy for reduced energy consumption. [↑](#footnote-ref-6)
6. EIA CBECS, 2022, Table E1-Average Building Energy Consumption from Lighting, North East Central region, <https://www.eia.gov/consumption/commercial/data/2018/ce/pdf/e1.pdf>. [↑](#footnote-ref-7)
7. ES Lighting, benefits of LED lighting in commercial buildings, <https://www.energysavinglighting.org/benefits-of-led-lighting-in-commercial-buildings/>. [↑](#footnote-ref-8)
8. Purchase cost informed by 2021 ICCT report <https://theicct.org/wp-content/uploads/2021/12/charging-up-america-jul2021.pdf>. Install cost informed by Table 3 from ICCT 2019 report <https://theicct.org/wp-content/uploads/2021/06/ICCT_EV_Charging_Cost_20190813.pdf>. [↑](#footnote-ref-9)
9. Based on 408 kWh per month from <https://www.energysage.com/electricity/house-watts/how-many-watts-does-an-electric-car-charger-use/>. [↑](#footnote-ref-10)
10. This average for annual miles driven is in-line with average of recent years’ data from US DOT Federal Highway Administration Table VM-1 data for LDVs. [↑](#footnote-ref-11)
11. US DOT, Estimated US Average Vehicle Emissions Rates, Table 4-43, <https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and>. [↑](#footnote-ref-12)
12. 235 commute days per year assumed based on 260 weekdays (5 days per 52 weeks) per year, less 25 days to account for vacation, sick time, and public holidays. [↑](#footnote-ref-13)
13. Central Indiana Travel Survey, March 2011, Table R-27, <https://d16db69sqbolil.cloudfront.net/mpo-website/downloads/Technical-Studies/Central_Indiana_Travel_Survey_2008-2009.pdf>. [↑](#footnote-ref-14)
14. Conservative cost of $642,000 per bus assumed, informed by <https://www.eesi.org/files/eesi_hybrid_bus_032007.pdf> and including 7% tax rate for vehicle purchase in Indiana. Annual fuel cost estimate of $21,270 multiplied by 10 years of fueling covered for each bus, informed by <https://www.transportation.gov/sites/dot.gov/files/images/Life%20Cycle%20Cost%20Overview%20for%20Different%20Transit%20Technologies.pdf>. Conservative purchase cost meant to also account for some uncertain costs such as initial route construction, bus maintenance, variability in fueling costs, etc. [↑](#footnote-ref-15)
15. Assuming conservative 6 miles per gallon for Class 7/8 heavy-duty vehicles informed by data from EIA <https://www.eia.gov/todayinenergy/detail.php?id=26832>. [↑](#footnote-ref-16)
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17. NEBR, How The Hybrid Transit Bus Can Lower Carbon Emissions, March 2022, <https://nebr.us/news/hybrid-transit-bus-lower-co2/>. [↑](#footnote-ref-18)
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