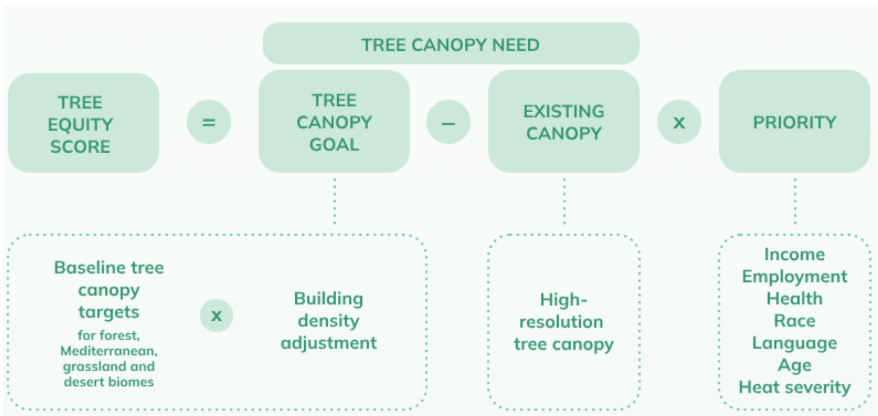
This appendix explains the methodology and assumptions used for developing the priority measures emissions reduction estimates.

Increasing Urban Tree Canopy

Methodology:

- The Tree Equity Score website estimates the annual quantity of carbon dioxide, particulate matter, nitrogen dioxide, sulfur dioxide, and ozone removed as a result of the plantings. The Tree Equity Score is calculated using the following formula:



- This data was compiled for all urban areas in the MSA. The annual reductions provided are summarized in the table below:

	Tree Score of 60						
Municipality	**Trees**	**CO2 (MT)**	**PM2.5 (lbs)**	**PM10 (lbs)**	**NO2 (lbs)**	**SO2 (lbs)**	**Ozone (lbs)**
Paris	896	16	24	85	54	36	512
Winchester	1,361	24	29	178	85	57	807
Lexington	2,899	51	81	297	183	123	1,727
Nicholasville	16,297	286	457	1,690	1,014	638	9,618
Wilmore	1,191	21	33	124	74	47	703
Georgetown	2,205	39	80	248	153	102	1,439
Versailles	5,729	101	144	621	351	220	3,328
TOTAL	**30,578**	**537**	**848**	**3,242**	**1,912**	**1,224**	**18,134**

- It should be noted that the tool uses i-Tree methods for these calculations which assume medium-sized urban trees. To reap as many benefits as possible from the plantings, the MSA will prioritize ball and burlap tree installations. While more mature than seedlings, it is understood that it will take some years to receive the annual benefits estimated by the Tree Equity Score website.
- To estimate the possible emissions reductions by 2030 and 2050, the following assumptions were made:
  - Trees will only produce 20% of the benefits from 2025-2030.

  - Trees will produce 50% of the benefits from 2030-2035.
  - Trees will produce full benefits from 2035-2050.
- Based on these assumptions, the annual reductions provided by Tree Equity Score were prorated to produce the following results:

	CO2 (MT)	PM2.5 (lbs)	PM10 (lbs)	NO2 (lbs)	SO2 (lbs)	Ozone (lbs)
By 2030	107	170	648	382	245	3,627
By 2050	9,512	15,006	57,380	33,844	21,656	320,972

Models/Tools Used:

- Tree Equity Score - https://www.treeequityscore.org/

Assumptions:

- Benefit totals provided by Tree Equity Score website are assumed to be accurate.
- Reduction totals assume that 100% of the measure is funded by a CPRG Implementation Grant.
- Trees will be installed annually until the target number of trees is achieved.

Durability/Reasonableness of Methods:

- i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools. It was first released in 2006. It is the industry standard for calculating benefits associated with trees.
- There are many factors that play into how much carbon a tree may sequester including age, species, temperature, precipitation, and soil quality. The actual amount of carbon sequestered year to year may vary. Furthermore, there may be a period of root shock lasting several months to several years depending on the extent of root damage during transplanting.
- While actual carbon sequestration rates may vary from tree to tree, they will begin sequestering carbon immediately as demonstrated by the table below from the U.S. EPA. These benefits will increase as time goes on.

Table 2: Survival Factors and Annual Carbon Sequestration Rates for Common Urban Trees

Tree Age (yrs)	Survival Factors by Growth Rate			Annual Sequestration Rates by Tree Type and Growth Rate (lbs. carbon/tree/year)					
				Hardwood			Conifer		
	Slow	Moderate	Fast	Slow	Moderate	Fast	Slow	Moderate	Fast
0	0.873	0.873	0.873	1.3	1.9	2.7	0.7	1.0	1.4
1	0.798	0.798	0.798	1.6	2.7	4.0	0.9	1.5	2.2
2	0.736	0.736	0.736	2.0	3.5	5.4	1.1	2.0	3.1
3	0.706	0.706	0.706	2.4	4.3	6.9	1.4	2.5	4.1
4	0.678	0.678	0.678	2.8	5.2	8.5	1.6	3.1	5.2

Residential Solar

Methodology:

- The average number of kWh (1550 kWh) produced per kW by a residential solar installation in KY was obtained from SolarReviews.com.
- The average size solar installation in KY (4-8 kW) was obtained from KY EEC's Resources for Residential Rooftop Solar Installations page. An average 6 kW was assumed.
- The average solar installation price for Solarize Lexington was found to be $21,721.07.
- A budget of $15,000,000 for solar installations was assumed. Based on this total, approximately 691 homes could be served.
- Using 6 kW x 1550 kWh, approximately 9,300 kWh of solar energy could be produced per home annually.
- Using the KY electricity emission factor of 1,739 lbs/MWh, 5,066 MT CO2e could be avoided annually by these installations.
- Extrapolating these reductions out to 2030 and 2050 yields the following reductions:

	CO2 (MT)
By 2030	25,332
By 2050	126,659

- Using the KY electricity emission factor of 1,739 lbs/MWh, 5,066 MT CO2e could be avoided annually by these installations.
- It is understood that all panels will not be installed and providing benefits immediately. Therefore, these totals were prorated to align with the estimated installation schedule. It is expected that the majority of solar installations will occur within the first four years of the five-year grant period. As such, it was assumed that panels installed in the first year would provide benefits for the full 5- and 25-year terms, panels installed in the second year would provide benefits for 4 and 24 years, panels installed in the third year would provide benefits for 3 and 23 years, and panels installed in the fourth year would provide benefits for 2 and 22 years.
- Prorating the totals to account for the installation schedule provides the following reductions:

	CO2 (MT)	CH4 (MT CO2e)	N2O (MT CO2e)	TOTAL (MT CO2e)
By 2030	17,606	53	73	17,732
By 2050	118,214	356	490	119,060

Models/Tools Used:

- SolarReviews.com - https://www.solarreviews.com/solar-panels/kentucky#:~:text=A%20solar%20system%20that%20is,year%20per%201kW%20in%20Kentucky
- KY EEC - https://eec.ky.gov/Energy/News-Publications/Pages/Residential-Rooftop-Solar-Resources.aspx

Assumptions:

- Data regarding the average energy production, size of solar installations, and cost of installation are assumed to be accurate and representative.
- Kentucky's climate and annual maximum sun were assumed to be constant for the evaluation period.
- Kentucky's resource mix was assumed to be constant for the evaluation period.

Durability/Reasonableness of Methods:

- This method is based on quantifying the emissions associated with the avoided electricity from the grid. eGRID emission factors are calculated using standard methodologies developed by the EPA.
- Every unit of solar electricity produced is one less unit required to be purchased from an electric utility. If Kentucky make significant improvements in converting its resource mix to cleaner energies, the electricity emission factor will decrease resulting in fewer avoided emissions.
- Actual energy generated per installation may vary from averages depending on specific location, capacity, and annual sun availability.

Weatherization

Methodology:

- The U.S. DOE estimates that weatherization measures reduce energy emissions by one metric ton per home annually.
- According to Community Action Council, when U.S. DOE and Low-Income Home Energy Assistance Program funds are available, homes receive up to $15,000-$20,000 for weatherization.
- A budget of $8,000,000 was assumed.
- Using a conservative estimate of $20,000 per home, 400 homes would be able to be served.
- Extrapolating these reductions out to 2030 and 2050 yields the following reductions:

	CO2 (MT)
By 2030	2,000
By 2050	10,000

- It is understood that all homes will not be weatherized immediately. Therefore, these totals were prorated to align with the estimated schedule. It is expected that the majority of homes weatherized will occur within the first three years of the five-year grant period. As such, it was assumed that homes weatherized in the first year would provide benefits for the full 5- and 25-year terms, homes weatherized in the second year would provide benefits for 4 and 24 years, homes weatherized in the third year would provide benefits for 3 and 23 years and homes weatherized in the fourth year would provide benefits for 2 and 22 years.
- Prorating the totals to account for the schedule provides the following reductions:

	CO_2 (MT)
By 2030	1,400
By 2050	9,400

Models/Tools Used:

- U.S. DOE - https://www1.eere.energy.gov/wip/pdfs/wap_factsheet.pdf

Assumptions:

- Kentucky's climate was assumed to be constant for the evaluation period.

Durability/Reasonableness of Methods:

- Depending on the measures selected to be undertaken, the emissions reductions potential could be greater. An annual one (1) MT reduction per home is a conservative estimate provided by the U.S. DOE.

Lextran Electric Vehicle Shelter & Charging Infrastructure

Methodology:

- The average number of kWh (1550 kWh) produced per kW by a solar installation in KY was obtained from SolarReviews.com.
- On average, 1 kW can be installed per 100 square feet of roof space. Based on a canopy size of 12,000 square feet, a 120-kW array could be installed.
- Using 120 kW x 1550 kWh, approximately 186,000 kWh of solar energy could be produced annually.
- Using the KY electricity emission factor of 1,739 lbs/MWh, 147 MT CO_2e could be avoided annually by this installation.
- Extrapolating these reductions out to 2030 and 2050 yields the following reductions:

	CO_2 (MT)
By 2030	734
By 2050	3,668

- It is assumed that the panels will be installed in the first year of the five-year grant period.
- Lextran used the Federal Transit Administration's Transit Bus Electrification Tool to estimate lifecycle GHG emission savings for replacing a diesel bus with an electric bus. The tool accounts for eGRID subregion when considering the emissions generated from charging. The tool estimates that based on the average annual vehicle miles traveled by one of Lextran's diesel buses it produces 72 MT CO_2e annually. An electric bus is estimated to produce 50% fewer emissions at about 36 MT CO_2e annually.

- The canopy project will allow for 15 additional electric buses. While the buses themselves are not included in this grant request, this project facilitates the electrification of Lextran's fleet. Assuming all are converted yields the following reductions:

	CO2 (MT)
By 2030	2,710
By 2050	13,549

- The emissions reductions from the solar panels and electric buses were totaled to obtain the following results:

	CO2 (MT)
By 2030	3,443
By 2050	17,217

- These emissions were then multiplied by the percentage of funding from an Implementation Grant, 78.6%.

	CO2 (MT)
By 2030	2,707
By 2050	13,533

Models/Tools Used:

- HUD Exchange - https://files.hudexchange.info/resources/documents/Appendix-F-Rooftop-Calculation-Tool.pdf
- Federal Transit Administration's Transit Bus Electrification Tool - https://www.transit.dot.gov/regulations-and-programs/environmental-programs/fta-transit-bus-electrification-tool

Assumptions:

- Data regarding the average energy production, size of solar installations, and cost of installation are assumed to be accurate and representative.
- Kentucky's climate and annual maximum sun were assumed to be constant for the evaluation period.
- Kentucky's resource mix was assumed to be constant for the evaluation period.

Durability/Reasonableness of Methods:

- The method used for solar is based on quantifying the emissions associated with the avoided electricity from the grid. eGRID emission factors are calculated using standard methodologies developed by the EPA.

- Every unit of solar electricity produced is one less unit required to be purchased from an electric utility. If Kentucky make significant improvements in converting its resource mix to cleaner energies, the electricity emission factor will decrease resulting in fewer avoided emissions.
- Actual energy generated per installation may vary from averages depending on specific location, capacity, and annual sun availability.
- The methods used for estimating emissions reductions associated with converting diesel buses to electric are based on lifetime calculations.

Electric Vehicle Charging Need Study

Methodology:

- Based on data from the U.S. DOE Alternative Fuels Data Center and Beyond Tailpipe Emissions Calculator, electric vehicles in Kentucky produce at least 50% less emissions than gasoline vehicles.
- It is assumed that increased confidence in charging reliability will precipitate a 10% increase in EV ownership by 2030 and a 30% increase by 2050.
- The on-road gasoline emissions for passenger cars and light duty trucks in the MSA were separated out and the above percentages were applied to yield the following results:

	CO2 (MT)
By 2030	125,814
By 2050	377,442

Models/Tools Used:

- Alternative Fuels Data Center - https://afdc.energy.gov/vehicles/electric_emissions.html
- Beyond Tailpipe Emissions Calculator – https://www.fueleconomy.gov/feg/Find.do?year=2024&vehicleId=46973&zipCode=40507&action=bt3

Assumptions:

- It is assumed that the study will identify charging station gaps within the MSA and agencies in the area will work to remedy these gaps, decreasing range anxiety, one of the largest factors holding consumers back from switching to EVs.

Durability/Reasonableness of Methods:

- The Biden-Harris administration has set a target for EVs to comprise 50% of vehicle sales by 2030. However, there are many factors in determining the adoption of EVs in the consumer market. It is difficult to predict human behaviors. Therefore, a conservative 10% reduction through 2030 was used. As more charging stations become available and EV costs come down, it is assumed that more consumers will switch, resulting in a conservative 30% reduction through 2050.