TECHNICAL APPENDIX: ASSUMPTIONS FOR EMISSION REDUCTIONS CALCULATIONS
for EPA Climate Pollution Reduction Grant – Implementation Phase
Kane County, Illinois Coalition

These emission reduction calculations utilized EPA calculators at www.epa.gov/energy/greenhouse-gas-equivalencies-calculator, values at www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references#houseelec, and other sources as referenced. Refer to the attached reduction calculations spreadsheet.

Emissions associated with powering equipment from grid electricity was not calculated. It is assumed that electric equipment is powered by renewable energy – green electricity aggregation, solar or wind energy, or community (utility-scale) solar systems. Emission reductions are claimed for chargers as they will serve existing electric vehicles (EVs); education will introduce additional EVs in the future, which emissions reductions are claimed separately. Emission reductions are claimed separately per budget request; for example, cold climate air source heat pumps are eligible for both a rebate and group buy. Group buys tend to run in cycles for contractors, so this program may not be available; likewise, the rebate may be expended for the year when a household is in need of replacing this equipment.

Existing federal and state financial incentives (tax credits and rebates) can be combined with the coalition's incentives to further reduce the cost of electric equipment. The coalition is not claiming the emissions reductions from these existing incentives and reduces the emissions reduction calculation by a percentage for this award's education and outreach and group buy discounts and rebates, as shown below. Subaward costs subtract existing financial incentives before the budget request, so no percentage in reduction of claims are computed.

Item	Average Cost	Existing Federal Tax Credit	Existing State Rebates	Existing Regional Rebates	Total of other incentives ($)	Reduction from other incentives (%)	Total incentives from this award ($)	Reduction claimed for this award
Solar system (residential)	$24,500	30%	35%	$0	n/a	65%	$0	35%
Cold climate air source heat pump	$8,000	$2,000	$0	$0	$2,000	25%	$1,800	75%
Heat pump water heater	$2,250	$1,750	$0	$0	$1,750	78%	$1,000	22%
Electric vehicle (new) -fleet	$45,000	$7,500	$0	$0	$7,500	17%	$0	83%
Electric vehicle (new) - personal	$45,000	<$7,500	$4,000 low-income	$0	$11,500	26%	$0	74%
Electric school bus	$320,000	$40,000	$0	$0	$40,000	12%	$0	88%
Electric vehicle charger (light-duty)	$12,000	$0	$0	$5,000	$5,000	42%	$1,000	58%

Electric vehicle charger (light-duty) - rural or low-income	$12,000	30% ($1,200)	$0 Unavailable at this time	$7,500	$8,700	73%	$1,000	28%
Exterior building maintenance equipment	$800	$0	$0	$0	$0	n/a	$300	100%

To account for the deployment of technology over the 5-year award period, calculations use a multiplier of 15 (5+4+3+2+1 years) for time in-service (see calculations worksheet, tab 'multiplier'). Because equipment will be deployed over the period of 2025 to 2030 and is expected to remain in place between 2030 and 2050, reductions are computed using 20 years in-service for the period 2030 to 2050, added to the 2025 to 2030 period for the cumulative reductions from 2025 to 2050. It is assumed that all equipment installed or an energy saving measure is employed will remain in service for the entire performance period.

According to the 2020 census data, the population encompassed by the coalition area is approximately 2,395,762 residents living in 814,131 households. There are approximately 859,044 housing units within the coalition area, with 73% occupation by owners. There are about 66,130 employers. There are about 34,790 commercial, industrial, and institutional buildings in the member counties (Kane, DuPage, and Will).

According to the Illinois Department of Motor Vehicles (DMV), there are approximately 18,844 passenger class EVs registered in the coalition currently, equating to about 1.3% of personal vehicles. Expected sales of EVs are forecast at 2% annually due to the availability of new models, replacing a portion of the 1,453,282 registered passenger vehicles. Although the Illinois DMV does not specify the number of municipal vehicles and school buses that are zero emissions, they provide the total number of vehicles registered – 19,436 municipal vehicles and 7,228 school buses within the coalition area.

POWER SECTOR

Subaward Projects

Consultants who scoped municipal and county sites for solar systems provided the estimate of average annual production (kWh). They have software that computes the annual production based on system size, direction orientation, and average daily direct sunlight at the site location. Energy production was entered into the calculator webpage for the resulting emissions reduction in MT CO_2e.

Education and Outreach

Per EPA the average home each consumed 12,154 kWh of delivered electricity (EIA 2022a). The national average carbon dioxide output rate for electricity generated in 2021 was 852.3 lbs CO2 per megawatt-hour (EPA 2023a), which translates to about 919.1 lbs CO2 per megawatt-hour for delivered electricity, assuming transmission and distribution losses of 7.3% (EIA 2022b; EPA 2023b). Annual home electricity consumption was multiplied by the carbon dioxide emission rate (per unit of electricity delivered) to determine annual carbon dioxide emissions per home.12,154 kWh per home × 852.3 lbs CO_2 per megawatt-hour generated × 1/(1-0.073) MWh delivered/MWh generated × 1 MWh/1,000 kWh × 1 metric ton/2,204.6 lb = 5.067 metric tons CO_2/home, or 18.6 MT CO_2e. Installing solar systems, which are typically sized to produce 100% of the electricity used annually.

Assume 3% of the housing units will adopt solar panels annually. 859,044 housing units x 3%/yr = 25,771 units/yr
25,771 units/yr x 18.6 MT CO_2e = 479,347 MT CO_2e/yr

Incentives for solar include a federal tax credit of 30% and state renewable energy credits based upon estimated annual production. Combined, these incentives typically reduce the cost to install solar panels by 65%. Therefore, the emissions reduction will be reduced by 35% with the associated costs to implement this workplan. The coalition is not offering any incentive to residents – only educating them on the benefits of solar systems.

BUILDINGS SECTOR

Nonresidential Buildings

Subaward Projects

Estimates for energy reduction for proposed building improvements (lighting, windows, sealing, and insulation) at municipal and county facilities were referenced from energy audits and assessments completed by consultants. Energy reductions of electricity and natural gas were input into EPA's calculator webpage to determine MT CO_2e annually.

Technical Assistance – Building Energy and Greenhouse Gas Emissions Benchmarking Program

Assume 5% per year of participants will improve their building to use less energy. Since buildings typically waste 30% of their energy due to poor envelope sealing, air leaks, and lack of insulation, assume that buildings will decrease their energy use by 10% through improvements. Per US EPA Energy Star, it is possible to reduce energy use by 10% with little to no costs.
www.epa.gov/sites/default/files/2016-04/documents/promoting_energy_efficiency_with_energy_star.pdf

34,790 commercial, industrial, and institutional buildings in the counties of coalition members
34,790 buildings x 5% = 1,740 buildings per year reduce energy use
Average nonresidential building energy use (electricity and gas) from CMAP 394 MT CO2e annually
Reduce energy use by 10% 394 MT CO2e annually *10% = **39.4 MT CO2e reduction per year**
39.4 MT CO2e reduction per year * 1,740 buildings participate per year = 68,556 MT CO2e reduction per year
This amount is not reduced by other incentives, as other incentives are unique to each building and dependent on energy reduction and tax liability.

Residential Buildings

Per EPA, natural gas: 38,567 cubic feet per home × 0.0550 kg CO2/cubic foot × 1/1,000 kg/metric ton = 2.12 metric tons CO2/home = **7.8 MT CO_2e/yr**
Furnace heating uses 45% of home energy use, per DOE **3.51 MT CO_2e/yr**
Water heating uses 18% energy use, per DOE **1.404 MT CO_2e/yr**

Group Buy

Cold climate air source heat pump (CCASHP)
1000 group buy participants estimated per year: 1000 x 3.51 MT CO_2e per building = 3,510 MT CO_2e/yr

Rebates

Heat pump water heaters

1000 rebate participants per year x 1.404 MT CO_2e per year per building = 1404 MT CO_2e/yr

Cold climate air source heat pumps (CCASHP)
1000 rebate participants per year x 3.51 MT CO_2e per building = 3150 MT CO_2e/yr

Education and Outreach
Assume 1% of housing units will adopt heat pump water heaters annually. 859,044 housing units x 1%/yr = 8,590 units/yr
8,590 units/yr x 1.404 MT CO_2e/yr = 12,061 MT CO_2e/yr
Federal tax credit is $1750. Per the Energy Star "Ask the Experts" webpage, the average cost of is $1,500-3,000.
$1750 / $2,250 = 78% 22% reduction claimed

Assume 2% of housing units will adopt cold climate air source heat pumps annually. 859,044 housing units x 2%/yr = 17,181 units/yr
17,181 units/yr * 3.51 MT CO_2e/yr = 60,305 MT CO_2e/yr total

The tax credit is $2,000, which is 25% of the average cost ($8,000). The coalition is claiming 75% of the emission reduction for CCASHPs because it would be up to the resident to apply for either a federal tax credit or rebate. The group buy discount can be stacked with the rebate and tax credit.

TRANSPORTATION SECTOR

CHARGERS

Emission reductions that result from chargers occur at the vehicle. Assumptions are provided for the impact of adding new chargers for existing EVs.
Regional EV charger rebates are offered by electric utility (ComEd): $5,000 - $7,500, higher amount if disadvantaged. https://comed.chooseev.com/commercial/promos/
https://afdc.energy.gov/files/u/publication/ev_emissions_impact.pdf

The average cost of installing a level-2 EV charger (commercial) is $2,000 - $6,000 per port.
www.greenlancer.com/post/guide-commercial-electric-vehicle-charging-stations
Use $12,000 for dual-port (charger only) and no electrical upgrade costs are included, for multi-family properties. Local government facilities have costs provided by consultants.

Level-2 chargers
One port on a level-2 charger provides 10-20 miles per electric range per hour of charging according to www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds Use 15 miles/hour of charging as average. Assume all charging ports are used 16 hours per day.
15 miles/hour of charging x 16 hours/day usage = 240 miles/day per port
Per EPA, weighted average fuel economy is 23 miles per gallon
240 miles/day per port gasoline reduction / 23 miles per gallon = 10.4 gallon/day reduced
Per EPA, 8,887 grams of CO_2/gallon of gasoline = 8.887×10^{-3} metric tons CO_2/gallon of gasoline 0.009 MT CO_2e/gallon of gasoline
10.4 gallon/day reduced x 0.009 MT CO_2e/gallon of gasoline = **0.036 MT CO_2e/day per port (level-2)**

Level-3 (fast chargers) chargers

One port on a level-3 charger provides 180-240 miles per electric range per hour of charging according to www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds Use 210 miles/hour as average.
Assume fast charger ports are used 8 hours per day.
210 miles/hour of charging x 8 hours/day usage = 1,680 miles/day per port
Per EPA, weighted average fuel economy is 23 miles per gallon
1,680 miles/day per port gasoline reduction / 23 miles per gallon = 73 gallon/day reduced
Per EPA, 8,887 grams of CO_2/gallon of gasoline = 8.887×10^{-3} metric tons CO_2/gallon of gasoline 0.009 MT CO_2e/gallon of gasoline
73 gallon/day reduced x 0.009 MT CO_2e/gallon of gasoline = **0.657 MT CO_2e/day per port (level-3)**

Subawards
Level-2 chargers public/government facilities
Level-2 chargers (2 ports each)
Assume each port is used 16 total hours/day: 8 hours during the day for public visitors and 8 hours overnight for fleet; assume each port is used 350 days/year (reduced for government holidays)
Assume installed FY25 and in service for 5 years.

Level-3 fast chargers public/government facilities
Level-3 chargers (2 ports each)
Assume each port is used 8 total hours/day by a mix of public visitors and fleet vehicles. Assume each port is used 350 days/year (reduced for government holidays).
Assume installed FY25 and in service for 5 years.

Level-2 public chargers for multi-family buildings, low-income prioritized
It is assumed that 50% of the chargers from group buys will be installed in low-income or rural census tracts, which qualify for additional federal and regional incentives.
Assume 10 properties per year 20 ports per year
50 properties total over performance period 100 ports by 2030
Assume chargers are used 365 days per year

VEHICLES
Gallons of gasoline consumed
Per EPA webpage, gasoline vehicles: 8.89×10^{-3} metric tons CO_2/gallon gasoline × 10,746 VMT $_{\text{car/truck average}}$ × 1/22.9 miles per gallon $_{\text{car/truck average}}$ × 1 CO_2, CH_4, and N_2O/0.993 CO_2 = **4.20 metric tons CO_2E/vehicle /year**

Electric passenger vehicles per year
The weighted average combined electric efficiency of U.S. electric vehicles sales from 2019 and earlier is 3.60 miles per kWh (DOE 2023). The average vehicle miles traveled (VMT) in 2021 was 10,746 miles per year and is assumed to be the same for electric cars (FHWA 2023). The amount of carbon dioxide equivalent emitted per MWh is 857.0 pounds (EPA 2023).

857.0 lbs CO2e/MWh × 10,746 VMT $_{\text{car/truck average}}$ × 1/3.60 miles per kWh $_{\text{all EVs average}}$ x 1/1000 MWh/kWh x 1 metric ton/2,204.6 lbs = **1.16 metric tons CO2E/vehicle/year reduction**

Therefore, replacing an ICE vehicle with an EV reduces emissions by: (4.20 metric tons CO_2E/vehicle /year) – (1.16 metric tons CO_2E/vehicle/year) = **3.04 metric tons CO2E/vehicle/year**

This value accounts for grid electricity for charging, rather than assuming an EV is truly zero emissions. The EPA's calculator for number of vehicles converted into a number in MT CO_2e that is greater than this calculation.

Education and Outreach
Assume 2% of 1,453,282 vehicle owners will purchase an electric vehicle annually. 1,453,282 residents x 2%/yr = 43,598 EVs/yr

Assume 1% of businesses will purchase an electric vehicle annually for their fleet. 66,130 employers x 1% = 661 EVs/yr

The federal tax credit is up to $7,500 per vehicle, depending on the vehicle's components and assembly; it is assumed that people will purchase a qualifying vehicle. A state rebate has been available, but difficult for most to attain, as low-income applicants are prioritized. The average cost per vehicle is $45,000.

Technical Assistance for local agencies
Municipal/Counties/Agencies
Passenger class municipal fleet vehicles – existing number registered to DMV in coalition area: 19,436
Assume 2% conversion to electric fleet vehicles per year. 19,436 x 2% = 389 EVs replace ICE per year
389 EVs replace ICE per year * 5 years = 1,944 EVs replace ICE by 2030
389 EVs replace ICE per year * 4.20 MT CO_2E/vehicle/year = 1,182 MT CO_2e per year
Direct pay $7,500 per vehicle; average cost per vehicle $45,000; $7,500/$45,000 = 17% of vehicle cost

Schools
Gallons of diesel consumed
In the preamble to the joint EPA/Department of Transportation rulemaking on May 7, 2010 that established the initial National Program fuel economy standards for model years 2012-2016, the agencies stated that they had agreed to use a common conversion factor of 10,180 grams of CO_2 emissions per gallon of diesel consumed (Federal Register 2010). For reference, to obtain the number of grams of CO_2 emitted per gallon of diesel combusted, the heat content of the fuel per gallon can be multiplied by the kg CO_2 per heat content of the fuel.
This value assumes that all the carbon in the diesel is converted to CO_2 (IPCC 2006).
10,180 grams of CO_2/gallon of diesel = 10.180×10^{-3} metric tons CO_2/gallon of diesel = **0.037 MT CO_2e/gallon of diesel**

Per https://www.nysbca.com/fastfacts, school buses travel about 12,000 miles per year per bus or almost 6 billion cumulative miles per year.
Each school bus, at an average 7 mpg and 12,000 miles, uses 1,700 gallons of fuel per year.

There is no information available from EPA on the CO2e associated with charging electric school buses or medium-duty vehicles. CNBC reports that battery-electric Type A school buses can cost around $250,000, compared to $50,000 to $65,000 for diesel versions. For larger Type C or Type D buses, electric options range from $320,000 to $440,000, while diesel versions cost about $100,000. https://www.gregorypoole.com/school-bus-costs/ Assume Type C are the standard purchase.

Existing number of school buses registered to DMV in coalition area: 7,228
Assume 1% conversion to electric school buses per year.
7,228 buses * 1% = 72 buses per year * 5 years = 361 buses by 2030

Per bus, 1,700 gal diesel/yr * 0.037 MT CO_2e/gallon of diesel = **62.9 MT CO_2e per bus per year**
72 buses/yr * 62.9 MT CO_2e per bus per year = 4,546 MT CO_2e /yr

Federal direct pay - $40,000 per bus
$40,000 / $320,000 = 12% 88% of emission reduction claimed
Assumes grants will not be secured, as competitive.

Group Buys
Exterior building maintenance equipment
Assume rebates are split equally between the 4 categories below. Use the average of typical use of gasoline per year (gal/year) of all the different types of equipment 475.5 gal/yr
Assume each piece of equipment uses various gallons of gasoline per year.
www.gasrushstories.com/how-much-gas-does-a-lawn-mower-use/
www.quietcleanpdx.org/wp-content/uploads/2019/11/Gas-Powered-Leaf-Blower-Emissions-Factsheet-11.12.pdf
www.mensjournal.com/pursuits/home-living/pros-cons-gas-vs-electric-snow-blowers-faq
Commercial mowers 3 gal/hr
Residential mowers 1 gal/hr
Leaf blowers 0.43 gal/hr
Snow blowers 1 gal/hr

Assume commercial mowers are used for 6 hours/day, 5 days/week, for 5 months of the year. Assume residential mowers are used for 1.5 hours each week for 5 months of the year. Assume leaf blowers are used commercially for 1.5 hours each day, 5 days/week for 5 months of the year. Assume snow blowers are run, for either commercial or residential use, for 1.5 hours each month for 3 months of the year.

Per EPA, 8,887 grams of CO_2/gallon of gasoline = 8.887×10^{-3} metric tons CO_2/gallon of gasoline **0.009 MT CO_2e/gallon of gasoline**
Typical use per year – 475.5 gal/yr
475.5 gal/yr x 0.009 MT CO_2e/gallon of gasoline = **4.3 MT CO_2e/yr**
2000 units replaced/year x 4.3 MT CO_2e/yr = 8,600 MT CO_2e/year

Since there are no other federal or state financial incentives for exterior maintenance building equipment, the coalition is claiming 100% of the emissions reduction.