

Table 1: Total GHG Emissions

Measure #	Measure	Cumulative GHG Emission Reductions (MTCO ₂ e)	
		2025-2030	2025-2050
1	Multifamily Program	7,592	37,663
2	Community Program	6,957	43,408
3	Embodied Carbon Program	59,213	90,355
4	Circular Lumber Program	25,005	161,394
5	Innovative Financing Program	2,758	2,758

This appendix provides GHG reduction estimates for the CPRG proposal priority measures.¹

MEASURE #1: MULTIFAMILY PROGRAM

The Multifamily Program includes three coordinated interventions that will generate GHG emissions reductions in small and mid-sized multifamily buildings:

1. Whole building retrofits of 50 naturally occurring affordable housing buildings;
2. Technical assistance to generate an additional 50 retrofits with external funding; and
3. Support for an additional 300 heat pump water heater installs to replace gas water heating.

All GHG estimates for this program rely heavily on the National Renewable Energy Lab’s (NREL) ResStock Analysis Tool, which was developed by NREL in partnership with the Department of Energy to provide accurate estimates of energy baselines and interventions for the public. A summary of GHG reduction methods, tools, and reference cases is provided across the three multifamily interventions followed by a breakout of specific GHG estimates and measure assumptions for each.

GHG Reduction Estimate Method and Tools Used - Estimates for this program use modeling from the National Renewable Energy Lab’s (NREL) ResStock Analysis Tool and Energy Efficiency and Electrification [Dashboard](#), a respected tool that uses real world data alongside sophisticated estimates of building electrification and energy efficiency interventions for single-family, multi-family, and mobile homes.² The tool provides estimates for climate zone 4c and for multifamily with 5+ units, which the program will target in this program.³

Reference Case Scenario (GHG Emissions or Activity Level) – ResStock uses the U.S. Energy Information Administration’s Residential Energy Consumption Survey, builder surveys, and other data from field studies along with data from DOE’s EnergyPlus™ to simulate baseline energy consumption.⁴ The tool generates baseline consumption estimates for electricity, gas, and other fuels for the state based on inputs for building type, income, climate zone, and heating fuel type. To estimate savings over time, we use guidance from Fannie Mae on the effective useful life (EUL) heat pump condensing components,

¹ Note that there may be minor variations in calculations due to rounding. Additionally, some of these estimates do not account for conversion to low-GHG energy grids available in a majority of the four counties covered in this plan, or statewide GHG-neutral electrical grids starting in 2030 due to CETA. Also note that the tools used below report MTCO₂e, and do not show disaggregated data by carbon dioxide, nitrous oxide and methane; as such MTCO₂e is reported in aggregate.

² National Renewable Energy Laboratory (NREL), “State Level Residential Building Stock and Energy Efficiency Analysis,” ResStock Energy Efficiency and Electrification Dashboard. [\[LINK\]](#); also see ResStock Public dataset [\[LINK\]](#). Accessed 2/22/24.

³ All four counties covered in this plan in Marine zone 4c. See: Heinking, Susan and Corey Sussman, “the Science of Building Codes and Climate Zones,” Pepper Construction Blog, August 15, 2019. [\[LINK\]](#). Also, DOE, “Building America Top Innovations Hall of Fame Profile: Building Science-Based Climate Maps,” January 2013. [\[LINK\]](#). Accessed 2/22/24.

⁴ Wilson et al. NREL “Energy Efficiency Potential in the U.S. Single-Family Housing Stock” [\[LINK\]](#) pp. iv. Accessed 3/27/2024.

domestic hot water systems, and energy efficiency measures.⁵ DHW systems range from 15 to 25 years for relevant applications and heat systems around 20 years, so we assume a default EUL of 20 years.

NOAH Whole-building Decarbonization for Multifamily Buildings

GHG Reduction Estimate Assumptions – in ResStock, the “Enhanced enclosure upgrade with heat pump water heater and high efficiency heat pump with electric backup” scenario closely matches the program and provides estimates for high-efficiency enclosure improvements and electrification of primary fossil fuel appliances (water and space heating). The model uses regional emissions factors, and the following additional inputs were used to source estimates for per Dwelling Unit Savings: (1) climate zone 4c, (2) Area Median Income of under 80%, (3) heating fuel is gas and (4) multifamily with 5+ units.⁶ Per unit savings estimated by the model are:

- Emissions savings average per unit: 1,399 kgCO₂e/yr., or 1.399 MTCO₂e/yr.
- Energy savings average from electricity: -1,211 kWh/yr.
- Energy savings from natural gas: 288 therms/yr.

Measure Implementation Assumptions and GHG Emissions Reduced – For the program, we assume the average multifamily building will have 10 units as the program targets small and mid-sized multifamily buildings with 5-15 units in the region, which are more likely to have gas space heating and hot water heating.⁷ Each building would represent 13.99 MTCO₂e/yr reduction (10 units*1.399). See Table 2 for the assumed program retrofits by year and associated GHG reductions.⁸

Table 2: NOAH Whole Building Total GHG Emissions 2025-2030

Program Year	Year	Buildings Retrofitted	Cumulative Retrofits	Cumulative Units	GHG Savings in Year (MTCO ₂ e)	Cumulative GHG Savings (MTCO ₂ e)
1	2025	0	0	0	0	0
2	2026	10	10	100	139.9	140
3	2027	20	30	300	419.7	560
4	2028	20	50	500	699.5	1259
5	2029	0	50	500	699.5	1959
6	2030	0	50	500	699.5	2658

For 2025 – 2030: by 2030, it is estimated that **2,658 MTCO₂e** could be reduced.

For 2025 – 2050: for 2030-2050, assume an annual reduction of value 699.5 MTCO₂e for the twenty-year expected useful life of the measures (see above), with claimed savings falling off starting in 2045 and to 0 MT/year by 2047. This results in total savings by 2050 of **13,291MTCO₂e**.

Multifamily Technical Assistance

This measure will offer energy benchmarking, both for NOAH and subsidized housing, with a target of benchmarking 150 buildings and offer technical assistance and HPWH replacements for gas water

⁵ See: <https://multifamily.fanniemae.com/media/6701/display>

⁶ See NREL 2023. “State Level Residential Building Stock and Energy Efficiency Analysis,” ResStock Energy Efficiency and Electrification Dashboard. [\[LINK\]](#);

⁷ NEEA 2019. Residential Building Stock Assessment II, “Multifamily Building Report 2016-2017,” [\[LINK\]](#) p. 24.

⁸ See GHGcalcs_KingCounty.xlsx, “Multifamily Programs” tab and NOAH Whole-building Decarbonization for Multifamily Buildings section

heaters (see section below). Technical assistance will focus first on benchmarking and then on supporting multifamily uptake of external incentives and financing with regional partners to achieve additional electrification and weatherization with funds outside of the CPRG proposal. The measure assumes that multifamily technical assistance will be helping buildings similar to those affordable housing buildings in the NOAH program – namely, helping multifamily buildings of 10 units each decarbonize, with each building representing 13.99 MTCO₂e/yr. reduction.

Measure Implementation Assumptions and GHG Emissions Reduced – From discussions with affordable housing lending partners, an estimated 50 buildings would pursue decarbonization with this comprehensive technical assistance. For GHG reduction estimates, this figure is reduced by half to 25, under the assumption that some buildings would pursue decarbonization independently or would have without the technical assistance, but these buildings owners may use this technical assistance to guide decision-making. See Table 3 for the assumed program retrofits by year and associated GHG reductions.⁹

Table 3: Multifamily Technical Assistance Total GHG Emissions 2025-2030

Program Year	Year	Buildings Retrofitted	Cumulative Retrofits	Cumulative Units	GHG Savings in Year (MTCO ₂ e)	Cumulative GHG Savings (MTCO ₂ e)
1	2025	0	0	0	0	0
2	2026	6	6	60	84	84
3	2027	10	16	160	224	308
4	2028	9	25	250	350	658
5	2029	0	25	250	350	1007
6	2030		25	250	350	1357

For 2025 – 2030: by 2030, it is estimated that **1,357 MTCO₂e** could be reduced.

For 2025 – 2050: we assume for 2030-2050 an annual reduction of value 350 MTCO₂e for the twenty-year expected useful life of the measures (see above), with claimed savings falling off starting in 2045 and to 0 MT/year by 2047. This results in total savings from 2030-2050 of 5,638 MTCO₂e. And total 2025-2050 estimated GHG reductions = **6,645 MTCO₂e**.

HPWH Replacement

GHG Reduction Estimate Assumptions – Estimates for HPWH incentives to replace gas water heating systems again used the NREL ResStock Energy Efficiency and Electrification [Dashboard](#).¹⁰ The program will prioritize replacing gas DHW systems where low income residents live, so the same model inputs are used as in the NOAH program (i.e. per Dwelling Unit Savings: (1) climate zone 4c, (2) Area Median Income of under 80%, (3) heating fuel is gas and (4) multifamily with 5+ units). The ResStock measure of “Heat pump water heater” with baseline fuel of gas shows the following data:

- Emissions savings average: 311 kgCO₂e/yr., or 0.311 MTCO₂e/yr.
- Energy savings average from electricity: 44 kWh/yr.
- Energy savings from natural gas: 231 therms/yr.

⁹ See GHGcalcs_KingCounty.xlsx, “Multifamily Programs” tab and NOAH Whole-building Decarbonization for Multifamily Buildings section

¹⁰ NREL, “State Level Residential Building Stock and Energy Efficiency Analysis,” ResStock Energy Efficiency and Electrification Dashboard. [\[LINK\]](#); also see ResStock Public dataset [\[LINK\]](#). Accessed 2/22/24.

Measure Implementation Assumptions and GHG Emissions Reduced – the heat pump water heater installations will occur in coordination with the other multifamily program elements so assumes a similar rate of deployment, shown in the GHG calculations attachment. See Table 4 for the assumed program retrofits by year and associated GHG reductions.¹¹

Table 4: Multifamily Heat Pump Water Heater Installs Total GHG Emissions 2025-2030

Program Year	Year	HPWH Installs	Cumulative Installs	Cumulative Units Served	GHG Savings in Year (MTCO2e)	Cumulative GHG Savings (MTCO2e)
1	2025	0	0	0	0	0
2	2026	50	50	500	156	156
3	2027	150	200	2000	622	778
4	2028	100	300	3000	933	1711
5	2029	0	300	3000	933	2644
6	2030		300	3000	933	3577

For 2025 – 2030: by 2030, it is estimated that **3,577 MTCO2e** could be reduced.

For 2025 – 2050: we assume for 2030-2050 an annual reduction of value 350 MTCO2e for the twenty-year expected useful life of the HPWHs (see above), with claimed savings falling off starting in 2045 and to 0 MT/year by 2047. Total 2025-2050 estimated GHG reductions = **17,727 MTCO2e**.

Table 5: Total GHG Emissions Reduced Multifamily Program

	2025-2030 (mtCO2e)	2025-2050 (mtCO2e)
NOAH Whole-building Decarbonization	2,658	13,291
Multifamily Technical Assistance	1,357	6,645
HPWH Replacement	3,577	17,727
Total	7,592 MT	37,663 MT

MEASURE #2: COMMUNITY PROGRAM

This measure includes two main components: (1) a full-service Family Care Program to electrify and weatherize 150 daycare centers, adult family homes, and similar structures and (2) a Community Grants Program to support electrifying 55 community buildings that provide a community gathering space or a community service divided between municipal and nonprofit entities. GHG reduction estimate methods, tools, and reference cases differ for the two programs so are addressed separately below.

Family Care Program

Estimates for the program again use the NREL ResStock Energy Efficiency and Electrification [Dashboard](#).¹² The program will serve at home care facilities such as daycares and adult family homes, which are typically in detached single family settings, and so use ResStock’s single family home assumptions. The following additional inputs were used to source estimates for per Dwelling Unit

¹¹ See GHGcalcs_KingCounty.xlsx, “Multifamily Programs” tab and NOAH Whole-building Decarbonization for Multifamily Buildings section

¹² NREL, “State Level Residential Building Stock and Energy Efficiency Analysis,” ResStock Energy Efficiency and Electrification Dashboard. [\[LINK\]](#); also see ResStock Public dataset [\[LINK\]](#). Accessed 2/22/24.

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Savings: (1) climate zone 4c, (2) heating fuel is gas and (3) single-family detached home.¹³ The modeled intervention that matched the program was “Enhanced enclosure upgrade with heat pump water heater and high efficiency heat pump with electric backup”, and provides for high-efficiency enclosure improvements and electrification of primary fossil fuel appliances (water and space heating). The following data is reported from the model for this measure:

- Emissions savings average: 4,815 kgCO₂e/yr., or 4.815 MTCO₂e/yr.
- Energy savings average from electricity: -2,137 kWh/yr.
- Energy savings from natural gas: 757 therms/yr.

Measure Implementation Assumptions and GHG Emissions Reduced – For a 5-year program, assuming 150 whole-building decarbonization projects, this assumes no buildings are retrofitted in the first year (2025) and the program ramps to complete installations by the end of 2028 as shown in Table 6, with savings continuing through the end of the equipment’s useful life of 20 years.¹⁴

Table 6: Family Care GHG Emissions Reduced 2025-2030

Program Year	Year	Buildings Retrofitted	Cumulative Retrofits	GHG Savings in Year (MTCO ₂ e/yr)	Cumulative GHG Savings (MTCO ₂ e/yr)
1	2025	0	0	0.0	0
2	2026	20	20	96.3	96
3	2027	100	120	577.8	674
4	2028	30	150	722.2	1396
5	2029	0	150	722.2	2119
6	2030	0	150	722.2	2841

For 2025 – 2030: it is estimated that **2,841 MTCO₂e** could be reduced.

For 2025 – 2050: we assume for 2030-2050, assume an annual reduction of value 722 MTCO₂e for the twenty-year expected useful life of the measures (see above), with claimed savings falling off starting in 2045 and to 0 MT/year by 2048. This results in total cumulative savings of **14,445MTCO₂e** by 2050.¹⁵

Community Building Electrification

Community electrification projects will occur in small commercial buildings that directly provide community benefits, such as libraries, community centers, nonprofit-owned buildings, senior centers, houses of worship, etc.

GHG Reduction Estimate Method and Tools Used - The City of Seattle recently completed an analysis of meeting its municipal building decarbonization goals, which included actual benchmarking data from all facilities, facility audits, City facility staff’s operational knowledge, and analysis from a building efficiency and electrification consultant recommendations. The analysis included data on existing mechanical and hot water heating systems, fuel specific consumption data, and custom cost estimates for electrification of those systems for over 200 facilities.

The City of Seattle analysis included 20 libraries, 28 community centers, and 2 senior centers, which were used to estimate the impact of the 15 grants expected to fund municipal building decarbonization projects. The analysis also included 23 community buildings in Seattle between 1,500 sf and 10K sf,

¹³ See NREL 2023. “State Level Residential Building Stock and Energy Efficiency Analysis,” ResStock Energy Efficiency and Electrification Dashboard. [\[LINK\]](#);

¹⁴ See GHGcalcs_KingCounty.xlsx, “Community Programs” tab.

¹⁵ See GHGcalcs_KingCounty.xlsx, “Community Programs” tab.

along with engineering estimates and pricing from City of Seattle municipal electrification planning work, which inform the estimates for the grants to community organizations.

Reference Case Scenario (GHG Emissions or Activity Level) – Reference data is sourced from City of Seattle benchmarking data for municipal buildings of similar types served by the grant program. Median benchmarking data for 2019 for the 20 libraries, 28 community centers, 2 senior centers, and 23 community buildings is used for annual gas and electricity data and heating system information.¹⁶

GHG Reduction Estimate Assumptions - To calculate baseline and future emissions for building types, gas emissions factors were sourced from ENERGY STAR Portfolio Manager.¹⁷ Electricity factors were sourced from King County’s recent emissions inventory.¹⁸ The regional electricity emissions is weighted by the expected proportion of projects in each utility area and declines to zero by 2030 since Washington’s clean electricity standard mandates carbon-neutral electricity by then. See the GHGcalcs_KingCounty.xlsx attachment for details.

Measure Implementation Assumptions – each building type retrofit includes a specific equipment replacement assumption provided by the City of Seattle engineering consultant, including increases in electricity consumption and equipment specification for heating and are shown in the GHGcalcs_KingCounty.xlsx attachment. According to NREL, the “typical RTU lifespan is 15 to 20 years, but they can last more than 30 years or fail in fewer than 10 years in harsh environments,” so it’s assumed that equipment will need replacement after 20 years.¹⁹ Assumptions are summarize in Table 7. Installations are expected to begin in 2026 (Year 2) after ramping up program processes in 2025 (Year 1).

Table 7: Measure Implementation Assumptions by Community Building Type

	Building Type	Number of Grants	% of Costs (and GHG savings) covered by program	Equipment Expected Useful Life
Grants - Municipal	Library	6	40%	20 years
	Community Center	6	40%	20 years
	Senior Center	3	40%	20 years
Grants - Community	Small Commercial Building	40	87.5%	20 years

GHG Emissions Reduced – phase in of projects by year and building type is summarized in the attached GHG calculation spreadsheet on the Community Programs tab. As the grants will fund full electrification projects, no gas consumption is anticipated in the and increased electricity consumption estimates from the engineering study is provided and factored into GHG outcomes. Emissions estimates for each building type are adjusted down by the percent of estimated costs covered by the grants. Total emissions for the grants and the Family Care Program are provided in Table 8.

Table 8: Total GHG Emissions Reduced Multifamily Program

¹⁶ See GHGcalcs_KingCounty.xlsx, “Community Programs” tab for calculations. And “Seattle Municipal Elec Data” for summary data from Seattle’s electrification study.

¹⁷ See ENERGY STAR Portfolio Managers “Thermal Energy Conversions” [\[LINK\]](#) and GHGcalcs_KingCounty.xlsx, “Emissions Factors + Conversions” tab.

¹⁸ See <https://your.kingcounty.gov/dnrp/climate/documents/2023/psrea-project-geographic-ghg-wedge-planning-tool-08-2023.xlsx>

¹⁹ Deru, M et al. NREL 2020. “Long and Winding Road to Higher Efficiency—The RTU Story,” [\[LINK\]](#) pp 3.

	2025-2030 (mtCO ₂ e)	2025-2050 (mtCO ₂ e)
Community Grants - Municipal	1,022	6,284
Community Grants - Community	3,094	22,678
Family Care Program	2,841	14,445
Total	6,956 MT	43,407 MT

MEASURE #3: EMBODIED CARBON PROGRAM

Assumes the following per type of **Measure** activity, applied to implementation in one (King) county. Note that the tools used below report MTCO₂e, and do not show disaggregated data by carbon dioxide, nitrous oxide and methane; as such MTCO₂e is reported in aggregate.

King County Capital Projects: In 2021, King County conducted a purchasing emission inventory for its 2019 operations and capital projects, matching construction contract expenses against the EPA’s U.S. environmentally-extended input-output ([USEEIO](#)) goods and services based on County staff review of deliverables in physical construction, landscaping, equipment, and professional services in typical projects. This report found that overall King County capital project embodied carbon equated to 58,380 MTCO₂e annually. For capital projects, it is assumed that no reduction would happen in year 1 during program development, and then every year embodied carbon emissions would reduce by 10% for King County capital projects, phasing in requirements for a targeted 40% reduction by 2030:²⁰

- Year 1, No change; 10% embodied carbon reductions annually thereafter (i.e., Year 2, 10%; Year 3, 20%; Year 4, 30% reduction, Year 4, 40%). Maintain 40% reduction through 2050. Would result in roughly 58,350 MTCO₂e reduced 2025 – 2030 and 467,050 MTCO₂e reduced from 2031 – 2050.
- However, after 2030 a majority of embodied carbon policy implementation will rely on local jurisdiction funding and support to maintain the program. As such, it is estimated that only 5% of embodied carbon emissions in this period will be attributable to the legacy of the initial program, or 23,350 MTCO₂e.
 - As such, the 58,350 MTCO₂e for 2025 – 2030 and the 23,350 MTCO₂e for 2031 – 2050 would result in a culminative 81,700 MTCO₂e for 2025 – 2050.

Code Amendments, Commercial and Multifamily 3+ Story Buildings:

- Assume a 2027 start date for emission reductions, given the projected embodied carbon code amendment schedule reviewed in Proposal Section 3.c Table 2 Timeline Gantt Chart.
- Assume the building code is amended to require a 20% reduction in embodied carbon for concrete effective in 2027, and phasing in a 40% reduction effective in 2030 per the 3-year code cycle.
- Embodied carbon GHG estimates require affected square footages, in turn requiring estimated building growth by type, as only certain types of buildings would be affected. Building type assumptions are adapted from the C40/Carbon Leadership Forum (CLF) Embodied Carbon Policy Calculator built on data for the cities of New York, Austin and Portland.²¹ Portland was selected as the closest analog, though data was modified for the UKC due to its rural areas. As such, Baseline growth must first be estimated, and then allocated by building type for per jurisdiction. Adaptation of the CLF calculator for these projections is included in GHG spreadsheet UKC and Seattle tabs.

Commercial Buildings

²⁰ A 40% reduction by 2030 is consistent with the World Green Building Council (WGBC) target; see WGBC, “Brining Embodied Carbon Upfront,” 2019. [\[LINK\]](#). Page 8.

²¹ Benke, B., Lewis, M., Carlisle, S., Huang, M., and Simonen, K. “Developing an Embodied Carbon Policy Reduction Calculator,” Carbon Leadership Forum, University of Washington, (2022). [\[LINK\]](#).

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- Assume 1.17% commercial sf growth per year based on 2002 to 2018 (16 year) growth norm per King County Assessor data, such that there would be 28 million (M) sf of growth from 2027 to 2030, and 207M sf of growth from 2030 to 2050, in all of King County and its cities.
- As there is no current disaggregation of commercial sf in King County by jurisdiction, this analysis estimates the proportion of commercial sf growth for UKC and Seattle based on 2018 employment numbers in these jurisdictions. Of the 1,368,241 person-workforce in King County in 2018, there were 622,121 jobs in Seattle (45.5%) whereas there were 16,400 jobs in UKC (1.2%).²² For 2027 to 2030, applied to the 28M sf total commercial growth projection equates to 12.7M sf growth in Seattle and 336,000 sf growth in UKC. For 2030 to 2050, applied to the 207M sf total commercial growth projection equates to 94.2M sf growth in Seattle and 2.5M sf growth in UKC.
- Growth by building type was projected per the above-referenced adaptation of the CLF calculator for commercial buildings as follows – **Seattle**: 37% low-rise buildings (1-5 floors), 46% mid-rise (6-10 floors), 16% high-rise (over 10 floors). **UKC**: 95% low-rise, 5% mid-rise, 0% high-rise.
- Embodied carbon codes would exempt small commercial buildings; exempting half of low-rise buildings yields assumptions that 81% of Seattle growth ((37%/2)+46%+16%), and 53% UKC growth would be affected. For **Seattle**, that is 10.287M sf from 2027 to 2030, and 76.3M sf from 2030 to 2050. For **UKC**, that is 178,080 sf from 2027 to 2030, and 1.325M sf from 2030 to 2050.
- These square footages were entered into the adapted CLF Embodied Carbon Policy Calculator.
- GHG reduction results: **Seattle** 23,257 MTCO₂e for 2025 – 2030 and 345,000MTCO₂e for from 2031 – 2050. For **UKC** 319 MTCO₂e for 2025 – 2030 and 4,749 MTCO₂e for 2031 – 2050;
 - The **UKC** cumulative amount for 2025 – 2050 would be 5,068 MTCO₂e (319 + 4,749).

Multifamily Buildings

- The 2021 King County Urban Growth Capacity Report includes a target of 307,277 housing units by 2044.²³ These targets occur for a 25-year period (2019-2044); they do not align with the proposal period but similar growth to 2050 is projected, and growth estimated as follows: 8% growth unregulated from 2025 – 2027 prior to code adoption, or 25,582 units; 12% from 2027 – 2030 or 36,873 units, and 80% is estimated in from 2031 – 2050, or 245,821 units.
- To approximate how much growth would occur in multifamily buildings, the current proportion of Seattle and UKC 2+ residential units against all King County housing (Seattle 25.32%, UKC 0.83%)²⁴ was applied to this growth projection. Although more multifamily development is projected in the future, this approach was considered more conservative for the slower projected sf growth rate. After units were derived, they were multiplied by average multifamily apartment size, or 816 sf:²⁵
 - For 2025-2030, UKC: 36,873 units x 0.83% = 307 units x 816 sf = 250,711 sf
 - For 2025-2030, Seattle: 36,873 x 25.32% = 9,335 units x 816 sf = 7,614,597 sf
 - For 2031-2050, UKC: 245,821 units x 0.83% = * 816 sf = 1,671,414 sf
 - For 2031-2050, Seattle: 245,821 units x 25.32%* 816 sf = 50,784,187 sf
- Growth by building type was projected per the above-referenced adaptation of the CLF calculator for multifamily buildings as follows – **Seattle**: 60% low-rise buildings (1-5 floors), 30% mid-rise (6-10 floors), 10% high-rise (over 10 floors). **UKC**: 95% low-rise, 5% mid-rise, 0% high-rise.
- Multifamily 3 floors or less would be exempted as they can be built under the residential code. Exempting half of low-rise buildings yields assumptions that 70% of Seattle growth ((60%/2)

²² King County and its cities, “2021 Urban Growth Capacity (UGC) Report,” June 2021. [\[LINK\]](#). Pg 42 (PDF 49).

²³ King County and its cities, “2021 Urban Growth Capacity (UGC) Report,” *ibid.* [\[LINK\]](#). Pg 78 (PDF 85).

²⁴ See Washington Office of Financial Management, “April 1 Official Population Estimates – Housing Units [Excel]” last updated September 12, 2023. [\[LINK\]](#).

²⁵ University of Washington Center for Real Estate Research, “Washington State Apartment Market Report,” 2021. [\[LINK\]](#). Pg 6

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+30%+10%), and 53% UKC growth would be affected. For **Seattle**, that is 5.33M sf from 2027 to 2030, and 26.66M sf from 2030 to 2050. For **UKC**, that is 175,498 sf from 2027 to 2030, and 877,492 sf from 2030 to 2050.

- These square footages were entered into the adapted CLF Embodied Carbon Policy Calculator.
- GHG reduction results: **Seattle** 20,206 MTCO₂e for 2025 – 2030 and 120,547 MTCO₂e for from 2031 – 2050. For **UKC** 544 MTCO₂e for 2025 – 2030 and 3,043 MTCO₂e for 2031 – 2050.
 - The **UKC** cumulative amount for 2025 – 2050 would be 3,587 MTCO₂e (544 + 3,043).

Other Notes: Integration of embodied carbon in state building codes is anticipated statewide starting in 2031 but, as this outcome is less certain, its GHG impacts are not incorporated here. Additionally, the probability of UKC adoption of embodied carbon codes is high. Although City of Seattle adoption of embodied carbon codes are also considered relatively high, this outcome is less certain. As such, **Seattle GHG estimates are not included in projected GHG outcomes.**

Total Embodied Carbon Savings (with UKC GHG Code Projections Only):

For 2025 – 2030, combining capital project (58,350 MTCO₂e), multifamily (544 MTCO₂e) and commercial (319 MTCO₂e) GHG reductions, it is estimated that 59,213 MTCO₂e could be reduced.

For 2025 – 2050, combining capital project (81,700 MTCO₂e), multifamily (3,587 MTCO₂e) and commercial (5,068 MTCO₂e) GHG reductions, it is estimated that 90,355 MTCO₂e could be reduced.

MEASURE #4: CIRCULAR LUMBER PROGRAM

Calculations are based on 101,000 tons/year of clean wood that flows through King County Solid Waste Division facilities with a projection that, by 2050, 50% of this waste stream (51,000 tons) may annually be diverted. This tonnage was entered into the EPA Waste Reduction Model (WARM) v16 tool based on the current mix of recycled, landfilled and combusted wood. Two WARM models were conducted, with one model for 51,000 tons recycled, and another model for 51,000 tons "source reduced,"²⁶ assuming that the products made from the salvaged wood waste stream would displace (source reduce) an equivalent amount of virgin lumber products. WARM model outputs were combined, and a percentage of these outputs extracted based on the lumber capture percentage out of a total 51,000 tons/ year. For 2025-2030, a 1% – 3% estimated increase in salvaged lumber reuse was incorporated. For 2031 – 2050, the Year 6 value (3%) is continued through 2050, assuming program seed funding will have a legacy impact even as other efforts gain momentum in contributing reductions. Note these calculations do not include reduced transportation GHGs of salvaged over virgin lumber; carbon sequestration in buildings using mass timber panels; and does not incorporate growth factors or other lumber waste streams.

By year, this assumes:

- Year 1: 0% salvaged lumber reuse, as the program will be established in this period.
- Year 2: 1% salvaged lumber reuse, resulting in 2,270 MTCO₂e reduced.
- Year 3: 2% salvaged lumber reuse, resulting in 4,550 MTCO₂e reduced.
- Year 4: 2% salvaged lumber reuse, resulting in 4,550 MTCO₂e reduced.
- Year 5: 3% salvaged lumber reuse, resulting in 6,820 MTCO₂e reduced.
- Year 6 (2030): 3% salvaged lumber reuse, resulting in 6,820 MTCO₂e reduced.
- Year 7 – onward (to 2050): 3% salvaged lumber reuse/year, or 6,820 MTCO₂e/yr.

For 2025 – 2030 (years 1 through year 6) it is estimated that 25,005 MTCO₂e could be reduced.

For 2025 – 2050 (all years) it is estimated that roughly 161,394 MTCO₂e could be reduced.

MEASURE #5: INNOVATIVE FINANCING PROGRAM

²⁶ EPA, "Versions of the Waste Reduction Model," December 2023. [[LINK](#)]. Accessed 2/21/24.

The financing program will work to support market transformation of financing building decarbonization in the region by building awareness of new products among building owners, building capacity among local lenders to scale up offerings, and pursuing innovative partnership or products. Attributing GHG emissions reductions outcomes to a financing program versus other factors determining whether the project would have moved forward in the absence the program is hard to assess. An ACEEE study of lending in LMI communities found that the “most common characteristic of successful [lending] projects...is that they included effective partnerships between financiers, building owners and managers, and project implementers.”²⁷

Measure Implementation Assumptions – This measure assumes that developing those effective partnerships and growing the overall pie of financing products and activity in the region with higher awareness of products among owners and expanded lender capacity, with a conservative assumption of supporting 30 multifamily projects and 30 small commercial projects over by 2030, with projects beginning in 2026. Since estimates of the impact of efforts to raise awareness and support for clean energy lending are difficult to source, we make a conservative assumption that program support moved up projects by two years and so claim just two years of the project savings.²⁸ We assume five projects successfully financed for each building type in 2026 and 2027, ramping to ten per year for each by 2028 and 2029, when the program ends.

GHG Reduction Estimate Assumptions and Reference Case Scenarios –Since the financing program will serve smaller buildings, to estimate GHG reductions, assumptions above for multifamily and commercial projects and building sizes are used. For multifamily buildings, the ResStock assumptions for GHG savings per unit are used. For small commercial buildings, baseline energy use, system information, and GHG savings from the Community Grants - Small Commercial Building case above is used.²⁹ Claimed savings fall beginning in 2030 as the last projects are completed in 2029 as two years of claimed savings from the programs impact will be zero by 2031.

Table 9: Financing Program GHG Emissions Reduced 2025-2030

Program Year	Year	Commercial Buildings Retrofitted	GHG Savings in Year (MTCO ₂ e/yr)	Multifamily Units Retrofitted	GHG Savings in Year (MTCO ₂ e/yr)
1	2025	0	0	0	0
2	2026	5	69	50	70
3	2027	5	187	50	140
4	2028	10	472	100	210
5	2029	10	855	100	280
6	2030	0	334	0	140
Total			1,917 MT		840 MT

For 2025 – 2030 (years 1 through year 6) it is estimated that 2,758 MTCO₂e could be reduced.

For 2025 – 2050 (all years) no additional GHG savings are claimed beyond 2030.

²⁷ James Barrett and Brian Stickles. “Lending for Energy Efficiency Upgrades in Low- to Moderate-Income Communities,” ACEEE July 2016. [\[LINK\]](#) p. 22.

²⁸ See Comparative Evaluation of Financing Programs: Insights From California’s Experience [\[LINK\]](#) and “Making it Count: Understanding the Value of Energy Efficiency Financing Programs Funded by Utility Customers” [\[LINK\]](#)

²⁹ GHGcalcs_KingCounty.xlsx, “Scaling Financing” tab with references to Community Programs and Multifamily Programs tabs.