MITIGATION SCENARIO ANALYSIS METHODOLOGY

September 2022

CONTENTS

INTRODUCTION

This analysis shows the greenhouse gas (GHG) emissions impact ranges from the key **mitigation** strategies identified in the Climate Protection and Resiliency Plan (CPRP). Many of the strategies interact with each other, and have variable impact based on how the strategies are implemented. To account for this variability, the emissions impact is shown as a range of potential impact. This will allow the City to review the impact of each strategy, with their semiannual GHG emissions inventory, and adjust expected emissions reduction by strategy appropriately to match current conditions. Note that this document only shows the analysis on carbon reduction impacts of strategies and does not incorporate **climate resilience** or community co-benefits.

Glossary
Words or terms defined in the glossary are shown in bold (**example**). Hold down the Ctrl button and click on the word to go to the glossary.

When the potential impact of a strategy is analyzed, there are three levels of potential impact considered as shown in Figure 1.

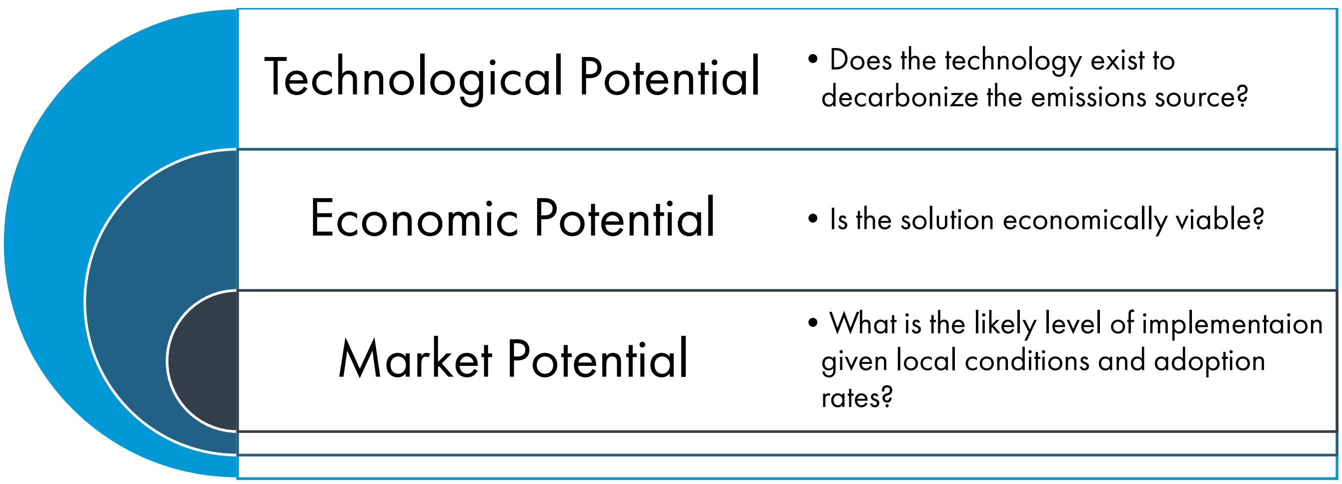

Figure 1: Levels of strategy impact potential.

In nearly all cases, the impact of strategies analyzed in this document is limited by economic or market potential rather than technological potential. These are the barriers that actions described in the short-term implementation plan are designed to overcome. The economic and market potential are also expected to evolve over the planning horizon, so assumptions used in this analysis should be updated accordingly to capture these changes.

CARBON MITIGATION GOALS

This analysis is designed to estimate the emissions reduction benefits of strategies in the CPRP against climate **mitigation** goals outlined in Resolution No. 200005:

1. Reduce community GHG emissions by 30% from 2005 baseline by 2025.
2. Reduce community GHG emissions by 50% from 2005 baseline by 2030.
3. Carbon free electricity by 2030.
4. Climate neutral by 2040.

Through review of this analysis, more aggressive interim targets were set to reduce emissions to 7 million $MTCO_2e$ by 2025 and 4 million $MTCO_2e$ by 2030 along with a stretch goal of zero carbon emissions.

Note that there are more aggressive goals, for City facilities, that are not analyzed as part of this plan. The strategies identified for community goals would apply for City emissions as well, but the timeline would need to be accelerated. Key strategies to achieve municipal goals will be procurement of renewable energy and electrification of City facilities and fleet vehicles.

BASELINE, CURRENT, AND PROJECTED GHG EMISSIONS

Figure 2 shows the 2005 baseline GHG emissions referenced by Resolution No. 200005 as well as the annual GHG emissions calculations for 2013 and 2017-2020 using the Global Protocol for Community Reporting (GPC). See the Greenhouse Gas Inventory Maintenance Standard Operating Procedure appendix for more information about how the emissions inventory is calculated. GHG emissions were estimated for intermediate years using linear interpolation.

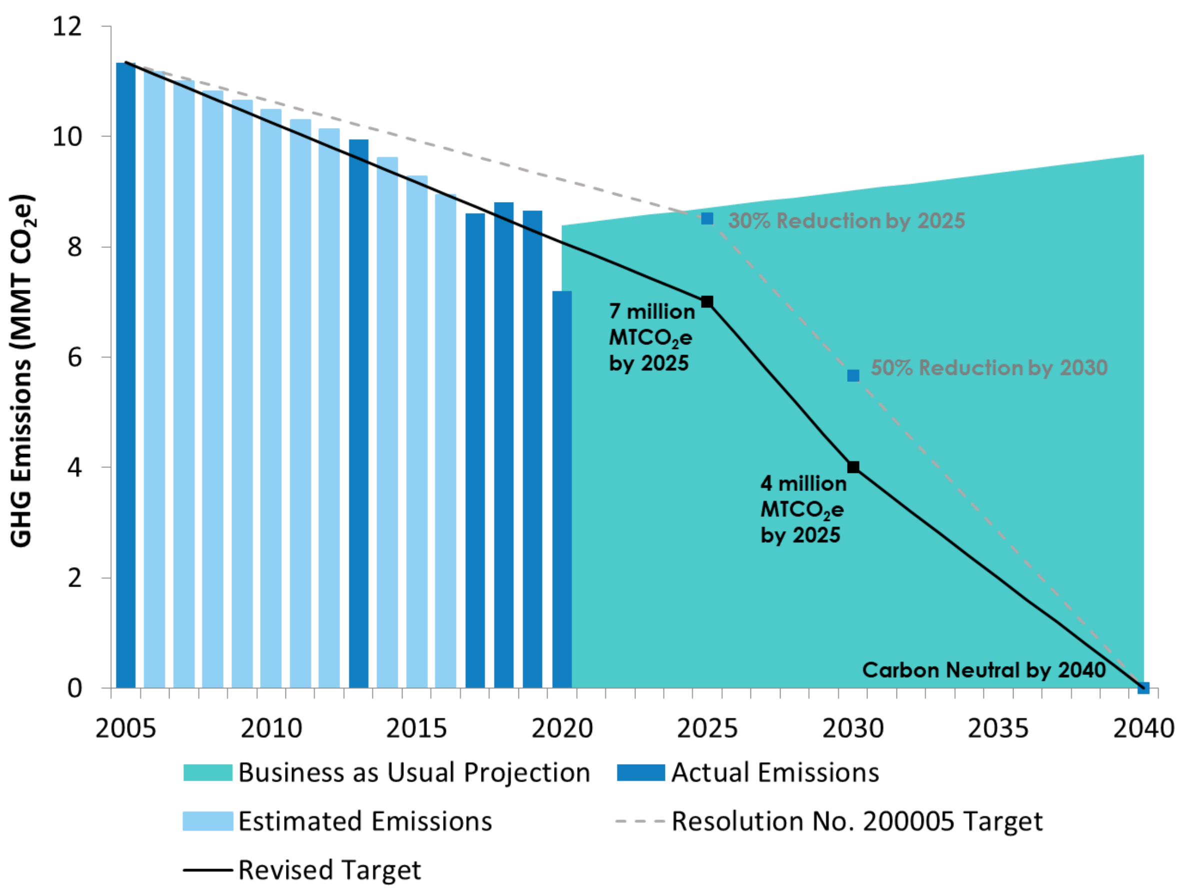

Figure 2: Historic and projected community GHG emissions.

For this planning effort the business-as-usual (BAU) projection is based on the 2019 inventory because COVID-19 lockdown significantly reduced on-road travel emissions in 2020. The business-as-usual projection assumes emissions factors for fuel use and typical energy use per person or per job remains constant based on analysis of historic trends. Each of the emissions sources was scaled by population or economic growth projections as shown in Table 1 (except industrial emissions, since these emissions have shown significant reductions over the last 10 years). These emissions are held constant in the BAU scenario.

Table 1: Scaling factors for each emission source.

Emission Source	Scaling Factor
Electricity - residential	Population Growth Rate
Electricity - commercial	Job Growth Rate
Electricity - industrial	Fixed
Electricity - other	Population Growth Rate
Natural gas - residential	Population Growth Rate
Natural gas - commercial	Job Growth Rate
Natural gas - industrial	Fixed
On-road vehicle transportation - gasoline	Population Growth Rate
On-road vehicle transportation - diesel	Fixed
Rail Transportation	Planned Rail Expansion
Transit	Population Growth Rate
Solid waste disposal	Population Growth Rate
Wastewater treatment	Population Growth Rate

To put into perspective the investment required to address these projected emissions, the total community fuel costs as well as the social cost of carbon emissions were also projected through 2040. This analysis shows that the KCMO community is projected to spend about $2.1 billion on fuel costs in 2040 (up about 30% from 2019). The social cost of carbon is a value that estimates the economic costs, or damages, of emitting one additional ton of carbon dioxide into the atmosphere. The estimated social cost of the carbon emissions in KCMO, based on projected emissions, is about $494 million in 2040 (Figure 3), based on a current carbon cost of $51/MTCO$_2$e (The Brookings Institution, 2021).

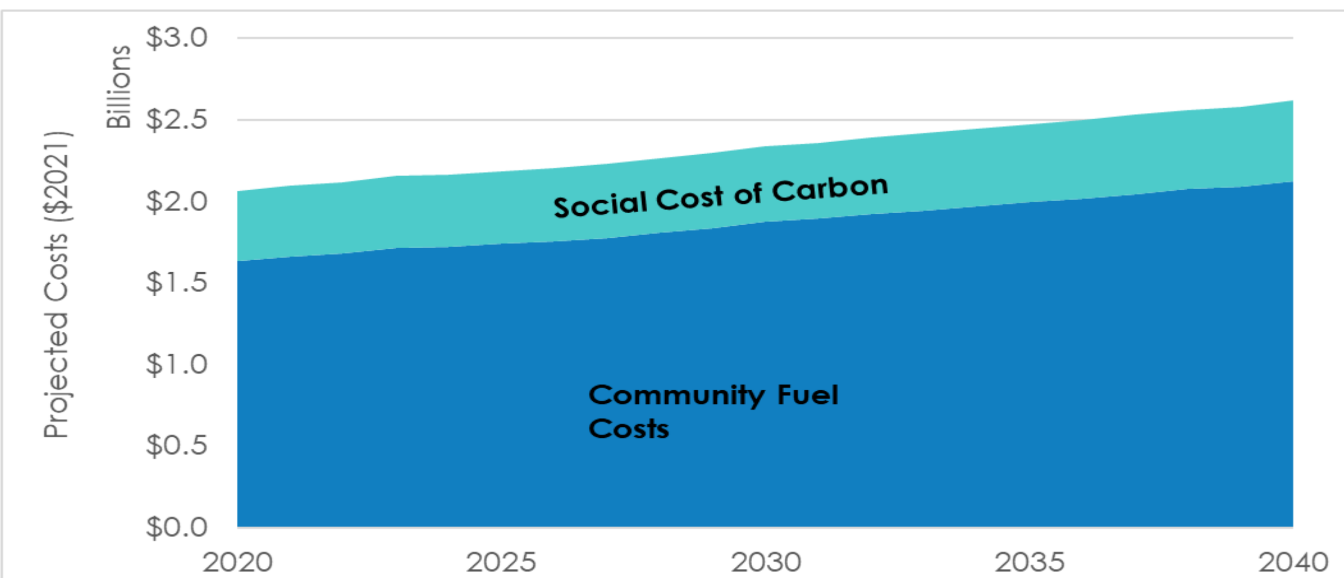

Figure 3: Community costs and social cost of carbon projections through 2030.

2019 EMISSIONS BREAKOUT

The 2019 GHG emissions breakout by sector is shown in Figure 4. Strategies in this analysis address on-road transportation and building energy emissions because other emissions sources account for less than 5% of the City's overall inventory and are considered to be **de minimis** by reporting protocols.

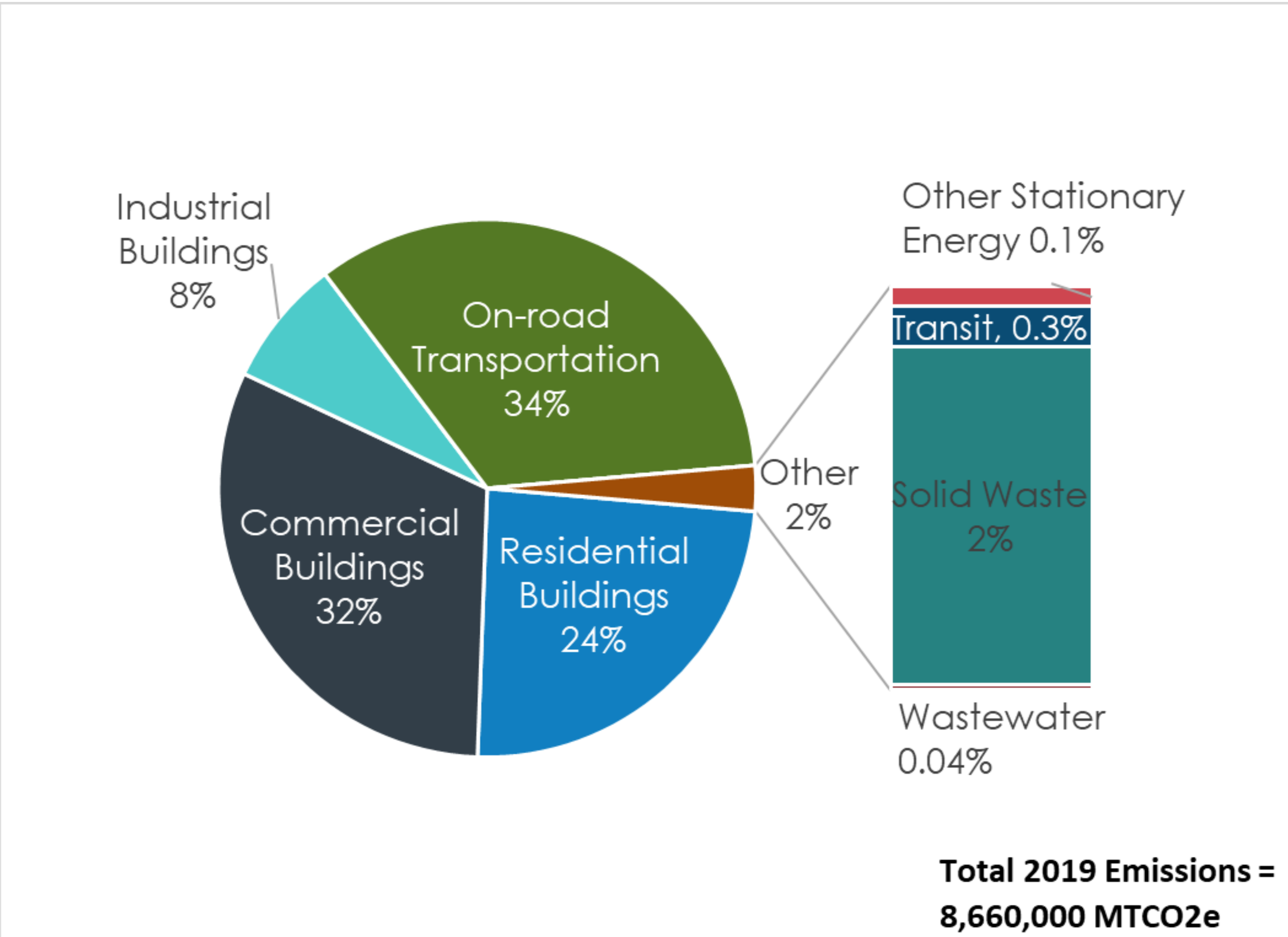

Figure 4: 2019 GHG emissions breakout by sector.

To better understand the contribution of each fuel type, the emissions are broken out by source in Figure 5. Based on this analysis, the largest sources of emissions in 2019 were electricity (46%), gasoline (26%), and natural gas (17%).

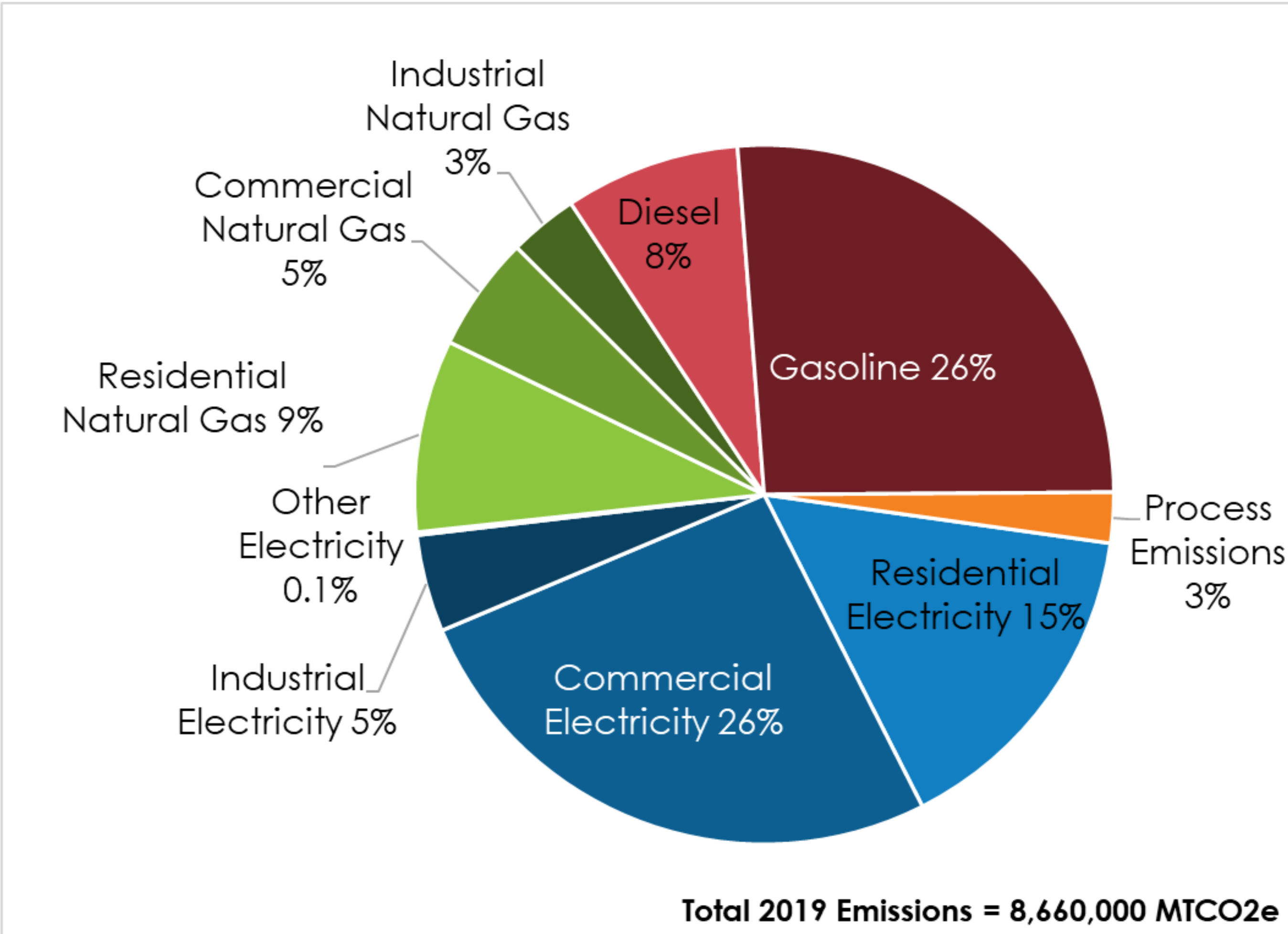

Figure 5: 2019 GHG Emissions by Source.

MITIGATION-CENTERED STRATEGIES

Of the strategies identified in the plan, fourteen are expected to have significant impact on the City's scope 1 and 2 GHG emissions as defined by the 2005 baseline. Other strategies will improve the City's resilience to expected climate impacts as well as reduce life-cycle emissions from products used by city residents. The mitigation strategies identified are shown in Table 2, along with the mitigation potential and cost effectiveness of each. More details on each strategy are provided by action area below.

Table 2: Climate Mitigation Strategies

Strategy #	Strategy Name	Maximum Emissions Reduction Potential	2040 Potential Max Cost Savings and Return on Investment (ROI)[1]
B-1	Increase building efficiency and health for commercial and public buildings	High	Cost Savings: $1.6 billion ROI: 4% for deep energy retrofits; 5.9% for medium retrofits (Nadel, 2020)
B-2	Improve the efficiency, affordability, and durability of homes	High	Cost Savings: $990 million ROI: 4% for deep energy retrofits; 5.9% for medium retrofits (Nadel, 2020)
B-3	Ensure climate-ready, efficient construction	Low	Cost Savings: $330 million ROI: 10-13% (Emerson & Sullivan, 2020)
B-4	Promote equitable building decarbonization	High	Cost Savings: None under current conditions ROI: Varies based on existing systems, utility rate structures (Lotus Engineering & Sustainability, 2021)
E-1	Transition energy grid mix to renewable energy	High	Cost Savings: unknown[2] ROI: no capital investment involved for community members
E-2	Expand neighborhood, commercial, and municipal renewable energy generation	Low	Cost Savings: $140 million ROI: 2.5%-5.6% for solar, depending on net metering and electric time-of-use (TOU) rates (Nadel, 2020)
E-3	Improve grid stability and resilience	N/A	Resilience-focused strategy so not analyzed. Supports other energy strategies
E-4	Purchase utility-scale renewable energy	High	Cost Savings: unknown – may be a subscription-based cost ROI: unknown; dependent on project and whether subscription-based or capital project with directed end-use customers
M-1	Reduce vehicle miles traveled (VMT) through coordinated and planned development	Medium	Cost Savings: $1.3 billion ROI: public investment; solution participants reducing trips save on fuel costs without bearing the capital investment directly

[1] Projected energy prices based on US Energy Information Administration projections for Missouri and the maximum savings potential for this strategy.

[2] We assume a neutral cost impact on the grid, noting that some studies are showing an increase, but prices are dropping and technology for integrating more renewables is increasing during this implementation period.

Strategy #	Strategy Name	Maximum Emissions Reduction Potential	2040 Potential Max Cost Savings and Return on Investment (ROI)[1]
M-2	Shift trips to bicycling and walking by expanding a network of safe and accessible routes	High	Cost Savings: $1.7 billion ROI: public investment; solution participants reducing trips save on fuel costs without bearing the capital investment directly
M-3	Shift trips to transit by building convenient and effective transit systems and mobility hubs	Low	Cost Savings: $510 million ROI: public investment; solution participants save on fuel costs without bearing the capital investment directly
M-4	Reduce vehicle emissions from idling by reducing congestion and improving parking management	Medium	Cost Savings: $990 million ROI: public investment; solution participants save on fuel costs without bearing the capital investment directly
M-5	Reduce vehicle emissions through low- and no-emission vehicles	High	Cost Savings: $4.7 billion ROI: Varies based on vehicle type and use patterns

Ranking Definitions for Carbon Emissions Reduction	Ranking
>=10% reduction	High
>=5% reduction	Medium
<5% reduction	Low

MEETING OUR GOALS

Based on this analysis, the keys to meeting each of the City's mitigation goals are summarized below.

Year	Goal(s)	GHG Emissions Reduction Required from BAU Projection	Notes
2025	Resolution No. 200005 Target: 30% reduction below 2005	769,000 $MTCO_2e$	The anticipated reduction in electricity emissions from Evergy's Integrated Resource Plan (IRP) will provide more than the required emissions reduction to meet the goals outlined in Resolution No. 200005. Based on this analysis, it is recommended that the City push toward the stretch goal to put the City on track to meet its 2030 goal.
2025	Revised Target: 7 million $MTCO_2e$ or 38% below 2005	1.7 million $MTCO_2e$	Best in class (as shown in the table below) performance between 2020 and 2025 will yield approximately 2.3 million $MTCO_2e$ carbon savings, with strategies B-1, B-2, E-1, M-1, M-2, and M-5 making up 90% of those savings.
2030	Resolution No. 200005 Target: 50% reduction below 2005	3.3 million $MTCO_2e$	If the City meets its carbon-free electricity goal, it will also meet the carbon emissions goal set by Resolution No. 200005 ; so a stretch goal is recommended to encourage action in Homes & Buildings, and Mobility action areas.
2030	Carbon-free Electricity	7.5 billion kWh renewable energy	Based on Evergy's IRP, the utility's generation mix is expected to be 70% from carbon free sources in 2030. This means the City will need to source at least 2.2 billion kWh annually from other clean energy sources[3]. This is well above what can be expected from local distributed generation based on current market projections, so the City will need to work with Evergy or other electricity generators to purchase utility-scale renewable energy. This is the equivalent of the energy production of about 1.5 GW of solar.
2030	Revised target: 4 million $MTCO_2e$ or 65% below 2005	5 million $MTCO_2e$	Best in class performance for all strategies (as defined byTable 3) will result in 6.4 million $MTCO_2e$, with strategies B-1, B-2, E-1, E-4, M-1, M-2, and M-5 making up over 90% of these emissions reductions.
2040	Carbon Neutral	9.7 million $MTCO_2e$	Based on current levels of technology and implementation potential, there will be at least a one million $MTCO_2e$ (11% of projected 2040 emissions) gap between emissions reduction from the strategies identified and carbon neutrality.

[3] This estimate assumes no substantial vehicle or building electrification before 2030 and assumes no reduction in electricity use from energy efficiency, for a conservative estimate.

Year	Goal(s)	GHG Emissions Reduction Required from BAU Projection	Notes
			This means the City will need to either invest in carbon offsets to cover the gap or adjust strategy assumptions as technology evolves. Some key emissions sources not covered well by the strategies outlined in this plan are on-road vehicle emissions (especially from heavy-duty vehicles) and natural gas end uses that are difficult to electrify. Much of this gap is due to slow uptake of new technologies (such as heat pumps or electric vehicles) and the slow turnover rate of this equipment (people infrequently replace furnaces, boilers, and vehicles).

Emissions savings by strategy for the best-in-class scenario providing the basis for the target emissions reductions are provided in each goal year below. These values represent the GHG emissions scenario that has the highest total savings in 2040 based on the parameters outline in this document. A summary of the Best-in Class assumptions can be found in Table 3.

Table 3: GHG Emissions Reduction Estimates by Strategy, Based on Best-in-Class Performance.

Strategy Name	2025 Target Emissions Reductions from BAU	2030 Target Emissions Reductions from BAU	2040 Target Emissions Reductions from BAU
B-1: Increase building efficiency and health for commercial and public buildings	411,500 (5%)	770,000 (9%)	1,506,700 (16%)
B-2: Improve the efficiency, affordability, and durability of homes	256,800 (3%)	479,900 (5%)	951,200 (10%)
B-3: Ensure climate-ready, efficient construction	77,700 (1%)	96,200 (1%)	183,600 (2%)
B-4: Promote equitable building decarbonization	100,000 (1%)	441,900 (5%)	611,000 (6%)
E-1: Transition energy grid mix to renewable energy.	674,300 (8%)	1,230,800 (14%)	2,489,300 (25%)
E-2: Expand neighborhood, commercial, and municipal renewable energy generation	44,900 (1%)	83,900 (1%)	144,700 (2%)
E-3: Improve grid stability and resilience	N/A	N/A	N/A
E-4: Purchase utility-scale renewable energy	0 (0%)	1,846,100 (20%)	0 (0%)
M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development	204,500 (2%)	409,000 (5%)	818,000 (8%)
M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes	183,300 (2%)	366,700 (4%)	733,300 (8%)
M-3: Shift trips to transit by building convenient and effective transit systems and mobility hubs	28,300 (0%)	53,500 (1%)	106,900 (1%)
M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management	79,100 (1%)	158,300 (2%)	316,500 (3%)
M-5: Reduce vehicle emissions through low- and no-emission vehicles	292,100 (3%)	502,000 (6%)	696,200 (7%)
Total Emissions Reduction from BAU	2,352,500 (27%)	6,438,300 (71%)	8,557,400 (88%)
Remaining GHG Emissions	6,357,200	2,583,300	1,129,000

Table 4: Summary of Best-in-Class Assumptions by Strategy

Strategy Name	Best-in-Class Targets and Assumptions
B-1: Increase building efficiency and health for commercial and public buildings	o Electricity use reduction from existing buildings: 2.1% per year o Natural gas use reduction from existing buildings: 2.1% per year
B-2: Improve the efficiency, affordability, and durability of homes	o Electricity savings: 2.1% per year o Natural gas savings: 2.1% per year
B-3: Ensure climate-ready, efficient construction	o Residential: 50 HERS score all electric o Commercial: EUI of 61.4 kBtu/sq. ft all electric
B-4: Promote equitable building decarbonization	By 2045: o Electrify 80% of gas usage in residential/commercial sectors o Electrify 50% of gas usage in the industrial sector o Electrification efforts start immediately, with significant technology uptake expected after 2030. In most cases, technology uptake rate is currently limited by system cost and unfamiliarity with new technology.
E-1: Transition energy grid mix to renewable energy.	o Percent carbon-free energy 2025: 60% o Percent carbon-free energy 2030: 70% o Percent carbon-free energy 2040: 100%
E-2: Expand neighborhood, commercial, and municipal renewable energy generation	o Additional installed solar 2030: 110 MW o Additional installed solar 2040: 285 MW
E-3: Improve grid stability and resilience	o No carbon emissions impact.
E-4: Purchase utility-scale renewable energy	o Procure 2.2 billion kWh annually
M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development	o Population density increase by 2040: 36%
M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes	o Commute – Walking: 32% o Commute – Biking: 5.4% o Work from Home: 10%;
M-3: Shift trips to transit by building convenient and effective transit systems and mobility hubs	o Commute – Transit: 12% o Percentage of buses that are all-electric: 100%;
M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management	o Emissions reduction from congestion management: 10% o Emissions reduction from traffic smoothing strategies: 10%
M-5: Reduce vehicle emissions through low- and no-emission vehicles	In 2040: o 27% light-duty vehicles are EVs o 29% heavy-duty vehicles being EVs in 2040

More information about the contribution of each strategy, as well as the assumptions used in analysis, are provided by action area below.

HOMES & BUILDINGS

CREATING HEALTHY INDOOR SPACES FOR LIVING, WORKING, AND ENJOYING.

The strategies in this section address the emissions from energy use in residential, commercial, and industrial buildings by reducing energy consumption through energy efficiency strategies and transitioning remaining fossil fuel use to clean electricity.

WHERE WE ARE IN 2019

In 2019, energy use in homes and buildings accounted for almost two thirds of the GHG emissions in Kansas City or 5.5 million MT CO_2e (Figure 6). These emissions come from electricity and natural gas use in these buildings. Since the 2005 baseline, the emissions from this sector are down by about 26% or 2 million MT CO_2e.

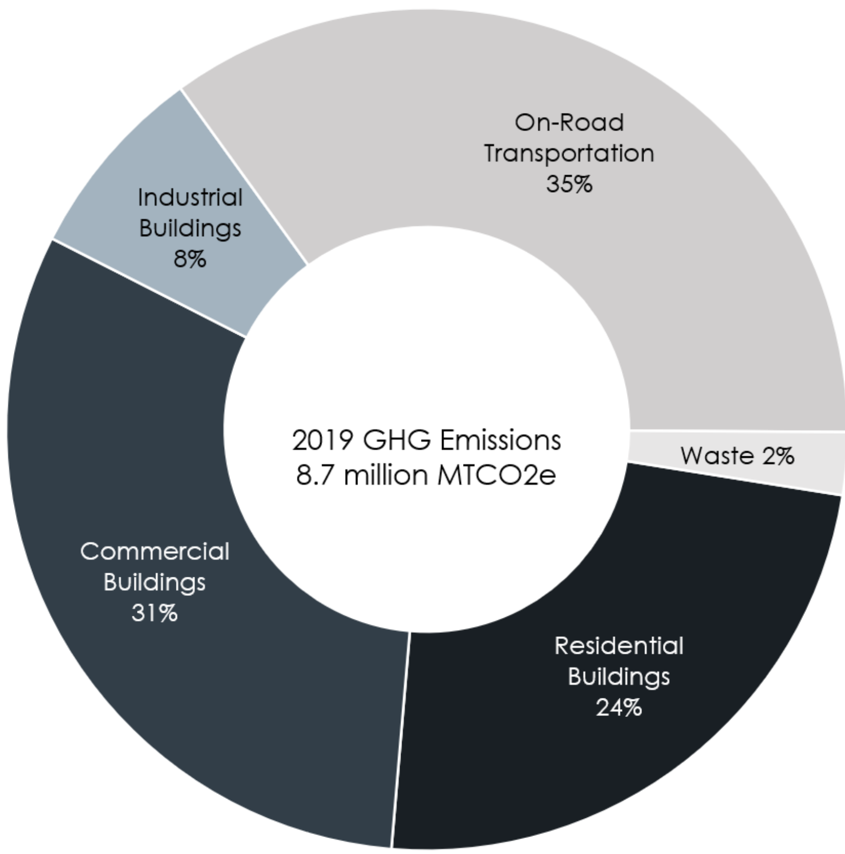

Figure 6: Industrial and Commercial Building Emissions as a Portion of 2019 Total Emissions

The reduction in GHG emissions is due to reduced emissions from the generation of electricity used in these buildings through increased use of renewable and carbon free energy sources, as well as reduced energy use from the industrial sector.

ANALYSIS SUMMARY

Mitigation strategies analyzed in this section are:

- B-1: Increase building efficiency and health for commercial and public buildings
- B-2: Improve the efficiency, affordability, and durability of homes
- B-3: Ensure climate-ready, efficient construction
- B-4: Promote equitable building decarbonization

The range of potential impacts from each of these strategies is shown in Figure 7 as a percentage of the total projected buildings emissions in 2040. The lower percentage represents the savings if the City continues to implement these strategies at the current level; the higher percentage for each strategy represents best in class performance. This analysis shows that 5-63% of GHG emissions in 2040 could be eliminated through building strategies, with B-1, B-2, and B-4 likely having the largest impact on emissions reductions. Because building emissions are also impacted by energy strategies, the range of contributions for all energy strategies are also shown. For more details on the impact of energy strategies see the Energy Supply section.

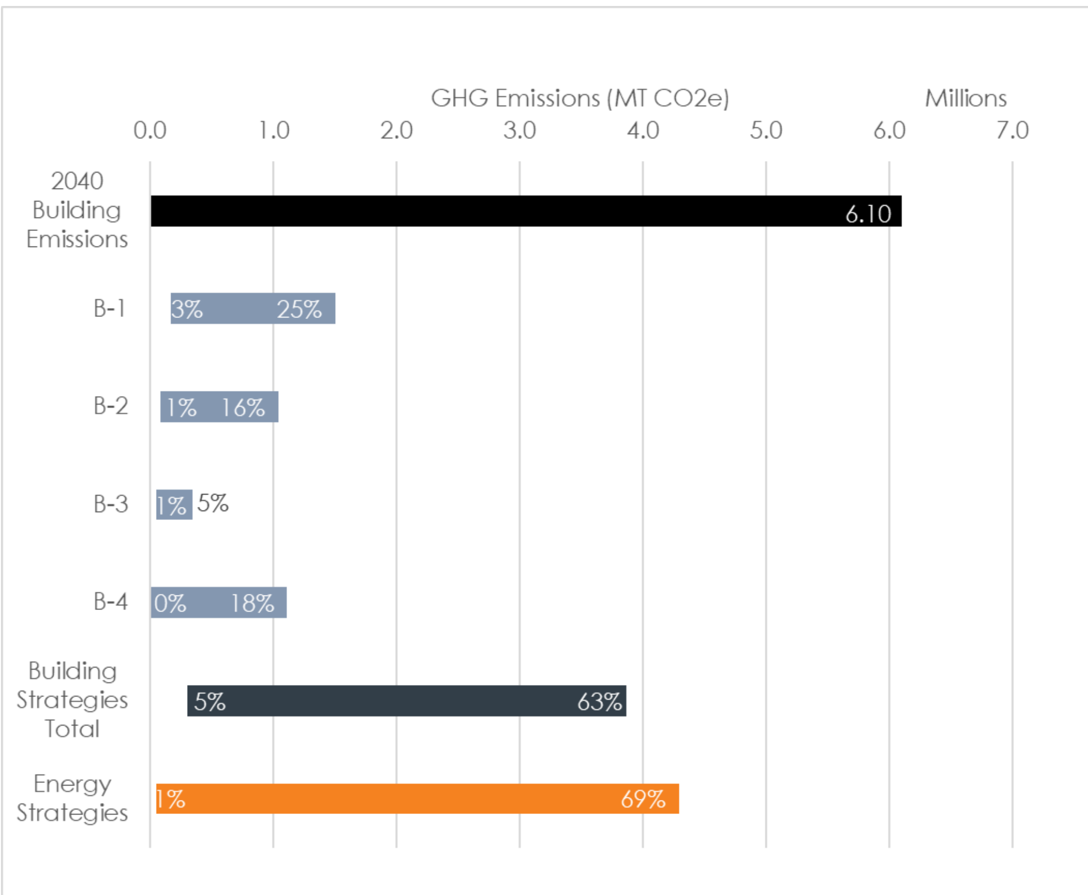

Figure 7: Homes & Buildings mitigation strategy impact[4]

[4] Note that maximum emissions reduction for building strategies and energy strategies cannot be achieved simultaneously because building system and energy strategies interact with each other. For example, if all electricity is provided by renewable energy, the GHG emissions reduction from electricity efficiency projects is zero.

STRATEGY ANALYSIS ASSUMPTIONS AND METHODOLOGY

Strategy	Estimated Emissions Reduction (MT CO2e)	% Of Total Building Emissions	% Of Total Community Emissions
B-1	167,000 - 1,507,000	3-22%	2-16%
B-2	88,000 - 951,000	1-16%	1-10%
B-3	49,000 - 294,000	1-5%	1-3%
B-4	0 - 1,113,000	0-18%	0-11%
Building Strategies Cumulative Impact	**304,000 - 3,561,000**	**5-63%**	**3-40%**

Assumptions and references used to establish the lower and upper bounds of each strategy, as well as a list of the other strategies that will influence the strategy's impact, are outlined by strategy below.

B-1: Increase building efficiency and health for commercial and public buildings

Emissions reductions for this strategy come from reduced electricity and natural gas use in existing commercial and industrial buildings.

- **Current level of Effort:** Based on reported savings from utility efficiency programs for the region.
  - Electricity savings: 0.28% per year (Sustainability Accounting Standards Board, 2020)
  - Natural gas savings: 0.06% per year (Spire, 2021), (Spire, 2020)
- **Best in Class**
  - Electricity savings: 2.1% per year (American Council for an Energy Efficienct Economy, 2021)
  - Natural gas savings: 2.1% per year (American Council for an Energy Efficienct Economy, 2021)
- **Other Considerations:**
  - Maximum energy efficiency savings capped at 40% of baseline buildings' energy use, based on maximum likely energy reduction from deep energy retrofits for commercial buildings (Environmental Protection Agency, 2021).
- **Connected Strategies**
  - B-4: Transition building systems to use clean, reliable electricity
  - E-1: Increase the percentage of renewable energy in the utility grid mix
  - E-2: Expand neighborhood and commercial renewable energy generation
  - E-4: Develop renewable natural gas resources for strategic end uses

B-2: Improve the efficiency, affordability, and durability of homes

Emissions reductions for this strategy come from reduced electricity and natural gas use in existing residential buildings.

- **Current level of Effort:** Based on reported savings from utility efficiency programs for the region.
  - Electricity savings: 0.28% per year (Sustainability Accounting Standards Board, 2020)
  - Natural gas savings: 0.06% per year (Spire, 2021), (Spire, 2020)
- **Best in Class**
  - Electricity savings: 2.1% per year (American Council for an Energy Efficienct Economy, 2021)
  - Natural gas savings: 2.1% per year (American Council for an Energy Efficienct Economy, 2021)
- **Other Considerations:**
  - Maximum energy efficiency savings capped at 50% of baseline energy use as maximum likely energy savings from deep energy retrofits for residential buildings (Environmental Protection Agency, 2021).
- **Connected Strategies**
  - B-4: Transition building systems to use clean, reliable electricity
  - E-1: Increase the percentage of renewable energy in the utility grid mix
  - E-2: Expand neighborhood and commercial renewable energy generation
  - E-4: Develop renewable natural gas resources for strategic end uses

B-3: Ensure climate-ready, efficient construction

This strategy addresses emissions reductions from energy efficient new construction as well as electrification of new buildings.

- **Current level of Effort:** Based on current energy code (IECC 2012).
  - Residential
    - Energy efficiency: 80 HERS score; based on current building code (IECC 2012: zone 4)
    - Percent of energy from natural gas: 60%; based on current energy use breakout data for residential buildings in KCMO
  - Commercial
    - Energy efficiency: 61.4 kBtu/sq. ft.; based on average building performance of current energy code (Pacific Northwest National Labratory, 2015)
    - Percent of energy from natural gas: 40%; based on current energy use breakout data for residential buildings in KCMO
- **Best in Class**
  - Residential
    - Energy efficiency: 50 HERS score; based net zero residential building guidelines (US Department of Energy, 2021)
    - Percent of energy from natural gas: 0%; based on existing all-electric home construction
  - Commercial
    - Energy efficiency: 61.4 kBtu/sq. ft.; based on average building performance of current energy code (Pacific Northwest National Labratory, 2015)
    - Percent of energy from natural gas: 0%; based on all-electric existing building construction
- **Other Considerations:**
  - No industrial growth, based on history of declining energy use over the last 10 years.
- **Connected Strategies**
  - E-1: Increase the percentage of renewable energy in the utility grid mix
  - E-2: Expand neighborhood and commercial renewable energy generation

- E-4: Develop renewable natural gas resources for strategic end uses

B-4: Promote equitable building decarbonization

Emissions reduction from this strategy comes from transitioning natural gas systems in existing residential, commercial, and industrial facilities to electricity.

- **Current level of Effort:** Based on current energy use breakout provided by Evergy and Spire during the annual GHG emissions inventory update.
  - Residential percent of energy from natural gas: 60%
  - Commercial percent of energy from natural gas: 40%
  - Industrial percent of energy from natural gas: 70%
- **Best in Class:** Based on a National Renewable Energy Laboratory (NREL) study suggesting that 80% of gas usage in residential/commercial sectors and 50% of gas usage in the industrial sector could be electrified (National Renewable Energy Laboratory, 2017).
- **Other Considerations:**
  - Assume 25% efficiency gains from electrifying building systems. This is a conservative estimate based on modeling of heating systems in commercial buildings and homes, which ranged from 37-50%.
  - Savings in this strategy depend strongly on the electricity grid mix. There are no emissions savings from electrification without investing in renewable energy.
- **Connected Strategies**
  - B-1: Increase building efficiency and health for commercial and public buildings
  - B-2: Improve the efficiency, affordability, and durability of homes
  - E-1: Increase the percentage of renewable energy in the utility grid mix
  - E-2: Expand neighborhood and commercial renewable energy generation
  - E-4: Develop renewable natural gas resources for strategic end uses

ENERGY SUPPLY
PROVIDING CLEAN AND AFFORDABLE ENERGY

Strategies in this section are focused on the source of natural gas and electricity used in the city and transitioning to carbon free sources.

WHERE WE ARE IN 2019

GHG emissions from fuel burned to generate the electricity used in the city accounts for about 46% of Kansas City's total emissions or four million $MTCO_2e$ (Figure 8). These emissions have decreased by about 28% since 2010, driven by the reduction in electricity emissions factor.

Emissions from natural gas used in our homes and buildings releases about 1.5 million $MTCO_2e$ or about 17% of Kansas City's 2019 GHG emissions. These emissions have increased over the last 10 years due to an increase in natural gas use in homes and businesses.

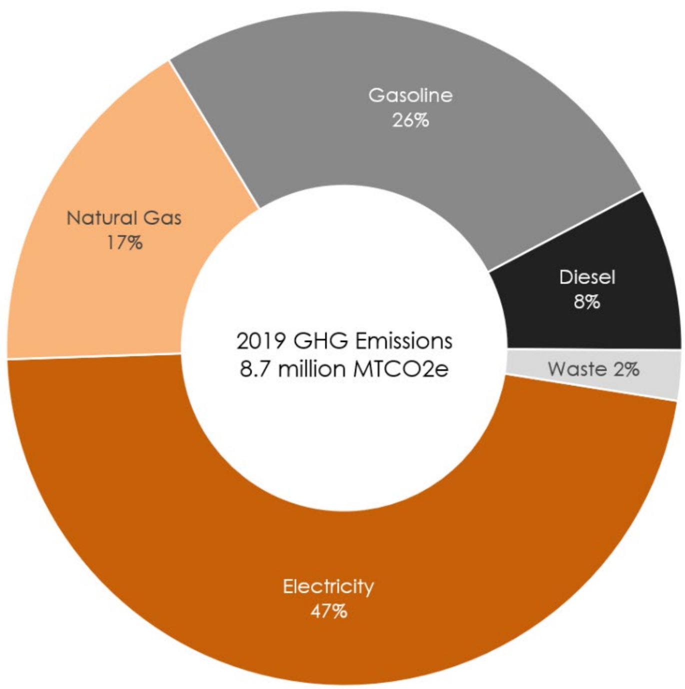

Figure 8: Emissions breakout by fuel source

ANALYSIS SUMMARY

Mitigation strategies analyzed in this section are:

- E-1: Transition energy grid mix to renewable energy
- E-2: Expand neighborhood, commercial, and municipal renewable energy generation
- E-3: Improve grid stability and resilience. (Resiliency focused strategy, so not analyzed but supports other energy strategies)

- E-4: Purchase utility-scale renewable energy

The range of potential impacts from each of these strategies is shown in Figure 9 as a percentage of the total electricity and natural gas emissions in 2040. The lower percentage represents the savings if the City continues to implement these strategies at the current level; the higher percentage for each strategy represents best in class performance. Based on this analysis, 1-69% of total energy emissions (natural gas and electricity) could be reduced through the strategies in this section - with strategies E-1 and E-5 being the most impactful. The range of total potential impact from the building strategies are shown again here for reference.

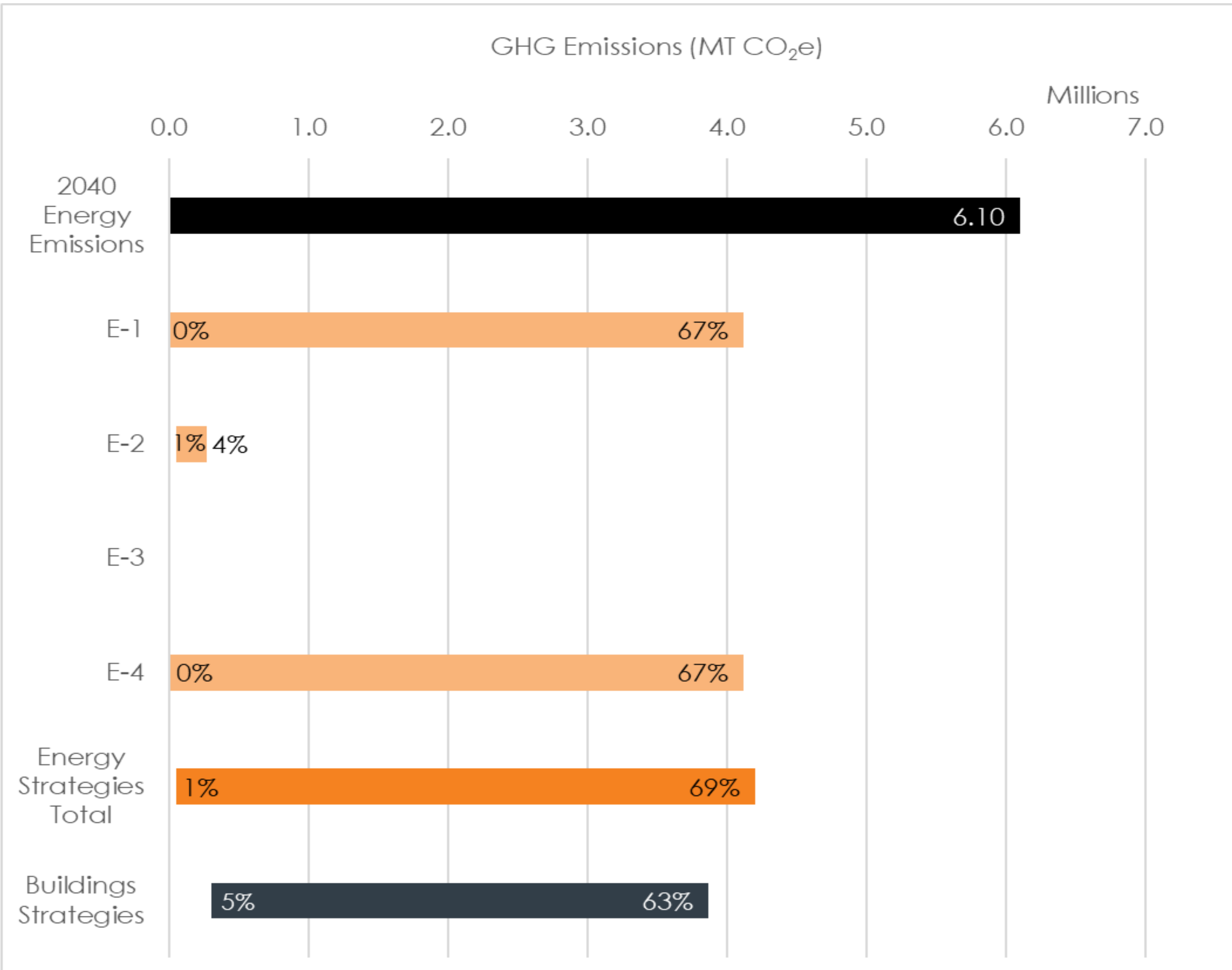

Figure 9: Energy supply mitigation strategy impact[5]

[5] Note that maximum emissions reduction cannot be achieved in all categories simultaneously because building system and energy strategies interact with each other. For example, if all building systems are electrified, renewable electricity strategies will have more impact than if 50% of energy is supplied by natural gas. Additionally, renewable energy strategies also interact with each other. For example, renewable energy provided through the utility grid mix would not also be purchased through utility-scale renewable energy programs.

STRATEGY ANALYSIS ASSUMPTIONS AND METHODOLOGY

Strategy	Estimated Emissions Reduction (MT CO2e)	% Of Total Energy Emissions	% Of Total Community Emissions
E-1	0 – 4,115,000	0-67%	0-42%
E-2	54,000 - 218,000	1-4%	0.6-2.3%
E-3	N/A Resiliency Strategy	N/A	N/A
E-4	0 – 4,115,000	0-67%	0-42%
Energy Strategies Cumulative Impact	**54,000 - 4,115,000**	**1-69%**	**1-43%**

Assumptions and references used to establish the lower and upper bounds of each strategy, as well as a list of the other strategies that will influence the strategy's impact, are outlined below by strategy.

E-1: Transition energy grid mix to renewable energy

This strategy shows the emissions reduction benefits of transitioning the electric utility generation mix to carbon-free sources.

- **Current level of Effort:** Assumes no changes to Evergy's current generation mix of 28% renewable energy.
- **Best in Class:** Calculated based on Evergy's public goals and resource plan (Evergy, 2021) adjusted to encourage Evergy to push toward 100% carbon free by 2040, to match the pledges from other more aggressive utility commitments from across the country.
    - Percent carbon-free energy 2025: 60%
    - Percent carbon-free energy 2030: 70%
    - Percent carbon-free energy 2040: 100%
- **Other Considerations:**
    - Assumes that planned reductions in carbon emissions in Evergy's IRP will correspond with increased renewable energy percentage. Emissions reductions are calculated based on the reduced emissions factor described in the IRP, but the City's 2030 goal relies on carbon-free percentage assumptions.
- **Connected Strategies**
    - B-1: Increase building efficiency and health for commercial and public buildings
    - B-2: Improve the efficiency, affordability, and durability of homes
    - B-3: Ensure climate-ready, efficient construction
    - B-4: Transition building systems to use clean, reliable electricity
    - E-2: Expand neighborhood and commercial renewable energy generation

E-2: Expand neighborhood, commercial, and municipal renewable energy generation

Emissions reductions from this strategy come from installation of distributed solar generation including roof-top and community solar projects.

- **Current level of Effort:** Based on low-growth scenario for distributed generation growth in Evergy's 2021 IRP (Evergy, 2021).
  - Additional installed solar 2025: 19,150 kW
  - Additional installed solar 2030: 38,299 kW
  - Additional installed solar 2040: 122,843 kW
- **Best in Class:** Based on distributed solar installation targets provided by local experts.
  - Additional installed solar 2030: 110 MW
  - Additional installed solar 2040: 175 MW
- **Other Considerations:**
  - Assumes 1,419 kWh per year/kW based on PV Watts estimates for Kansas City south-facing, rooftop installations (National Renewable Energy Laboratory, 2021)
- **Connected Strategies**
  - B-1: Increase building efficiency and health for commercial and public buildings
  - B-2: Improve the efficiency, affordability, and durability of homes
  - B-3: Ensure climate-ready, efficient construction
  - B-4: Transition building systems to use clean, reliable electricity
  - E-1: Increase the percentage of renewable energy in the utility grid mix

E-4: Purchase utility-scale renewable energy

Purchase renewable energy from utility-scale solar and wind sources to supplement renewable energy available through the grid.

- **Current level of Effort:** Assume no large-scale utility renewable energy purchases.
- **Best in Class:** Purchase enough renewable energy to cover the difference between renewable energy supplied by the grid and the City's 100% renewable energy by 2030 goal.
  - Based on energy use projections and reductions from energy efficiency efforts, this would be about 2.2 billion kWh.
- **Connected Strategies**
  - B-1: Increase building efficiency and health for commercial and public buildings
  - B-2: Improve the efficiency, affordability, and durability of homes
  - B-3: Ensure climate-ready, efficient construction
  - B-4: Transition building systems to use clean, reliable electricity
  - E-1: Increase the percentage of renewable energy in the utility grid mix
  - E-2: Expand neighborhood and commercial renewable energy generation.

MOBILITY
MOVING AROUND THE CITY

The strategies in this action area focus on reducing on-road transportation emissions within the city through three main strategies 1) reducing the number of **vehicle miles traveled** (VMT) per person, 2) transitioning these trips to active transportation or public transit, and 3) eliminating emissions of remaining on-road vehicles.

WHERE WE ARE IN 2019

In 2019, on-road transportation became the largest source of GHG emissions in Kansas City, accounting for about one-third of total emissions or 3 million MT CO_2e (Figure 10). These emissions come from gasoline and diesel used in cars and trucks, including public transit vehicles, traveling on roads in the city.

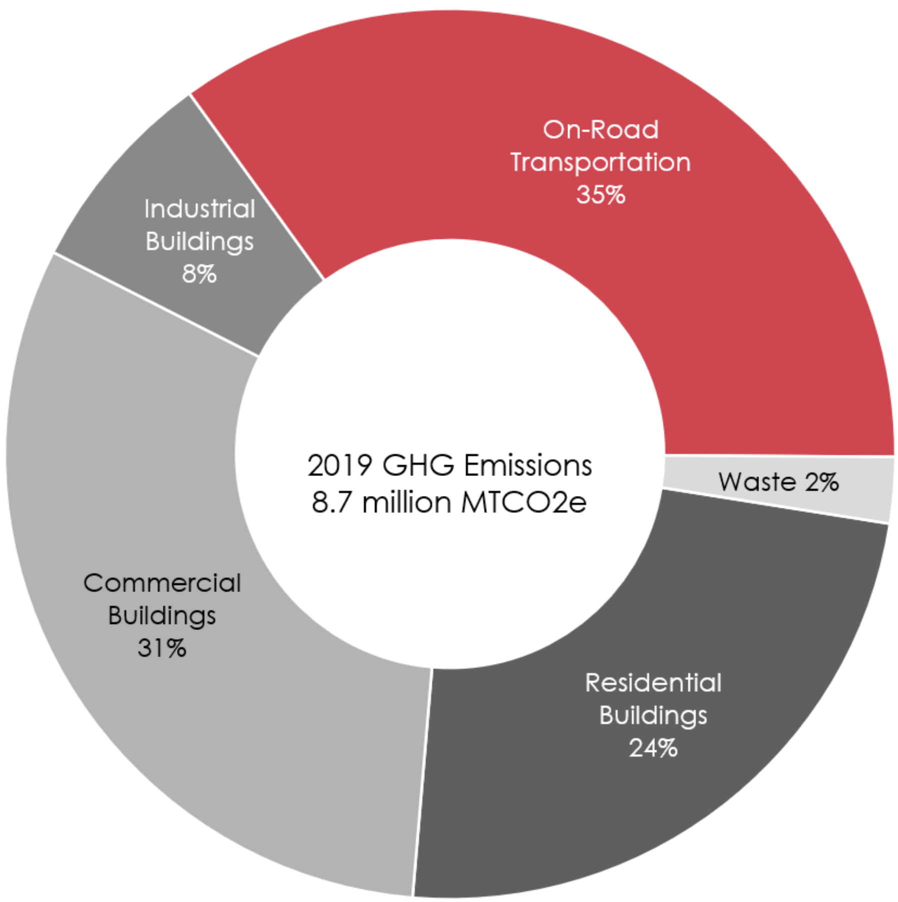

Figure 10: Portion of 2019 GHG emissions attributed to Mobility

Since 2005, emissions from on-road vehicles have decreased by about 19%. This decrease is driven by increasing fuel efficiency of vehicles, while VMT per person has increased by about 5% over the last 10 years.

ANALYSIS SUMMARY

Mitigation strategies analyzed in this section are:

- M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development
- M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes
- M-3: Shift trips to transit by building convenient and effective transit systems and mobility hubs
- M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management
- M-5: Reduce vehicle emissions through low- and no-emission vehicles

The range of potential impacts from each of these strategies is shown in Figure 11 as a percentage of the total projected transportation emissions in 2040. The lower percentage represents the savings if the City continues to implement these strategies at the current level, and the higher percentage for each strategy represents best in class performance. Based on this analysis, strategies in this plan reduce projected emissions from on-road vehicles by 14-73%, with M-1, M-2, M-4, and M-5 being most impactful. The emissions not accounted for by these strategies are from vehicle classes slower or more difficult to electrify.

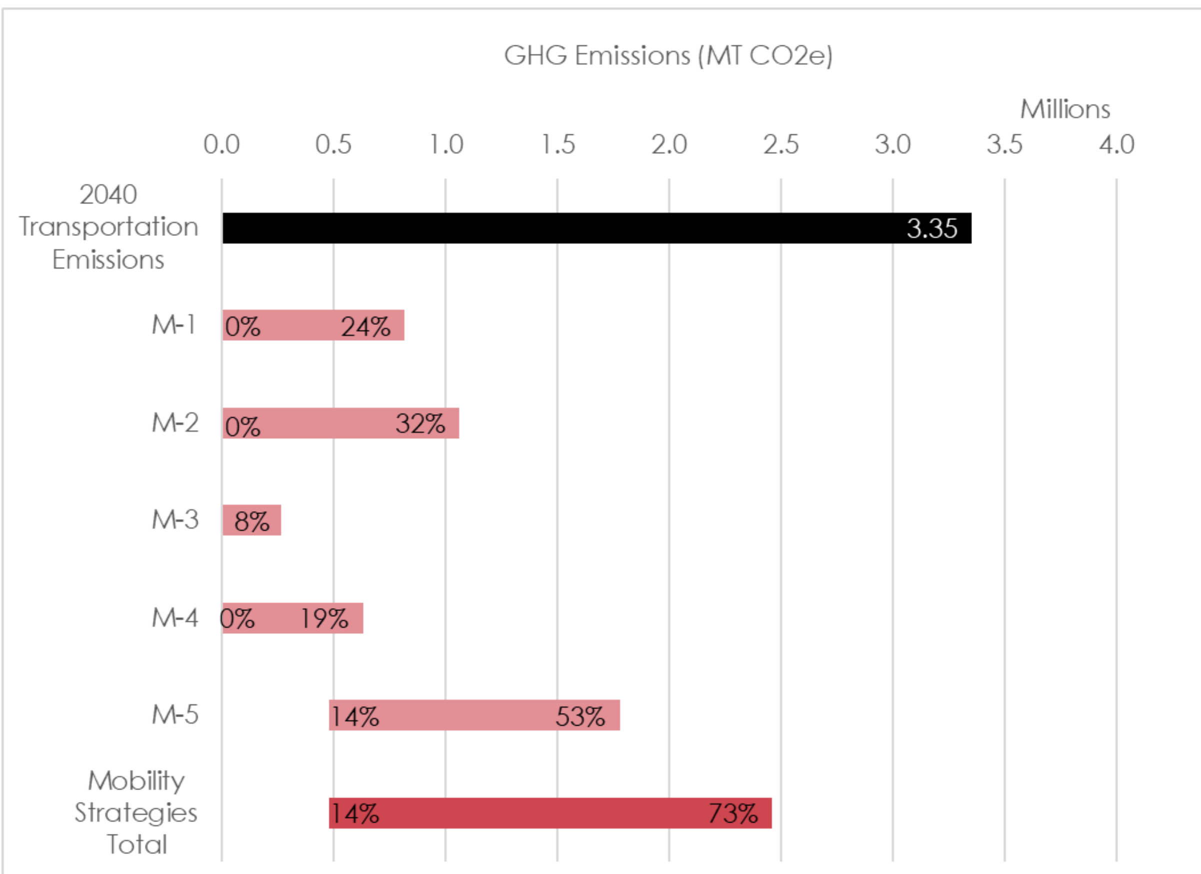

Figure 11: Mobility mitigation strategy impact

Note that maximum emissions reduction cannot be achieved in all categories simultaneously because the strategies interact. A person who chooses to ride the bus cannot also make that trip with an electric vehicle. The impact range for M-3 and M-5 are also impacted by the energy supply strategies because both incorporate transition to electric vehicles. Emissions reductions are higher when the electricity used to power electric vehicles is created using carbon free sources. These savings are incorporated into the ranges for electric vehicle strategies (M-3 and M5).

STRATEGY ANALYSIS ASSUMPTIONS AND METHODOLOGY

Strategy	Estimated Emissions Reduction (MT CO2e)	% Of Total Transportation Emissions	% Of Total Community Emissions
M-1	0 - 818,000	0-24%	0-8%
M-2	0 – 1,062,000	0-32%	0-11%
M-3	0 - 267,000	0-8%	0-3%
M-4	0 - 632,000	0-19%	0-7%
M-5	477,000 - 1,780,000	14-53%	5-18%
Mobility Strategies Cumulative Impact	**477,000 - 2,460,000**	**14-73%**	**5-25%**

Assumptions and references used to establish the lower and upper bounds of each strategy, as well as a list of the other strategies that will influence the strategy's impact, are outlined by strategy below.

M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development

Savings from this strategy comes from planned growth and redevelopment that reduces the distance residents need to travel to access employment, goods, and services.

- **Current level of Effort:** Over the last 10 years, the number of vehicle miles traveled (VMT) per person increased slightly, so the current level of effort is assumed to be no change in VMT per person.
- **Best in Class:**
  - Population density increase by 2040: 36%; based in historical best in class performance (Brownstone, 2008)
  - Key impact factors used (Florida, 2017)
    - Elasticity of distance to downtown on driving distance: -0.64
    - Elasticity of population density on driving distance: -0.22
  - Calculated reduction in VMT: 31%
- **Other Considerations:**
  - It is assumed that as population density increases with intentional development, the distance to downtown also decreases
  - It is assumed that planned growth will also benefit existing residents adjacent to the development, so benefit is applied to all VMT within the city
- **Connected Strategies**
  - M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes
  - M-3: Shift trips to transit by building convenient transit systems and mobility hubs
  - M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management
  - M-5: Reduce vehicle emissions through low- and no-emission vehicles

M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes

Emissions reductions from this strategy come from residents choosing to commute to work by walking or biking, as well as residents who work from home.

- **Current level of Effort:** Commuter percentages based on 2019 data from the Census Bureau American Community Survey (ACS) 1-year estimates (Data USA, 2021)
    - Commute – Walking: 2%; has remained constant since 2013
    - Commute – Biking: 0.2%; has been decreasing since 2013
    - Work from Home: 5%; increased slightly since 2013
- **Best in Class:**
    - Commute – Walking: 32%; Most similar community on the top ten list, North Chicago, IL. (Gilbert, 2017)
    - Commute – Biking: 5.4%; Goal from Bike KC Plan (City of Kansas City, Missouri)
    - Work from Home: 10%; based on typical performance of top ten cities (Burgett, 2018)
- **Other Considerations:**
    - Savings applied to gasoline emissions only. It is assumed that most diesel vehicles are commercial vehicles that would not benefit from this strategy.
- **Connected Strategies**
    - M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development
    - M-3: Shift trips to transit by building convenient transit systems and mobility hubs
    - M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management
    - M-5: Reduce vehicle emissions through low- and no-emission vehicles

M-3: Shift trips to transit by building convenient and effective transit systems and mobility hubs

This strategy estimates the emissions savings from residents choosing to commute via public transportation.

- **Current level of Effort:** Commuter percentages based on 2019 data from the Census Bureau ACS 1-year estimates (Data USA, 2021)
    - Commute – Transit: 2.6%; slight decline since 2013
    - Percentage of buses that are all-electric: <1%
- **Best in Class:**
    - Commute – Transit: 12%; Based on Chicago, IL, the most similar high performing city (Burrows, Burd, & McKenzie, 2019)
    - Percentage of buses that are all-electric: 100%; based on Los Angeles bus electrification goal (GoEV City, 2021)
- **Other Considerations:**
    - Savings applied to gasoline emissions only. It is assumed that most diesel vehicles are commercial vehicles that would not benefit from this strategy.
    - Planned rail expansion is included in the forecast, so is not included here.
- **Connected Strategies**
    - E-1: Increase the percentage of renewable energy in the utility grid mix
    - E-2: Expand neighborhood and commercial renewable energy generation
    - M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development
    - M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes
    - M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management
    - M-5: Reduce vehicle emissions through low- and no-emission vehicles

M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management

Emissions savings from this strategy come from reducing the idle time of vehicles traveling in the city, as well as working to eliminate abrupt acceleration.

- **Current level of Effort:** Baseline is no change from current congestion and idling patterns.
- **Best in Class:** Based on modeled benefits from highway traffic in California (Barth & Boriboonsomsin, 2009)
    - Emissions reduction from congestion management: 10%
    - Emissions reduction from traffic smoothing strategies: 10%
- **Other Considerations:**
    - Assumed most traffic speeds within the city are less than 55 mph, so emissions benefits from speed management.
- **Connected Strategies**
    - M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development
    - M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes
    - M-3: Shift trips to transit by building convenient transit systems and mobility hubs
    - M-5: Reduce vehicle emissions through low- and no-emission vehicles

M-5: Reduce vehicle emissions through low- and no-emission vehicles

The emissions savings in this strategy look at the benefits of higher efficiency internal combustion engine (ICE) vehicles as well as the transition to electric vehicles (EVs).

- **Current level of Effort:** Projected changes in fuel efficiency of ICE vehicles (US Energy Information Administration, 2020) and no change in the number of EVs.
  - Light-duty ICE vehicle efficiency
    - 2020: 25 mpg
    - 2030: 30 mpg
    - 2040: 35 mpg
  - Heavy-duty ICE vehicle efficiency
    - 2020: 6 mpg
    - 2030: 7 mpg
    - 2040: 7.5 mpg
  - Percent light-duty vehicles that are EVs: 2%
  - Percent heavy-duty vehicles that are EVs: 0%
- **Best in Class:**
  - 100% of light-duty vehicles registered are EV by 2050, based on Denver and Los Angeles goals (Bui, Slowik, & Lutsey, 2020)
    - This results in 27% light-duty vehicles being EVs in 2040.
  - Thirty percent of new heavy-duty vehicle sales are all-electric by 2030 and 100% by 2050, based on multi-state MOU (US Department of Energy, 2021)
    - This results in 29% heavy-duty vehicles being EVs in 2040, assuming a 6% vehicle turnover rate based on the national average (US Energy Information Administration, 2018)
- **Other Considerations:**
  - An exponential vehicle adoption curve is assumed for both light- and heavy-duty vehicles, based on historical trends in other markets.
  - Opportunities to leverage hydrogen-fuel cells to further reduce vehicle emissions are not considered here because there are no commercially available models.
- **Connected Strategies**
  - E-1: Increase the percentage of renewable energy in the utility grid mix
  - E-2: Expand neighborhood and commercial renewable energy generation
  - M-1: Reduce vehicle miles traveled (VMT) through coordinated and planned development
  - M-2: Shift trips to bicycling and walking by expanding a network of safe and accessible routes
  - M-3: Shift trips to transit by building convenient transit systems and mobility hubs
  - M-4: Reduce vehicle emissions from idling by reducing congestion and improving parking management

GLOSSARY

Term	Definition
Climate Resilience	The ability to prepare for, recover from, and adapt to the impacts of climate change.
De Minimis	Too trivial or minor to merit consideration.
Kilowatt (kW)	A measure of power equal to 1,000 watts.
Kilowatt hour (kWh)	A unit of energy equal to one kilowatt of power sustained for one hour.
Life-Cycle Emissions	An assessment of the overall greenhouse gas (GHG) impacts of a product, including each stage of its production, use, and disposal.
Mitigation	The action of reducing the severity, seriousness, or painfulness of something.
PV Watts	An online calculator provided by the National Renewable Energy Laboratory (NREL) to estimate solar energy production based on location, array size, and other system characteristics (https://pvwatts.nrel.gov/)
Social Cost of Carbon	An estimate of the economic costs or damages of emitting one additional ton of carbon dioxide into the atmosphere.
Vehicle Miles Traveled	The total miles of Motor Vehicle travel that are generated by a population over a given timeframe.

WORKS CITED

American Council for an Energy Efficienct Economy. (2021, December 3). *Arizona*. Retrieved from State and Local Policy Database: https://database.aceee.org/state/arizona

Barth, M., & Boriboonsomsin, K. (2009). Traffic Congestion and Greenhouse Gases. *ACCESS*. Retrieved from https://www.accessmagazine.org/fall-2009/traffic-congestion-greenhouse-gases/

Brownstone, D. (2008). *Key Relationships Between the Built Environment and VMT.* University of California, Irvine. Retrieved from https://onlinepubs.trb.org/Onlinepubs/sr/sr298brownstone.pdf

Bui, A., Slowik, P., & Lutsey, N. (2020). *Update on electric vehicle adoption across U.S. cities*. The International Council on Clean Transportation. Retrieved from https://theicct.org/sites/default/files/publications/EV-cities-update-aug2020.pdf

Burgett, B. (2018). Ten cities with the most remote workers. *Haven Life*. Retrieved from https://havenlife.com/blog/cities-with-the-most-remote-workers/

Burrows, M., Burd, C., & McKenzie, B. (2019). *Commuting by Public Transportation in the United States: 2019*. US Census Bureau. Retrieved from https://www.census.gov/content/dam/Census/library/publications/2021/acs/acs-48.pdf

City of Kansas City, Missouri. (n.d.). *Bike KC Master Plan*. Retrieved from https://drive.google.com/file/d/1U9Bdz-xaNzXBN-MDH0QTlIR624cVlF33/view

Data USA. (2021, December 3). Retrieved from Kansas City, MO: https://datausa.io/profile/geo/kansas-city-mo/

DiChristopher, T. (2021, March 15). Spire's path to carbon-neutral goal may include renewable gas, fuel cells. Retrieved from https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/spire-s-path-to-carbon-neutral-goal-may-include-renewable-gas-fuel-cells-63156183

Emerson, J., & Sullivan, B. (2020, May 12). *Zero Energy Homes – A Financial Win for Homeowners*. Retrieved from Zero Energy Project: https://zeroenergyproject.org/2019/03/23/everybody-profits-with-zero-energy-homes/

Environmental Protection Agency. (2021, December 3). *Rules of Thumb: Energy Efficiency in Buildings*. Retrieved from State and Local Climate and Energy Program : https://www.epa.gov/sites/default/files/2016-03/documents/table_rules_of_thumb.pdf

Evergy. (2021). *Evergy 2021 Integrated Resource Plan Overview*. Evergy. Retrieved from https://www.evergy.com/-/media/documents/smart-energy/evergy-2021-irp-overview.pdf?la=en

Evergy. (2021). *Evergy Kansas Centrol and Evergy Metro 2021 Integrated Resource Plan*. Evergy. Retrieved from https://estar.kcc.ks.gov/estar/ViewFile.aspx/S20210528081200386 2.pdf?Id=b2c17b30-9138-49bc-ab62-4ac8ed8d2074

Florida, R. (2017, April 6). What Drove the Driving Downturn? *Bloomberg CityLab*. Retrieved from https://www.bloomberg.com/news/articles/2017-04-06/does-compact-development-reduce-driving

Gilbert, K. (2017). US Cities With The Most Pedestrian Commuters. *Society*. Retrieved from US Cities with the Most Pedestrian Commuters: https://www.worldatlas.com/articles/us-cities-with-the-most-pedestrian-commuters.html

GoEV City. (2021, December 3). *Policy Toolkit*. Retrieved from Electrify Public Transportation: https://www.goevcity.org/electrify-public-transportation

Goldman School of Public Policy. (2020). *2035 The Report: Plummeting Solar, Wind, and Battery Costs can Accelerate our Clean Energy Future*. Berkeley, CA: University of California Berkeley. Retrieved from https://www.2035report.com/wp-content/uploads/2020/06/2035-Report.pdf

Lotus Engineering & Sustainability. (2021). *The Energize Denver Renewable Heating and Cooling Plan*. Denver, CO: Denver Climate Action, Sustainability, & Resiliency. Retrieved March 7, 2021, from https://www.denvergov.org/files/assets/public/climate-action/documents/hpbh/renewable-hampc/denver-renewable-heating-and-cooling-plan_june-2021.pdf

Mintz, M., & Voss, P. (2020, October). *Database of Renewable Natural Gas (RNG) Projects: 2020 Update*. Retrieved from Argonne National Laboratory: https://www.anl.gov/es/reference/renewable-natural-gas-database

Nadel, S. (2020, September 30). *Zero-energy Buildings are Focus of Growing Number of Energy Efficiency Programs*. Retrieved from Americal Council for an Energy-Efficeint Economy: https://www.aceee.org/blog-post/2020/09/zero-energy-buildings-are-focus-growing-number-energy-efficiency-programs

National Renewable Energy Laboratory. (2017). *Electrification & Decarbonization: Exploring U.S. Energy Use and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization*. US Department of Energy. Retrieved from https://www.nrel.gov/docs/fy17osti/68214.pdf

National Renewable Energy Laboratory. (2021, December 3). *PVWatts Calculator*. Retrieved from NREL Energy Calculators: https://pvwatts.nrel.gov/pvwatts.php

Pacific Northwest National Labratory. (2015). *Energy and Energy Cost Savings Analysis of the 2015 IECC for Commercial Buildings*. US Department of Energy. Retrieved from https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24269.pdf

Spire. (2020). *Stepping Forward*. Spire. Retrieved from https://s25.q4cdn.com/231862843/files/doc_financials/2020/ar/Spire-2020-Form-10-K-Web-121620-FINAL.pdf

Spire. (2021, May 21). *Spire releases third annual Corporate Social Responsibility report*. Retrieved from Spire: https://investors.spireenergy.com/news/news-details/2021/Spire-releases-third-annual-Corporate-Social-Responsibility-report/default.aspx

Sustainability Accounting Standards Board. (2020). *2020 Evergy ESC SASB Table*. Sustainability Accounting Standards Board. Retrieved from https://investors.evergy.com/SASB

The Brookings Institution. (2021, December 8). *The social cost of carbon: Advances in long-term probabilistic projections of population, GDP, emissions, and discount rates*. Retrieved from BPEA Article: https://www.brookings.edu/bpea-articles/the-social-cost-of-carbon/

US Department of Energy. (2021, December 3). *DOE Zero Energy Ready Home Program Requirements*. Retrieved from Office of Energy Efficiency & Renewable Energy: https://www.energy.gov/eere/buildings/doe-zero-energy-ready-home-program-requirements

US Department of Energy. (2021, December 3). *Medium- and Heavy-Duty Zero Emission Vehicle (ZEV) Deployment Support*. Retrieved from Alternative Fuels Data Center: https://afdc.energy.gov/laws/12460

US Energy Information Administation. (2021). *Summary of Legislation and Regulations Included in the Annual Energy Outlook 2021*. Washinton, DC: US Department of Energy. Retrieved from https://www.eia.gov/outlooks/aeo/assumptions/pdf/summary.pdf

US Energy Information Administration. (2018, August 2018). *U.S. households are holding on to their vehicles longer*. Retrieved from Today in Energy: https://www.eia.gov/todayinenergy/detail.php?id=36914

US Energy Information Administration. (2020). *Transportation*. US EIA. Retrieved from https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Transportation.pdf