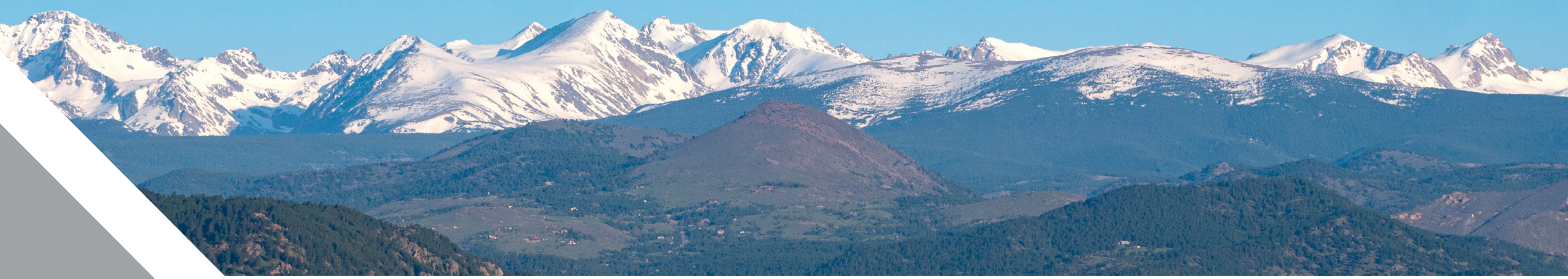
University of Colorado **Boulder**

CLIMATE ACTION PLAN



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FROM THE CHANCELLOR

CHANCELLOR

As science continues to offer greater clarity around climate change, the University of Colorado Boulder has a responsibility to be a leader in climate action. The Boulder campus has a long history of environmental action, including the milestone moment in 2007 when former Chancellor Bud Peterson signed the American College and University Presidents' Climate Commitment.

As chancellor of the University of Colorado Boulder, it is my duty to ensure that the campus aligns its policies and procedures to uphold this Climate Commitment. Our collective goal is to build a culture around concern for our climate by making decisions that support our mission - to shape tomorrow's leaders, be the top university for innovation, and to positively impact humanity - and also empower staff, faculty, and students to live out that mission.

Therefore, I am honored to present the following 2024 Climate Action Plan. This plan's core focus is to drive down emissions to align with the Paris Agreement to limit global temperature increases to 1.5 degrees Celsius. Our plan calls for a 50% reduction in campus emissions by 2030, followed by a linear reduction to zero emissions by 2050. It does so without the use of purchased offsets or unbundled renewable energy certificates, making it an example of stringency and integrity among similar climate action plans.

We also recognize the potential for climate action to create community benefits such as improved air quality and transportation access, to address environmental justice issues in our state, to increase the level of transparency and engagement with the campus community, and to promote equity through the implementation of specific strategies.

The next few years are incredibly important in limiting global temperature increases to 1.5 degrees Celsius. It is our duty to pursue emissions reductions that are consistent with that goal.

The university's goals are ambitious. For our aims to be realized, we need to approach them with thought and intention. We must act collectively to support these efforts, ensuring that the proper resources are committed and that our entire community is included in this endeavor. By applying our technical expertise and research to our internal operations, we can make a bold commitment to advancing environmental sustainability at CU Boulder.

Sincerely,

Philip P. DiStefano, Chancellor

FROM THE CAP STEERING COMMITTEE

As staff, faculty and students[1] who were recruited by Infrastructure & Sustainability Leadership to serve on the Steering Committee to oversee the update of CU Boulder's Climate Action Plan, we worked hand-in-hand with a consulting team hired by CU Boulder[2] to create a set of prioritized actions that will help meet the campus greenhouse gas (GHG) reduction goals. The goal of including all emissions sources (Scopes 1-3), and the aim of a 50% reduction by 2030 was an important and constant focus, as was the linear reduction to zero emissions, by 2050, without the purchase of unbundled Renewable Energy Credits (REC) or offsets.

For each of the recommended actions, four important considerations were made, in addition to the fundamental aim of GHG reductions: community health, equity and social justice, resilience, and financial feasibility. Any plan that didn't deliver the necessary emissions reductions would be fundamentally inadequate. But also, a plan that didn't consider the intersecting issues associated with campus energy systems, transportation, procurement, food, etc., would be equally short sighted.

We recognize that energy systems are a significant cause of environmental justice issues: neighborhoods near refineries, power plants, heavy industry, and highways bear the brunt of environmental impact in very tangible ways. In addition, climate change disproportionately affects disadvantaged and vulnerable populations, both locally and globally. Therefore, each strategy within this plan, which focuses on greenhouse gas reduction measures, is also assessed according to its impact on the ability to deliver co-benefits, including social justice and equity.

We are confident that the goals outlined in this plan are technically and economically feasible. By implementing actions with the tools that we have, we will advance and improve our campus, contributing to better air quality, sustainable mobility and efficiency, operability, well-being, and reputation.

The Climate Action Plan is an intentional "living document" that will be continually monitored and evaluated through an on-line platform accessible to everyone who has interest. The campus-wide Sustainability Council is charged with monitoring the implementation of this plan, supported by an ongoing working group of faculty, staff and students who have particular interest and expertise in these areas. Regular reports on progress or status of the projects will be an essential component so that course corrections can be made as needed (see Governance Chapter below).

We commend the Board of Regents for having originally adopted the GHG emission reduction commitments that guided this plan and commend the Chancellor for updating and aligning the campus climate goals to be Paris-aligned. It will take the support of the entire campus to reach our collective goals, and we look forward to successful implementation of this plan in service to creating a more sustainable and environmentally just CU Boulder.

Sincerely,

[1] The Steering Committee is composed of three types of members: (1) the Vice Chancellors, (2) central administrators other than Vice Chancellors, and (3) independent members such as faculty, students, or research associates.

[2] Blue Strike Environmental.

LAND
ACKNOWLEDGMENT

CU Boulder recognizes that Indigenous peoples are the original stewards of the land on which the University now stands. As the **University's Land Acknowledgment** states, our campus is committed to "educating, conducting research, supporting student success and integrating Indigenous knowledge" into our campus and its activities. This knowledge can provide crucial understanding for addressing the impacts of climate change on our region and globally.

In the development of the Climate Action Plan (CAP), the steering committee and equity subcommittee met with the CU Boulder Center for Native American and Indigenous Studies (CNAIS) to begin to identify intersections and specific strategies that enable the CAP to honor the University's commitment to Indigenous communities while reducing greenhouse gas emissions. Given the scope of the CAP and its emphasis on infrastructure and operations, this plan is limited in its capacity to directly support the goals of CU Boulder's Land Acknowledgment. However, attention to equity in implementing the plan and ongoing collaboration with CNAIS, the Associate Vice Chancellor, and Indigenous communities on and off campus provides opportunities to advance these efforts in the future. This can be done by increasing support of the **Tribal Climate Leaders Program**, increasing Indigenous leadership on campus by recruiting and retaining more Indigenous students, faculty, and staff, and by creating more opportunities for learning and training around the intersections of climate action and Indigenous history, knowledge, and experiences, thereby increasing our collective capacity to achieve the goals of the CU Land Acknowledgment.

[3] **CU Land Acknowledgment.**

ACKNOWLEDGEMENTS

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University of Colorado Boulder Photo Staff

[4] Two student members (Michael Borkan and Brigid Mark) joined the Steering Committee in May of 2023, while the other members of the Steering Committee have been part of the process since October 2022.

[5] Karen Bailey and Brigid Mark served on both the Steering Committee and on the Equity Subcommittee.

[6] Hired by CU Boulder in August 2022 in response to a Request for Proposals.

EXECUTIVE SUMMARY

Call to Action

Actions taken during the next few years will be vital to limiting global temperature rise to 1.5°C and to mitigating the most severe impacts of climate change. According to the Paris Agreement, global GHG emissions need to be reduced 50% by 2030 with a linear reduction to 100% by 2050. This Climate Action Plan (CAP) establishes a course for the University of Colorado's Boulder campus (CU Boulder) to achieve these targets for its own emissions. Greenhouse Gas (GHG) emissions are cumulative, meaning that the sooner reductions are made, the greater the impact and the less difficult it is to make reductions in the future.

The CU Boulder campus seeks to be a leader in pursuing climate action. With the signing of the "American College & Universities Presidents Climate Commitment" (ACUPCC) in 2007, CU Boulder began assembling a formal vision and structure for sustainability governance, one that prioritizes reducing greenhouse gas emissions to net zero as soon as possible. In 2009, the campus published the "Conceptual Plan for Carbon Neutrality" (CPCN); and, though not fully implemented, this document served as an underlying framework for this 2024 Climate Action Plan (CAP). Most recently, the Chancellor has published a ***Call to Climate Action***, committing the campus to carbon neutrality by 2050, among other environmental goals.

With the announcement of the **Right Here Right Now Human Rights Climate Commitments**, CU Boulder has positioned itself as a global leader in advancing human rights as we address the climate crisis. Climate change and the actions we take to mitigate the climate crisis have direct connections to and impacts on inequality, inequity, and injustice, locally and globally. A fair and just transition to a more sustainable CU Boulder demands that we consider how individuals and communities are disproportionately impacted by CU Boulder's operations and the climate crisis more broadly. Reflecting the campus **Diversity, Equity, and Inclusion (DEI)** values, one goal of the CAP is to assess and mitigate the impact of its climate goals and strategies on inequity. This approach allows us to advance climate action while also acknowledging how climate change and climate change mitigation differentially impact individuals and communities based on socio-economic status, race and ethnicity, ability, gender, sexual identity, nationality, geographic location, and a host of other factors. Equity refers to fairness and justice in the distribution of resources, opportunities, and benefits, as well as the distribution of impacts. We view equity as both a benefit of inclusive climate action and a framework through which climate action can be evaluated. By assessing the impact of the CAP on equity, the campus acknowledges systemic injustices and endeavors to make our efforts more inclusive. Our vision is to ensure that the climate action plan does not worsen inequity and that we prioritize actions that both mitigate the climate crises while advancing the University's equity goals.

Core Goals

This 2024 CAP is organized around **five Core Goals**, reflecting the Chancellor's Call to Action, and intended to strengthen CU Boulder's commitment to climate action.

1. **Achieve 50% reduction in Scope 1 and 2 emissions (see Table 1) by 2030, from the baseline year of 2019, with a linear reduction to zero emissions by no later than 2050.** Do so without the use of purchased offsets or unbundled Renewable Energy Certificates (RECs).[7]

2. **Achieve a 50% reduction from 2019 by 2030 for those Scope 3 emissions where accurate estimates can be established and which are within the University's influence and control. Further reduce these emissions to zero by 2050.** The CAP begins the process of developing a Scope 3 inventory and then developing the strategies to achieve reductions in indirect emissions. It is anticipated that the quality of the inventory and the robustness of the reduction strategies will increase over time now that inclusion of Scope 3 emissions in the CAP is established.

3. **Use climate action to deliver to the CU Boulder community the co-benefits of equity, health, and resilience.** As the opportunity to connect climate action to these co-benefits becomes increasingly apparent, we anticipate additional strategies to be included in subsequent CAPs to do so.

4. **Strengthen internal and external management and accountability structures to ensure the campus achieves the goals outlined in the plan.** An implementation plan that includes governance solutions and accountability structures is also included in this CAP.

5. **Build a Community Engagement Strategy to integrate communication, feedback, and reporting and increase transparency with campus and the broader community.** The implementation plan also includes communication, engagement, and reporting mechanisms in support of campus operations and emission reduction strategies.

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[7] RECs are used to track and assign ownership to renewable electricity generation and use. Unbundled REC means the non-physical REC has been separated from the physical electricity. When a REC is unbundled, it may lack the same credibility as a bundled REC. If CU were to use the energy from an off-campus renewable energy plant, under a virtual net metering agreement, the associated "bundled" RECs would count toward reduction goals.

The CU Boulder Climate Action Plan is ultimately a strategy document that outlines a pathway to achieve these stated goals. It begins with an inventory of GHG emissions which establishes a baseline from which to measure and forecast future GHG reductions. It then assesses strategies to achieve emission reductions on campus (Scopes 1 and 2) and through relevant Scope 3 categories. In addition to reducing emissions, these strategies have the potential to achieve certain co-benefits. Therefore, strategies have been identified and prioritized to enhance these complementary aspects, and to protect against possible negative outcomes (e.g., excluding some members of the community from engaging in climate action programs or incentives). Finally, implementation recommendations are included that address governance, communication and financing strategies to help ensure the Plan's execution.

TABLE 1: Working definition of three emission scopes

SCOPE 1	Carbon emissions resulting directly from fuel combustion on campus, primarily natural gas for heating or CU Boulder-owned vehicles.
SCOPE 2	Carbon emissions associated with energy purchased by CU Boulder and generated elsewhere, primarily grid electricity used on campus.
SCOPE 3	Carbon emissions resulting indirectly from CU Boulder operations, either from upstream activities, such as purchases of goods and services, or downstream activities, such as students and faculty commuting to and from campus. The University does not have direct control over these emissions, though it can exert influence over its operations, procurement and other activities to reduce these emissions.

GHG Baseline, Forecasts and Targets

CU Boulder has created an inventory of its Scopes 1 and 2 emissions, and set targets for reductions in those emissions by 2030 and further linearly reducing to zero emissions by 2050. The Campus has also conducted its first ever Scope 3 emissions inventory, covering eight of the fifteen[8] Scope 3 categories[9]. It set targets in six of those categories (purchased goods and services, capital goods, fuel and energy related activities, waste from operations, business travel, employee commuting), with suggestions for expanded reporting for any remaining categories in the future.

Baseline. In 2019, the University produced 130,593 metric tons of carbon dioxide equivalent (MTCO2e) from its scope 1 and 2 activities.[10] This is down from a 2005 baseline of 135,609 MTCO2e, according to CU's records in SIMAP,[11] a reduction of 4.6%. Adding Scope 3, emission estimates increase to 163,027 MTCO2e. Table 2 and Figure 1 summarize CU Boulder's total emissions.

[8] Categories including Category 10 (Processing of sold products) and Category 11 (Use of goods and services sold), do not apply to the Campus value chain since CU Boulder does not sell intermediary products used in manufacturing, nor are there necessarily emissions associated with using one's college degree. Emissions from Category 4 (Upstream transportation and distribution) are currently included in Category 1, which uses a full life cycle emission factor, but will be specifically addressed in future CAP updates. Appendix D, entitled, "Scope 3 Emissions", details the methodology CU Boulder has taken to measure Scope 3 emissions, and lists concrete plans for measuring the remaining categories. The categories included in this CAP align with the campus' core goal of achieving 50% GHG emission reduction in certain Scope 3 emissions by 2030 and all categories by 2050, from a 2019 baseline.

[9] Emissions from "Investments" have also been estimated as an eighth stand alone category, due to the fact that investment decisions are handled at the University System level and not the campus level. An estimate of these emissions can be found in the Scope 3 Appendix.

[10] This figure may differ slightly from other reported estimates of campus emissions, including Campus Sustainability Indicator Management & Analysis Platform (SIMAP) reports. The reason is slightly different reported use data or emission factors. The figure here was created by a proprietary software called Climate and Energy Scenario Analysis, or CESA. CU Boulder will retain the CESA model that has been specifically designed for the campus.

[11] **SIMAP** is a carbon and nitrogen-accounting platform commonly used by universities to track, analyze, and improve campus-wide sustainability.

TABLE 2: Summary of emission totals from Scopes 1, 2, 3 in 2019.

CATEGORY	MTCO2e
SCOPE 1	**48,213**
Natural gas	45,097
Total Fleet	1,841
Fugitive Emissions, Fertilizer Usage, Refrigerant Leakage	1,275
SCOPE 2	**82,528**
Purchased electricity	82,528
SCOPE 3	**163,027**
Category 1: Purchasing	12,216
Category 2: Capital Goods	20,944
Category 3: Fuel and Energy Related Activities	21,782
Category 5: Waste Generated in operations	2,595
Category 6: Business Travel	32,041
Category 7: Employee and Student Commuting	16,407
Category 8: Upstream Leased Assets	538
Category 9: Downstream Transportation and Distribution	56,504

CU BOULDER EMISSION PERCENTAGES BY SCOPE (2019)

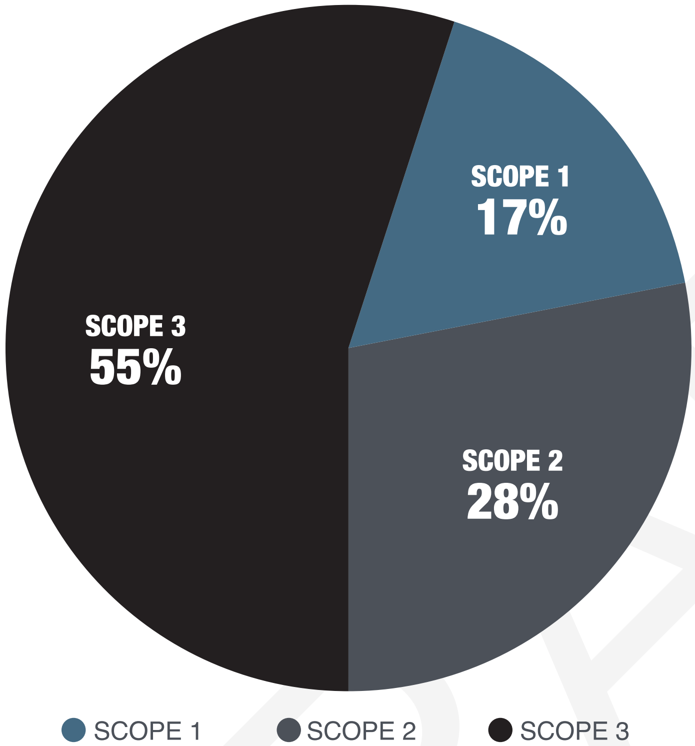

FIGURE 1

Scope 3 consists of 15 distinct categories of emissions as defined by the GHG Protocol. Eight of the categories have been included in CU Boulder's first Scope 3 inventory, some using significant assumptions given the lack of available data. Seven of the categories have reduction targets. The other categories were either not applicable to CU Boulder's operations or fell outside the direct control of CU Boulder.

The seven categories that include targets together represent about 67%, or approximately two thirds, of the calculated scope 3 emissions. These targets reflect a 50% reduction by 2030 and a 7% annual reduction through 2050, which would bring Scope 3 emissions close to zero.

TABLE 3: Summary of Scope 3 Categories that are included in the inventory and for which targets are set.

#	CATEGORY	INVENTORY	TARGET SET
1	Purchased goods and services	Y	✔
2	Capital goods	Y	✔
3	Fuel and energy related activities (FERA)	Y	✔
4	Upstream transportation and distribution	Included in Category 1[12]	
5	Waste generated in operations	Y	✔
6	Business travel	Y	✔
7	Commuting	Y	✔
8	Upstream leased assets	Y	✔
9	Downstream transportation and distribution	Y	
10	Processing of sold products	N/A	
11	Use of goods and services sold	N/A	
12	End-of-life treatment of sold products	N/A	
13	Downstream leased assets	N/A	
14	Franchises	N/A	
15	Investments	Out of CU Boulder direct Scope/Control. See Scope 3 Annex for an estimate.	

[12] These are emissions associated with the transportation and distribution of goods and services (i.e. food, merchandise, etc.) supplied to the university. For this inaugural iteration of a Scope 3 inventory, a life-cycle emissions factor that considers all emissions from upstream products, has been used for Category 1 meaning emissions for category 4 would be included. This will not be the most accurate way of measuring Category 4 emissions, and other strategies will be employed for future CAP updates.

Reducing Scope 1 and 2 Emissions

Several foundational strategies were developed and evaluated to reduce emissions from Scopes 1 and 2.[13] CU Boulder's 2022 Energy Master Plan[14] was used as a guide for many strategies, while their GHG impact, and various financial performance indicators were evaluated in an Excel-based software model called the Climate and Energy Scenario Analysis tool (CESA).[15] Projects were identified under four primary categories: building efficiency and electrification, decarbonization of the campus heating system, onsite and offsite renewable energy, and fleet conversion to electric vehicles. Then, using the CESA model, the CAP Steering Committee developed three carbon reduction scenarios to create a roadmap to meet the established Science Based Targets for CU Boulder.

Figure 2 provides a depiction of each scenario's GHG reduction pathway to 2050. The dotted line represents the 2019 baseline, while a gray dashed line shows the 2005 baseline for comparison. The solid black line is a business-as-usual scenario in which utility-sourced electricity gradually decarbonizes. The black dashed line represents CU Boulder's science based emissions target (SBT).[16] Finally, the colored lines are the three scenarios. The three scenarios are as follows:

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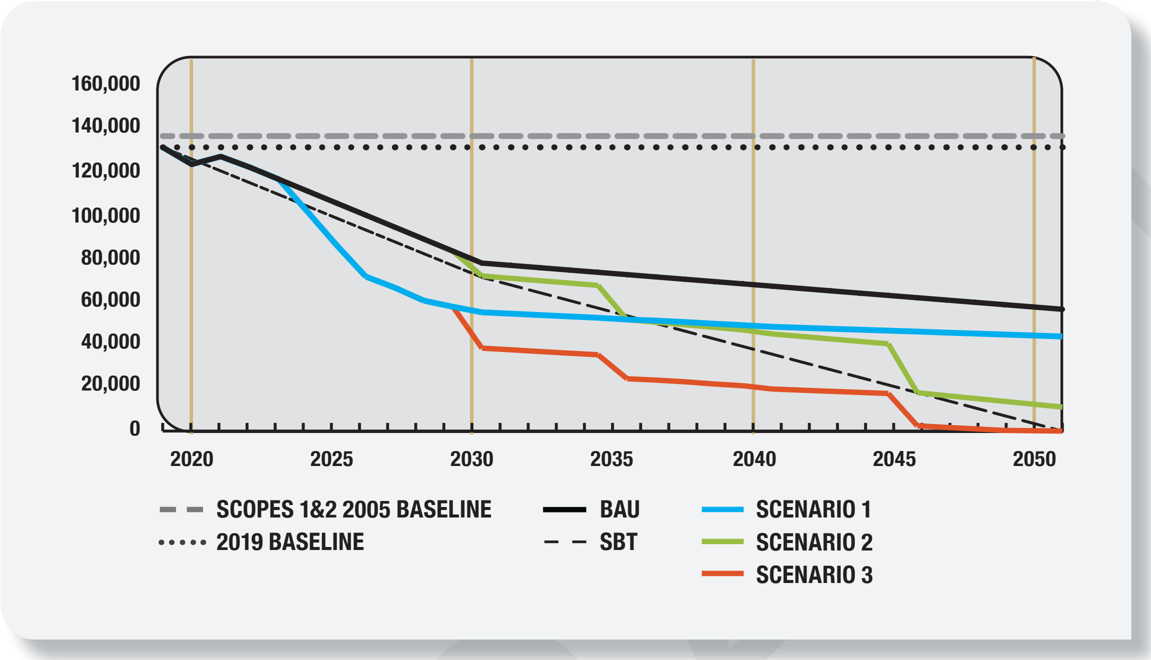
[13] Scope 2 emissions are not technically produced on campus, but at the source of electricity generation. Still, they can be directly controlled on campus by reducing electricity use. Further, as generation sources become less carbon intensive, emissions from all electricity consumption will fall.

[14] CU Boulder Energy Master Plan 2022.

[15] CESA is a proprietary tool of Blue Strike Environmental, a private consultancy. Blue Strike performed the tool customization and has delivered the completed tool to the Boulder Campus. CESA is a comprehensive techno-economic model that helps decision-makers understand the financial, environmental, and energy impacts of a suite of climate and energy mitigation measures. The tool has been designed to reflect the University's energy profile and facilities design, and is used to evaluate multiple strategies to achieve zero GHG emissions.

[16] A Science Based Target (SBT) refers to the emissions pathway for an entity such that it plays its part in keeping global temperature rise below 1.5°C. A SBT for a university such as CU Boulder, can be calculated using a downloadable calculator available from the Science Based Target Initiative (SBTi).

FIGURE 2: Scenario GHG Reduction Pathways for Scope 1 and 2 Emissions



SCENARIO 1 (blue line): Energy efficiency (EE), renewable energy (RE), and Fleet replacement. This Scenario considers over 300 energy efficiency projects (lighting, controls, envelope & HVAC), 7 MW of renewable energy installations, and the replacement of approximately 365 internal combustion campus fleet vehicles with electric vehicles. This combination of projects allows CU Boulder to achieve its short-term goals, but not its long-term goals.

SCENARIO 2 (green line): Heating system upgrade (HSU); this is the phased conversion of Central Campus heating to an electrified, lower temperature hot water system. This complex series of projects is currently being studied; results, including project schedule and costs, are expected in 2024. Decarbonizing the campus heating system is expected to contribute significant emission savings, but will not achieve zero emissions on its own.

SCENARIO 3 (red line): Combines Scenarios 1 and 2. This combination of projects will achieve CU Boulder's short and long term goals, of 50% reduction by 2030 and 100% by 2050.

The CAP recommends that Scenario 3, pictured with the red line, be pursued as the selected pathway to meet the zero emission science based target. This option accelerates short-term emissions reductions through building efficiency, renewable energy, and fleet decarbonization and would reduce Scope 1 and 2 emissions significantly below the science-based target. Scenario 3 saves 1,120,383 MTCO2e between now and 2050. Table 4 outlines the implementation timeline and carbon savings for this scenario, while Figure 3 shows the GHG reductions expected by decade, along with Figure 3 that visualizes the initial costs associated with implementation.

TABLE 4: Implementation timeline and carbon savings by strategy

STRATEGY/DECADE	YEARS 2024–2030	2031–2040	2041–2050
Building Efficiency	466,268 MTCO2e	25,001 MTCO2e	No projects
Renewable Energy	20,066 MTCO2e	No projects	No projects
Fleet Replacement	5,273 MTCO2e	5,434 MTCO2e	2,825 MTCO2e
Heating System Upgrades	83,770 MTCO2e	281,334 MTCO2e	263,629 MTCO2e

ZERO EMISSIONS DEFINITION

Zero emissions means that there are no greenhouse gas emissions produced from a particular source or activity. It indicates a complete elimination of carbon dioxide (CO2) and other greenhouse gas emissions.

Carbon neutrality means that the net greenhouse gas emissions produced by a source or activity are balanced by an equivalent amount of emissions removed from the atmosphere or offset through various measures.

FIGURE 3: Emission Reductions by Decade (MT CO2e)

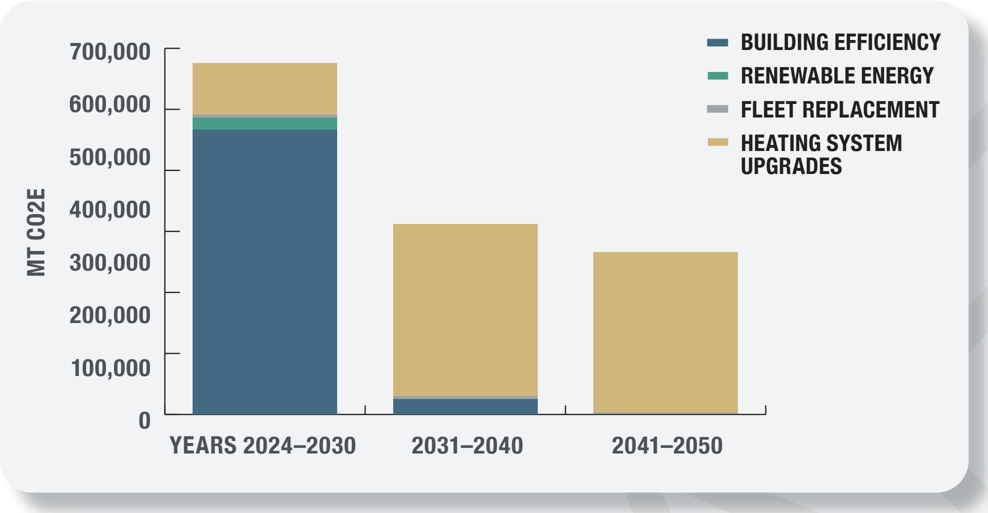
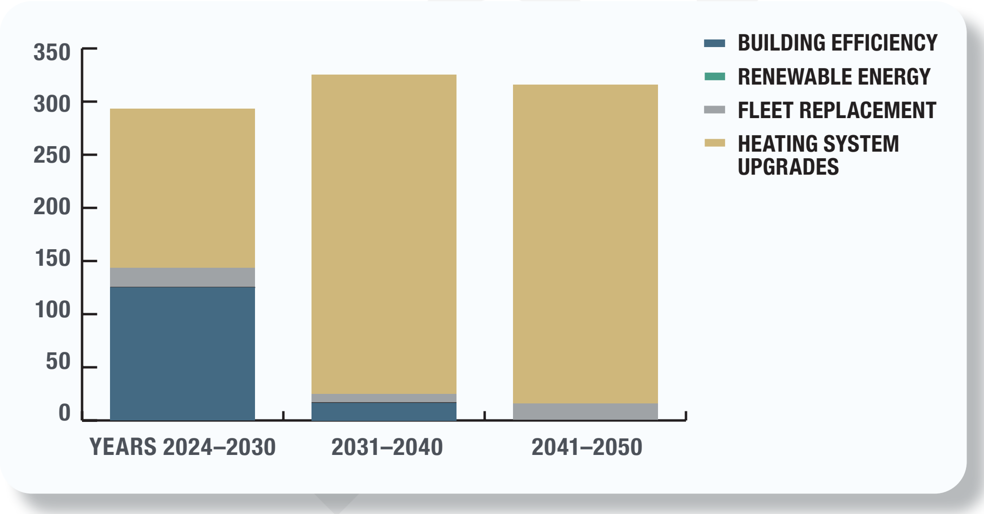


FIGURE 4: Total Investment by Decade (Million USD)



Often a net present value (NPV) is used to provide comparative evaluations of projects. NPVs include investment costs, ongoing operational and maintenance costs, but also cost savings benefits from many of the projects. Other benefits can be estimated by placing a value on the future carbon savings; this is called the social cost of carbon, and has been included in the evaluation to reflect this long-term benefit. Table 5 shows the NPVs of the strategies by decade.[17]

TABLE 5: Implementation timeline and net present value by strategy in millions of dollars

STRATEGY / DECADE	PROJECTS INITIATED IN YEARS 2024–2030	PROJECTS INITIATED IN YEARS 2031–2040	PROJECTS INITIATED IN YEARS 2041–2050
Building Efficiency	64.8	-8.7	No projects
Renewable Energy	0.7	No projects	No projects
Fleet Replacement	-15.7	-5.8	-11.7
Heating System Upgrades	-168.2	-241.9	-166.3

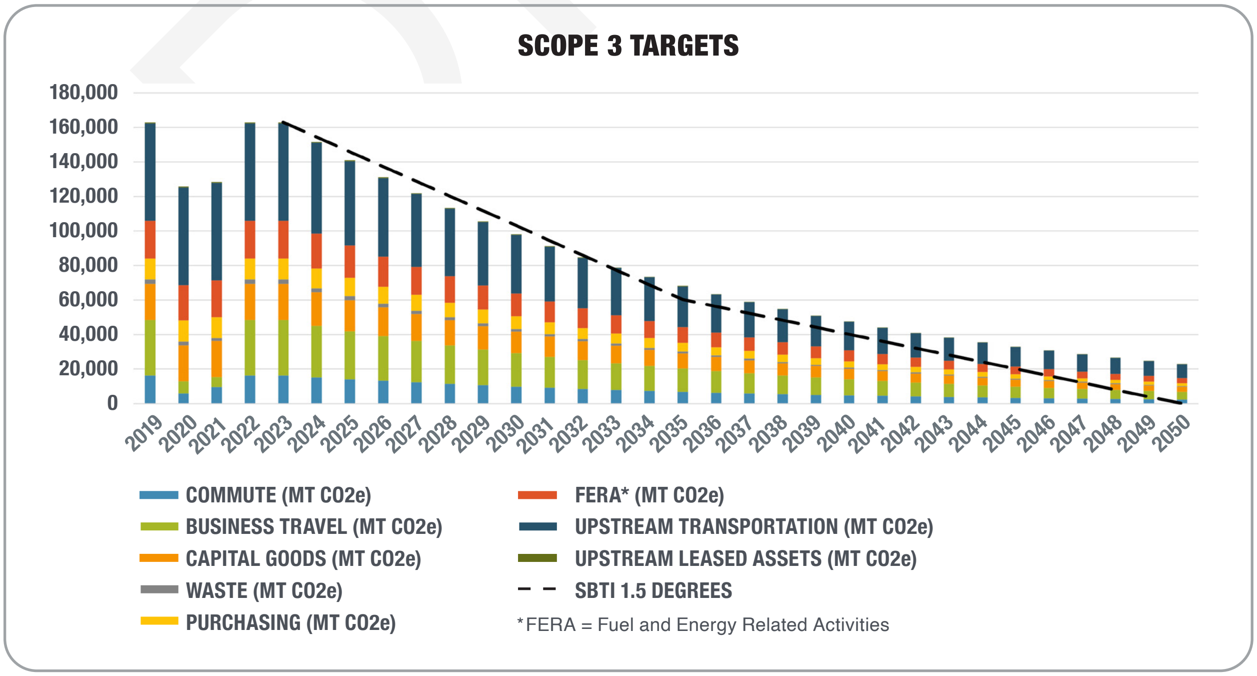
[17] Negative NPVs are often typical of a public institution, which seeks to deliver services and not a return on investment. NPVs compare costs to benefits, and many of the benefits delivered by public bodies are difficult to quantify and therefore absent from the numerical calculations. As a result, NPVs are often used as comparative indicators to differentiate the value of competing projects.

Reducing Scope 3 Emissions

Scope 3 emissions, which are sometimes called value-chain emissions, are produced through the upstream and downstream activities of CU Boulder's operations. While they are "owned" by others (generally, they are others' Scopes 1 and 2 emissions), CU can influence Scope 3 by establishing policies and programs that address the supply chain (e.g., food, building materials, services, or purchased goods), and foster lower impact transportation options (commuting and CU Boulder-related air travel).

For this CAP, strategies for reducing Scope 3 emissions are described at a high level, and are more directional than specific. Additional benchmarking and engagement with the owners of the emissions are required to develop more detailed strategies. However, a consistent annual aim of 7% GHG reductions in each category would closely mirror CU Boulder's goals. The following scenario shows plausible annual percentage-based reductions on the way toward the University's short term and long term goals.

FIGURE 5: Selected Scope 3 Categories and Targets



Co-Benefits

In this Climate Action Plan, "co-benefits" refer to positive outcomes that arise alongside efforts to reduce emissions. Co-benefits are expected from strategies in this plan, and some can be associated with particular strategies. While there are many reasons to take climate action, the CAP focuses especially on the co-benefits of equity, health, and campus resilience outcomes.

Equity: Implementing climate action measures at CU Boulder addresses not only the pressing environmental challenges, but can also serve as a catalyst for promoting equity within the university community. Climate action initiatives offer several equity co-benefits across key sectors. Recognizing the disproportionate effects of climate change on some communities, this CAP seeks to promote equity through the selected strategies. For example, transportation and mobility improvements can provide heightened access to underserved students; residential housing efficiency and electrification improve on-campus living space; and improving electricity resiliency with solar photovoltaic (PV) strengthens reliability for on-campus residents. With effort, initiatives can include members of the CU Boulder community that may otherwise be excluded from participation and the associated benefits. Our process has begun to seek out those voices to increase participation and feedback.

Health: Central to the CAP is a reduction in the use of combustible fuels. This will produce benefits in air quality, from reduced particulate matter, nitrogen oxides (NOx) emissions, and smog formation. Furthermore, the production and refining of fossil fuels causes direct impact to Colorado communities who have been historically and currently burdened by these operations. While the conversion from a diesel to an electric bus might have limited overall GHG emissions benefits, the impact to air quality, water quality, and noise are significant, and therefore this measure remains a high priority in the CAP.

Resilience: Many of the strategies will improve campus climate resilience, while also reducing emissions. However, many aspects of resiliency will require further investigation. Building efficiency will reduce loads on the electrical system, increase comfort in a warming environment, and provide improved operability and controllability. The conversion of fleet and building operations to electricity insulates the campus from the volatility of fossil fuel markets and can reduce certain operating costs. On the other hand, the central plant has the capability to provide gas-fired electricity to power the campus through a grid outage. It also plays an important role for the local utility in keeping high-emitting peaking plants off line. It is therefore critical that campus resilience and climate goals are considered in tandem.

There are other co-benefits as well. Several of the strategies will save the campus money, when compared to a baseline. These include many of the energy efficiency projects that have been recommended. Additionally, the campus' reputation as an environmentally conscious university will be accelerated through sustainability successes. As an example, CU Boulder currently enjoys Gold Status in the STARS Certification program, but many initiatives will help it reach Platinum Status, which is the highest level, and a significant achievement. Still more benefits, such as research opportunities and educational possibilities have not been tracked in the CAP.

TABLE 6: Co-Benefit Summary

CO-BENEFIT	SYMBOL
Promotes / Strengthens Climate Equity and Justice	
Increases Campus Resilience (infrastructure, operations, programs, people) to Climate Events	
Improves Community Health	
Augments STARS Rating	
Saves money against a baseline	

Implementation: Governance, Communication and Finance

Each strategy within this CAP is prioritized into three Tiers: Foundational (Tier 1), Supportive (Tier 2) and Complementary (Tier 3). Foundational strategies are those that directly reduce emissions and are drawn out as immediate priorities. Supportive strategies are ranked next and indicate strategies that have less of a direct GHG reduction potential but are still critical elements in reducing climate impacts. Complementary strategies are focused on educational and engagement areas that create durability and wider-reaching impact.

The implementation and progress of CAP will be overseen by the Sustainability Council, which will be appointed by the Chancellor and composed of staff, faculty, and students. The day to day implementation of the CAP will be driven by the department managers, subject matter experts, and campus leadership. The following strategies in the areas of governance, communication and finance have been developed to help ensure success over time:

1. **Governance:** Regular reporting of key metrics and progress to the Sustainability Council, which will offer formal reports to the Executive Sustainability Council and to the campus community three times per year. Specific outreach to campus governance groups will be undertaken to report progress, and/or course corrections needed.

2. **Engagement:** Successful implementation of the CAP will include an increasingly informed and engaged campus that understands how climate action is taking place and how they can participate and provide input and suggestions moving forward. The engagement goal for the CAP is to create regular communications and accessible points of connection with all parts of the campus community who wish to be engaged with this process.

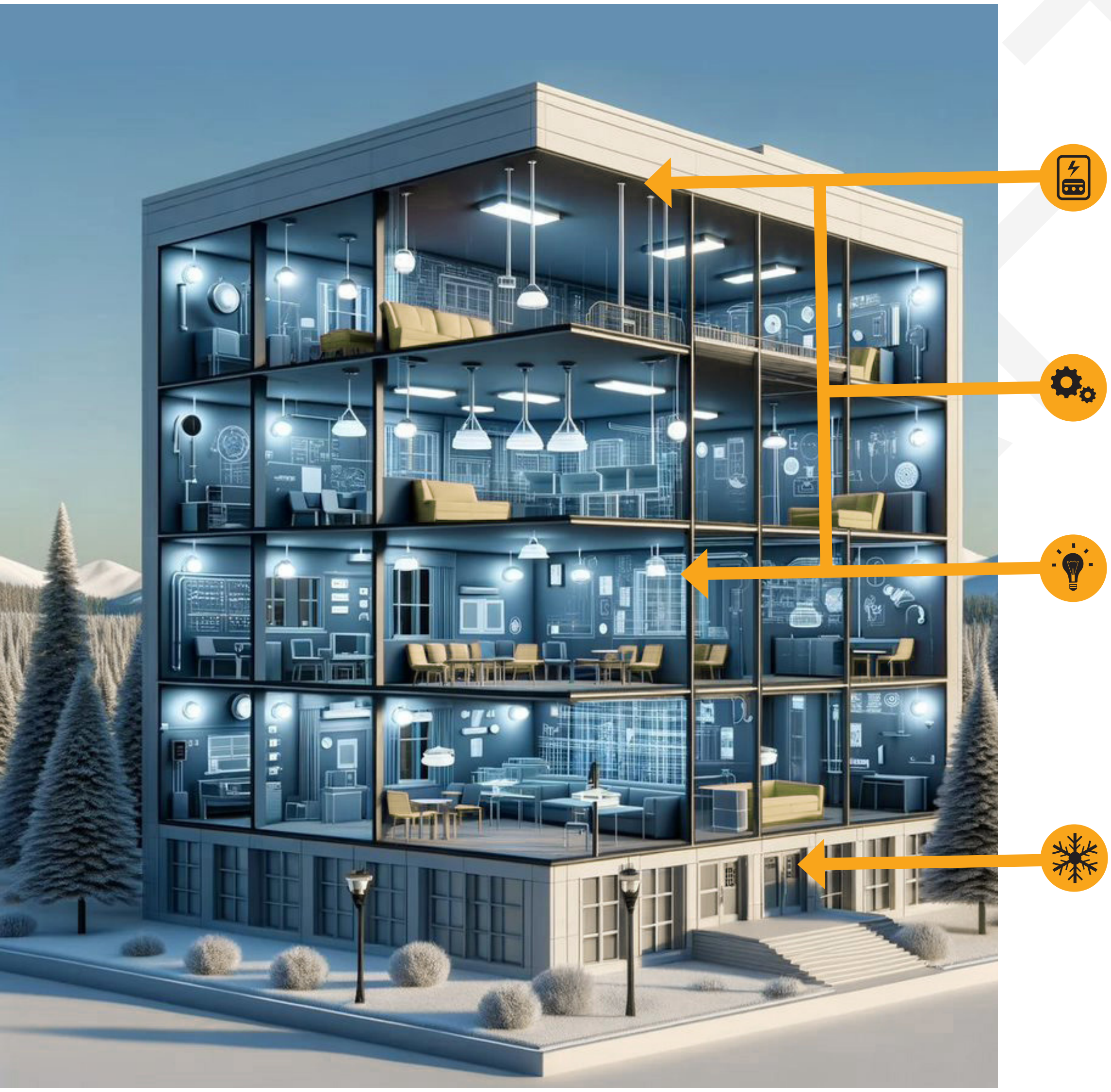
3. **Finance:** Developing cost effective and economically viable financing pathways that address both one-time and ongoing costs, and that achieve the maximum benefits has been a key consideration of this CAP. Financing a CAP requires a variety of strategies and sources of funds, including internal funds, grants from government and other organizations, debt and possibly public-private partnerships (PPP). The 2022 Inflation Reduction Act (IRA) has also provided an unprecedented source of funds that is available to public entities. All of these and other financing strategies will support CAP implementation. As a possible example of a capital expenditure plan, Table 6 outlines the planned investment totals required in the next ten years (2024-2034).

TABLE 7: 10-year estimated investment costs (in $ millions) associated with achieving Core Goal 1

YEAR	TOTAL ESTIMATE	LIGHTING	ENVELOPE	RCX	HVAC	FLEET & CHARGING	SOLAR	HSU
10-year Totals	$390	$34	$15	$4	$64	$23	$0	$250

Lighting = replacing lights and fixtures with high efficiency alternatives;
RCx = Building recommissioning: testing and optimizing system performance;
HVAC = heating, ventilation, and air conditioning;
HSU = Heating System Upgrades: replacing gas boilers with electric & transitioning central campus district energy system to a low-temp hot water system.

Building Projects



HVAC UPGRADES

Involves upgrading energy recovery, ventilation upgrades, HVAC Control Upgrades, piping and equipment insulation, temperature setbacks.

COMMISSIONING

Identifying and fixing building performance problems that have developed over time, optimizing systems, and ensuring energy efficiency goals are met.

LIGHTING UPGRADES

Involves: 1) replacing lamps and fixtures with energy efficient LED lighting, and 2) daylight controls and operating sensors

ENVELOPE UPGRADES

Includes weatherization and window upgrades.

Conclusion

Achieving climate goals and the associated benefits is considered vital to the University. It will require significant upfront investment, robust annual funding, and a re-evaluation of many of the business-as-usual modes of campus management. The projects and timelines throughout this report draw from Scenario 3, summarized above. Future investment decisions about all the projects associated with climate action activity are subject to currently unknown factors including available funding, emerging technologies, the findings of new studies, and the perspective of future stakeholders.

TABLE 8: Summary of All Strategies

TIER	SCOPE	SCOPE 3 CATEGORY	STRATEGIES	CO-BENEFITS
1	1+2	NA	Re-commissioning projects	Health, Resilience, STARS Platinum, Cost Savings
1	1+2	NA	HVAC system retrofits	Health, Resilience, STARS Platinum, Cost Savings
1	1+2	NA	Envelope improvements	Health, Resilience, STARS Platinum, Cost Savings
1	1+2	NA	New Building Efficiency Design Standards	Health, Resilience, STARS Platinum, Cost Savings
1	1	NA	Main campus heating system upgrade	Health, Resilience, STARS Platinum
1	2	NA	Lighting retrofits	Health, Resilience, STARS Platinum, Cost Savings
1	2	NA	On-campus solar PV	Health, Resilience, STARS Platinum, Cost Savings
1	3	2	Update building materials standards for new construction and major renovations	Health, Resilience, STARS Platinum
1	3	7	Institute a Transportation Demand Management Plan encouraging mode shifting	Equity, Health, Resilience, STARS Platinum
1	3	7	Develop an affordable community EV Charging plan	Equity, Health, Resilience, STARS Platinum
1	1	NA	Electrify campus vehicle fleet	Health
2	3	1	Identify opportunities to assess & implement carbon reduction with suppliers	STARS Platinum
2	3	2	Reduce embodied carbon by >10% and target 20% for new construction and major renovation projects; align with Buy Clean CO	STARS Platinum
2	3	5	Institute a construction waste diversion policy	STARS Platinum
2	3	6	Facilitate discussion on options to reduce business travel emissions	STARS Platinum
2	3	6	Incentivize use of airlines that promote sustainable fuel use, but not purchased carbon offsets	STARS Platinum
2	3	7	Develop a community shared EV program	Equity, STARS Platinum
2	1+2	NA	Optimize Existing Building Space	Equity, STARS Platinum, Cost Savings
2	3	3	Reduce upstream gas leakage (will result from decreased gas use)	STARS Platinum
3	3	1	Establish a food recovery program on campus for all catering and culinary events	Equity, STARS Platinum
3	3	1	Increase percentage of locally-grown foods purchased and plant-based meals served	Equity, Health, Resilience, STARS Platinum
3	3	5	Eliminate purchase of disposable or single-use plastics for nonessential uses	STARS Platinum
3	3	5	Establish a campus reuse center (clothes, furniture, etc.), and online reuse platform	Equity
3	3	5	Write a Zero Waste plan to address construction and demolition, and strategies around compostables and food recovery efforts	STARS Platinum
3	3	5	Translate the results of a pre- and post-waste audit into an actionable waste diversion roadmap with expected annual reporting metrics	STARS Platinum
3	3	7	Host engagement sessions with the campus community to determine best incentives for the use of electric vehicles and e-bikes. Consider distributing e-bikes to low-income students/staff through a sponsorship program.	Equity
3	3	7	Improve the VMT estimation process to ensure accuracy and replicability of the VMT number annually for sustainability reporting and program analysis	
3	3	7	Expand staff vanpools to make them available to more low-income staff	
3	3	9	Initiate surveys to measure student travel during breaks and family visit air travel	
3	3	9	Educate students and parents on emissions from air travel	
3	3	9	Explore options, along with CU system partners, to reduce travel related emissions during holiday breaks	

CO-BENEFITS KEY

- EQUITY
- HEALTH
- RESILIENCE
- STARS PLATINUM
- COST SAVINGS

1. INTRODUCTION

Background

The University of Colorado's Boulder campus has long been a leader in pursuing climate action. With the signing of the "American College & Universities Presidents Climate Commitment" (ACUPCC) in 2007, CU Boulder began assembling a formal vision and structure for sustainability governance, one that prioritizes reducing greenhouse gas emissions to net zero as soon as possible. The campus began benchmarking progress using the Sustainability Tracking Assessment and Reporting System (STARS), the de facto national standard for sustainability reporting. In 2009, per the requirements of CU's commitment to the ACUPCC, the campus published the "Conceptual Plan for Carbon Neutrality" (CPCN) which serves as an underlying framework for this 2024 Climate Action Plan (CAP). The 2009 CPCN was compiled by CU staff, faculty and students, reviewed and approved by NREL, and then approved by the CU Board of Regents who directed CU to implement it and report on implementation progress every three years. There was a 2014 Progress Report submitted to the Board of Regents.

CU Boulder is part of a university system in a state that has also been a climate leader. In 2004, Colorado residents were the first in the country to put a renewable energy standard on the ballot. Amendment 37, approved by voters, required state utilities to provide 10% of their electricity from renewable sources by 2010. That standard was doubled and then tripled. By 2019, Colorado established itself as a national climate leader by becoming the first state in the U.S. to put into statute both short- and long-term goals for cutting climate pollution. The state set targets to reduce greenhouse gas (GHG) emissions (from 2005 levels) by at least 26% by 2025, 50% by 2030, and 90% by 2050. Following the enactment of this statute, the state strengthened its 2050 target by further committing to achieve net-zero GHG emissions by 2050. To support these targets, the state has established five year performance metrics to ensure ongoing progress. CU Boulder is using the State of Colorado's guidance to adopt similar reduction goals.

The 2024 CAP is written in response to the 2020 “Call to Climate Action'' issued by Philip DiStefano, the University’s Chancellor. This “Call to Climate Action” directly re-commits the campus to reach carbon neutrality by no later than 2050, determine what’s required to achieve a Platinum STARS rating, advance campus as a living-learning laboratory for innovations in sustainability, and create a framework to hold the campus accountable to these commitments. CU Boulder has also joined global and national alliances committed to reducing emissions, including the Second Nature’s Climate Leadership Network and the International Sustainable Campus Network, and the American College & University Presidents' Climate Commitment. The latter is a pledge by over 700 colleges and universities to achieve carbon neutrality by 2050 or sooner.

These commitments, and the specific actions that follow, are based on the recognition of the following guidance, acknowledged by the CAP Steering Committee:

- Given the pressing nature of the climate crisis, there is a growing recognition of the moral imperative for all sectors of society, including higher education, to reduce their environmental impact and foster sustainability.
- As educational and research institutions, universities have a responsibility to lead by example. By setting emission targets, they demonstrate a commitment to tackling climate change and environmental stewardship.
- Having concrete emission targets helps to integrate sustainability into the curriculum and campus operations, providing a living laboratory for students to learn about and engage with sustainability practices. Further, by pursuing aggressive emissions targets, they can drive advancements in sustainable technologies and practices, potentially contributing solutions that can be adopted by other sectors.
- Many prospective students and employees are attracted to institutions that demonstrate a commitment to sustainability; actions taken to meet sustainability goals can enhance a university's reputation and make it more competitive.
- Setting and working towards emissions targets can help universities anticipate and adapt to the physical and regulatory risks associated with climate change and future legislation on carbon emissions.
- Institutions that show leadership in sustainability often find it easier to establish partnerships with government bodies, NGOs, and the private sector, which can lead to new funding opportunities for research and development.

With these acknowledgments as a foundation, the CAP Steering Committee ratified the following **guiding aims** at the outset of this initiative:

1. Develop a GHG inventory inclusive of Scopes 1, 2, and 3, and a reduction strategy that could meet Science-Based Targets consistent with UN & Science-Based Target Initiative definitions
2. Ensure that community health, equity, and resilience are an important lens through which recommendations made in the CAP can be evaluated.
3. Focus on reducing emissions (a) target 50% reduction in Scopes 1 and 2 by 2030 against 2019 baseline, (b) a similar 50% reduction in measurable subset of Scope 3 emissions by 2030, and (c) a clear path to a zero emissions target for all categories by no later than 2050.
4. Meet Scope 1 and 2 goals without the use of unbundled RECs or offsets.[18]
5. The University is a customer of Colorado's largest investor-owned utility, Xcel Energy. Given that Xcel's goal is to achieve 80% to 85% clean energy (from 2005 baseline) by 2030,[19] part of the goal will be to evaluate and implement electrification strategies that fully take advantage of this transition and include consideration of on- and off-site renewable electricity generation and the time of use impact of use and generation.
6. Find cost-effective and economically attractive pathways that address both one-time and ongoing costs, and that achieve the maximum benefits (including health, equity, resilience, life cycle, and local economic development) for the campus and its stakeholders in realizing its goals.

SET TARGETS

The targets set forth in this CAP are ambitious, but are based on a confidence that these goals are technically and economically viable. They build from of a series of past activities and current efforts including:

- **Bus and fleet electrification**
- **A preliminary study of options for heating system decarbonization**
- **Investigation into additional onsite solar options**
- **Development of an 5.9MW offsite solar array as part of the state's new Virtual Net Metering Program (VNEM)**
- **Renovation of buildings to be compatible with a future low temperature hot water system (e.g. Hellems)**
- **Design of RES1 to be combustion free and low temperature compatible**
- **The funding of energy efficiency projects in 18 buildings.**
- **Started phase 1 of the steam to low temperature hot water conversion for the Williams Village campus**
- **Pursinging two grant applications through the Colorado Energy Office to investigate viability of geothermal on CU Boulder campus**

[18] See Footnote 6.

[19] See Xcel Energy: Clean Energy Plan at: https://www.xcelenergy.com/company/rates_and_regulations/resource_plans/clean_energy_plan.

Core Goals and Guiding Principles

The CAP is organized around five Core Goals, based on the background and motivation stated above:

1. **Achieve 50% reduction in Scope 1 and 2 emissions by 2030,** from the baseline year of 2019, **with a linear reduction to zero emissions no later than 2050.** Do so **without the use of purchased offsets or unbundled RECs.**

2. **Achieve a 50% reduction of Scope 3 emissions by 2030** from the current baseline where accurate estimates can be established and which are within the University's influence and control. **Further reduce these emissions to zero by 2050.** The CAP begins the process of developing a Scope 3 inventory and then developing the strategies to achieve reductions in indirect emissions. It is anticipated that the quality of the inventory and the robustness of the reduction strategies will increase over time now that inclusion of Scope 3 emissions in the CAP is established.

3. Utilize climate action to **deliver to the CU Boulder community the co-benefits of health, equity, and resilience.** As the opportunity to connect climate action to other co-benefits becomes increasingly apparent, we anticipate additional strategies to be included in subsequent CAPs to do so.

4. Strengthen internal and external **management and accountability structures** to ensure the campus achieves the goals outlined in the plan. An implementation plan that includes governance solutions and accountability structures is included in this CAP.

5. Build a **Community Engagement Strategy** to integrate communication, feedback, and reporting and achieve an increasing level of transparency with campus and the Boulder community. The implementation plan also includes communication, engagement, and reporting mechanisms, in support of campus operations and emission reduction strategies.

6. Maintain an affordable education, in the face of the campus' competing investment needs.

Approach

The update of the campus CAP began, in part, with the formation of a CAP Steering Committee composed of faculty, staff and students[20] which has subsequently guided the strategy development process outlined in this plan. The Steering Committee oversaw all steps in contracting with Blue Strike consultants to support the creation of this CAP. Moving forward, the Sustainability Council will be charged with monitoring the implementation of the CAP and informing the Executive Sustainability Council of progress and recommending revised actions as needed.

Within the CAP Steering Committee, an Equity Subcommittee was formed to ensure equity and social justice were incorporated into the analysis. This subcommittee has authored the Equity Section found in Chapter 5. For climate action strategies specifically, this subcommittee reflected on campus Diversity, Equity, and Inclusion goals as well as requirements for recognitional, distributional, procedural, and structural justice, to provide prioritized strategies with strong equity co-benefits (see call out boxes throughout the plan), and guidelines for implementing the CAP in an equitable fashion (see Chapter 5). More broadly, the goals of the equity subcommittee for this CAP included raising awareness around the intersection of climate change and social justice; supporting the creation of economic opportunities for marginalized[21] and frontline communities[22] around climate action strategies; and promoting diversity, equity, and inclusion in all climate action efforts including CAP decision-making.

1. The first step was to perform an inventory of CU Boulder's current level of greenhouse gas (GHG) emissions, including Scopes 1, 2, and 3 sources. The inventory was performed using 2019 data, and established a baseline, against which to measure candidate carbon reduction strategies.

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[20] https://www.colorado.edu/sustainability/programs/climate-action-plan.

[21] Marginalized includes, but is not limited to people with disabilities, low-income, disabled, LGBTQIA+ communities, Black, Indigenous, and People of Color, including Asian and Asian Americans, Native Hawaiian and Pacific Islanders, multiracial individuals, and Hispanic and Latinos , and other communities that may be disproportionately impacted and/or historically excluded.

[22] Frontline communities refer to those who experience environmental and climate costs (or hazards or problems) first and worst, and lack access to environmental benefits, who tend to be marginalized by systems of oppression.

2. The second step was to develop a series of strategies that have the ability to reduce emissions over time.

3. The third step was to prioritize all the strategies into an executable timeline that would be able to consistently achieve the SBT goal between 2030 and 2050, and to clearly identify the bundle of strategies needed to achieve these goals. In some cases, certain strategies were prioritized because of the co-benefits they included (e.g. bus electrification) – such as equity, community health, or resilience – in addition to their GHG emissions impact.

4. The fourth step was to perform a benefits-cost analysis to estimate the first costs of implementation and the life-cycle impacts of operational costs. To integrate externalities associated with Climate Change, a "Social Cost of Carbon" was included to show how a given measure's net present value would change as a result.[23]

5. The fifth and final step was to develop an implementation plan for the recommended steps. This step included developing governance and communication structures to ensure CAP success. One such communication piece is the CAP Dashboard, an online tracking tool that monitors the progress that has been made.

[23] The social cost of carbon is an estimate of the economic damages associated with a small increase in carbon dioxide emissions, conventionally one metric ton, in a given year. This metric is intended to provide a comprehensive measure of the value of the impacts of climate change, including, but not limited to, changes in net agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning.

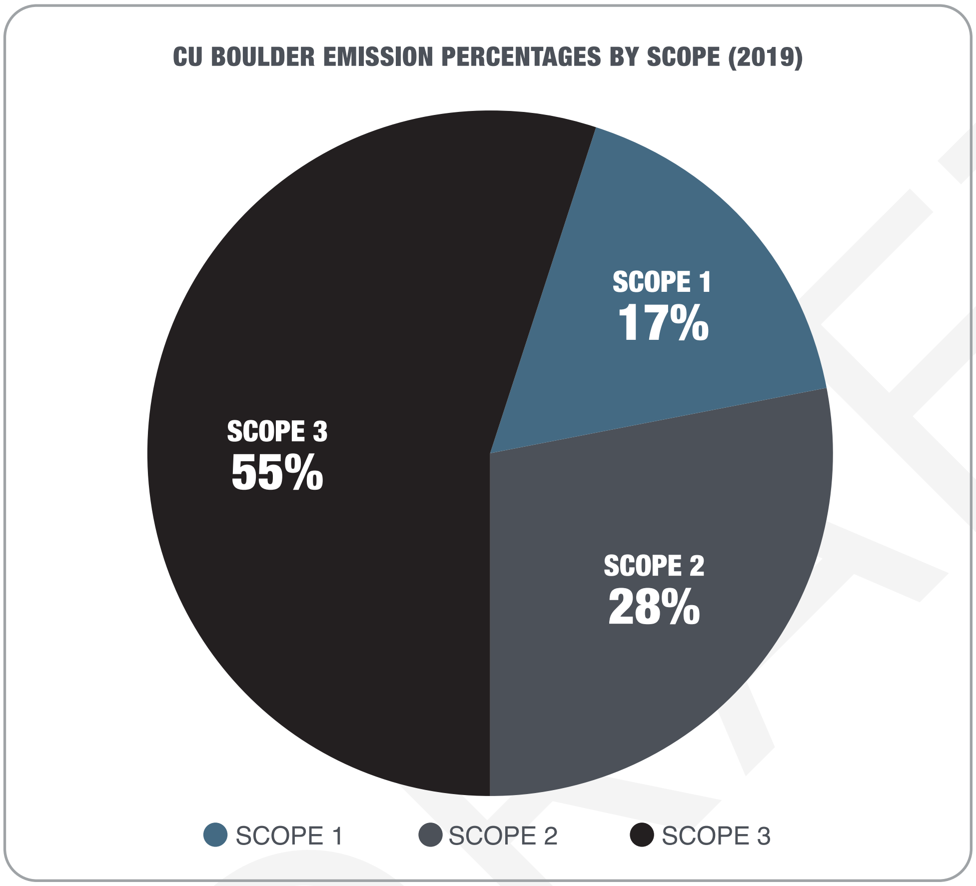
2. BASELINE, FORECASTS & TARGETS

As noted, the first step in the planning process was to undertake a GHG inventory. For the purpose of carbon accounting, emissions can be divided into three areas known as Scope 1, Scope 2, and Scope 3. Emissions from Scopes 1 and 2 can be calculated using energy consumption data, while Scope 3 emissions generally require activity data to estimate a GHG impact, Figure C shows the breakdown of emissions, by percentage, for each Scope. This CAP represents the first time that CU Boulder has included Scope 3 emissions in their GHG inventory.

TABLE 9: Working definition of three emission Scopes

SCOPE 1	Carbon emissions resulting directly from fuel combustion on campus, primarily natural gas for heating or CU Boulder-owned vehicles.
SCOPE 2	Carbon emissions associated with energy purchased by CU Boulder and generated elsewhere, primarily grid electricity used on campus.
SCOPE 3	Carbon emissions resulting indirectly from CU Boulder operations, either from upstream activities, such as purchases of goods and services, or downstream activities, such as students and faculty commuting to and from campus. The University does not have direct control over these emissions, though it can exert influence over its operations, procurement and other activities to reduce these emissions.

FIGURE 6: Breakdown of CU emissions by Scope.[24]



[24] For Scope 3 inclusions and rationale, see Appendix D.

Inventory

SCOPES 1 AND 2:

Total Scope 1 and 2 2019 baseline emissions for CU Boulder was 130,593 MTCO2e.[25] The year 2019 was used as the baseline for the analysis due to incomplete data for 2022, and to avoid the effects of COVID-19 experienced in 2020 and 2021.

The analysis began with an inventory of historical and current emissions from Scopes 1 and 2. The inventory was conducted in an Excel-based model called the Climate and Energy Scenario Analysis tool (CESA).[26] CESA's inputs are the "drivers" of emissions, including on campus fuel use for heating and vehicle fleet and purchased electricity. Within the tool, drivers are assessed an emission factor, which is a scientifically measured quantity of CO2e[27] per unit of energy source (e.g., therms of natural gas, kWh of electricity, or gallons of gasoline or diesel), or proxy data (e.g. tons of fertilizer used, tons of waste sent to the landfill, etc.). Figure 7 shows a detailed breakdown in emissions sources from Scopes 1 and 2. The vast majority of CU Boulder's Scope 1 and 2 baseline emissions – about 60% -- are from purchased electricity (Scope 2). An additional 38% is from natural gas use on campus. The remainder is from fleet fuels, fertilizer use, and leaked refrigerants, which together account for about 2% of campus emissions.

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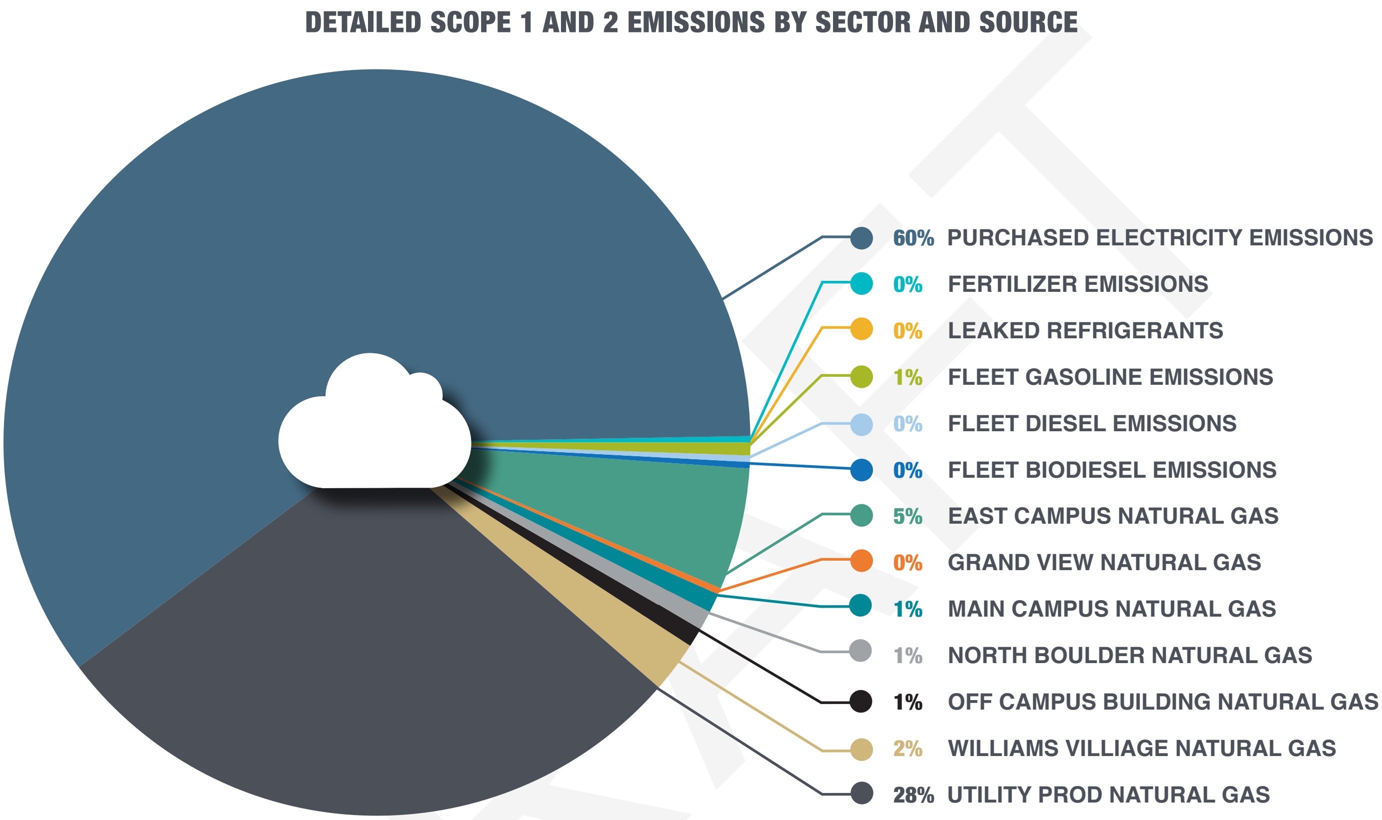
25 This figure deviates slightly from emission totals submitted to STARS in the same year. The reason is slight differences in use data and emission factors.

26 CESA is a proprietary, techno-economic model that helps decision-makers understand the financial, environmental, and energy impacts of a suite of climate and energy mitigation measures.

27 A CO2 equivalent is a measure used to compare the emissions from various greenhouse gasses on the basis of their global warming potential (GWP). It allows for the expression of emissions and reductions of different gasses in a common CO2 unit. For instance, if a gas is 25 times more effective than CO2 at trapping heat in the atmosphere, then one metric ton of that gas would be equivalent to 25 metric tons of CO2, hence its CO2 equivalent (CO2e) would be 25. This concept provides a unified framework to account for different gasses in terms of their impact on global warming.

FIGURE 7: Scope 1 and 2 Emissions Breakdown



SCOPES 3 EMISSIONS:

Scope 3 consists of 15 distinct categories of emissions as defined by the GHG Protocol. Seven of the categories have been included in this first Scope 3 inventory, some using significant assumptions given the lack of available data, and seven of the categories have reduction targets. These seven categories were selected following guidance from the Science Based Targets Initiative (SBTi): *"The nature of a Scope 3 target will vary depending on the emissions source category concerned, the influence a company has over its value chain partners and the quality of data available from those partners."*[28] These two conditions were used as criteria for whether to include the category in: a) the inventory, and b) the target.[29]

The one category that was estimated and included in the baseline inventory, but excluded from the targets is category 9, which considers out of state travel for those who are "consuming" CU Boulder's services (i.e. students flying to and from campus). This exclusion is due to the need for better underlying data and the limited sphere of influence the campus has on how and when people come and go from campus, per the SBTi guidance.

The seven categories that include targets together represent about 67%, or approximately two thirds, of the calculated Scope 3 emissions. These targets reflect a 50% reduction by 2030 and a 7% annual reduction through 2050.

Regarding the remainder of the categories, categories 10-14 were considered not applicable given CU Boulder's operations, since the University doesn't sell products, hold franchises or hold downstream leased assets.

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[28] SBTi has been leading the way in developing guidance for institutions in setting reduction targets for Scope 3 emissions. SBTi is a partnership between the Carbon Disclosure Project (CDP), the United Nations Global Compact, the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF). SBTi encourages companies and institutions to set targets for reducing greenhouse gas emissions in line with the latest climate science.

[29] Importantly, the University is not seeking to establish a science-based target at this time, nor is it seeking conformance with the GHG Protocol Scope 3 Standard. Neither are we seeking validation from SBTi on our inventory or target setting process. We have, however, sought guidance from the GHG Protocols and the Science Based Targets initiative (SBTi) to instruct our inventory and target setting process. This CAP is a "living document" in the sense that it will be updated regularly with more refined data, accurate forecasts, and mitigation steps. This is the first time CU Boulder has attempted a Scope 3 inventory, time will allow future iterations to be more comprehensive. Please see Appendix D for additional information.

Per the GHG Protocol, Category 15 *"includes Scope 3 emissions associated with the reporting company's investments in the reporting year, not already included in Scope 1 or Scope 2. This category is applicable to investors (i.e., companies that make an investment with the objective of making a profit) and companies that provide financial services. Investments are categorized as a downstream Scope 3 category because the provision of capital or financing is a service provided by the reporting company."*

Investments for CU take place at the university system level (not the Campus level) and are therefore not within the authority or scope of the CU Boulder Campus CAP. The CAP provides a very rough indicative estimate of what the emissions impact of these investments might be in the Scope 3 Annex, but does not include that figure in the formal baseline or in the reduction target setting.

The table below summarizes the emissions associated with each category.

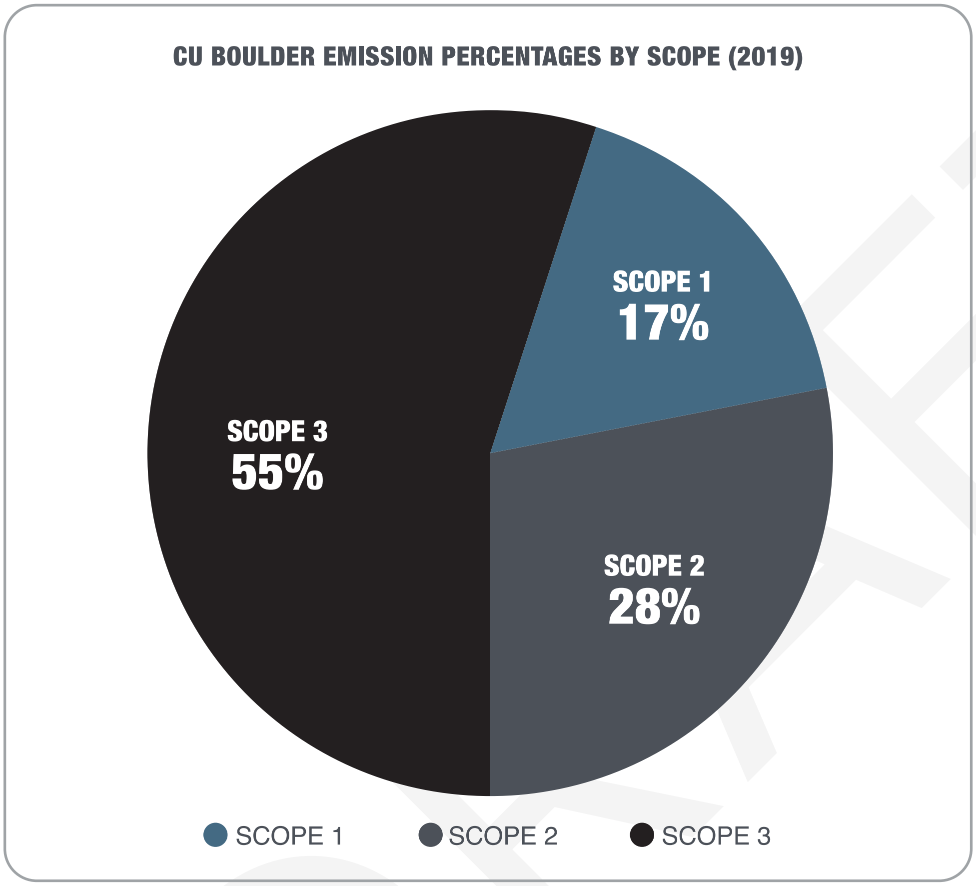
TABLE 10: Summary of Scope 3 Categories and Target

#	CATEGORY	INVENTORY	TARGET SET
1	Purchased goods and services	Y	✔
2	Capital goods	Y	✔
3	Fuel and energy related activities (FERA)	Y	✔
4	Upstream transportation and distribution	Included in Category 1[12]	
5	Waste generated in operations	Y	✔
6	Business travel	Y	✔
7	Commuting	Y	✔
8	Upstream leased assets	Y	✔
9	Downstream transportation and distribution	Y	
10	Processing of sold products	N/A	
11	Use of goods and services sold	N/A	
12	End-of-life treatment of sold products	N/A	
13	Downstream leased assets	N/A	
14	Franchises	N/A	
15	Investments	Out of CU Boulder direct Scope/Control. See Scope 3 Annex for an estimate.	

TABLE 11: Inventory of all Scope Emissions

CATEGORY	MTCO2e
SCOPE 1	**48,213**
Natural gas	45,097
Total Fleet	1,841
Fugitive Emissions, Fertilizer Usage, Refrigerant Leakage	1,275
SCOPE 2	**82,528**
Purchased electricity	82,528
SCOPE 3	**162,489**
Category 1: Purchasing	12,216
Category 2: Capital Goods	20,944
Category 3: Fuel and Energy Related Activities	21,782
Category 5: Waste Generated in operations	2,595
Category 6: Business Travel	32,041
Category 7: Employee and Student Commuting	16,407
Category 8: Upstream Leased Assets	532
Category 9: Downstream Transportation and Distribution	56,504

FIGURE 8: CU Boulder Emission Percentages by Scope



Scope 1 and 2 Forecasts

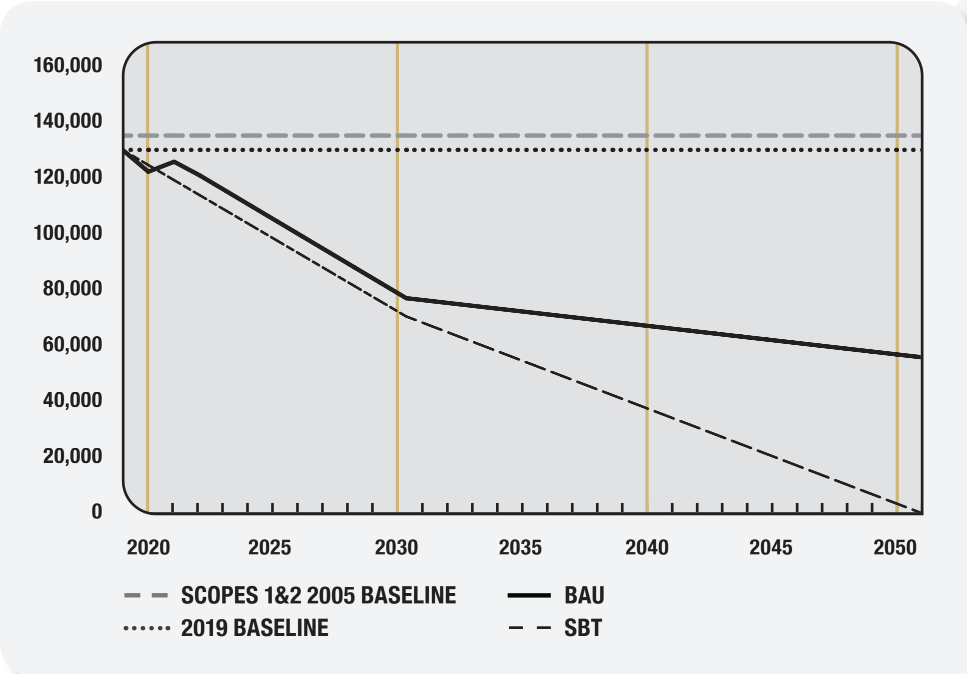
The emissions inventory provides a baseline from which to measure future reduction efforts. By contrast, a business-as-usual (BAU) emissions forecast provides a projection of the amount and sources of emissions CU Boulder would likely generate through 2050.The baseline and BAU serve as reference points for reduction targets, in addition to informing the strategy and selected actions. Under a business-as-usual scenario, which assumes that CU Boulder does not change its operations in any way, as shown by the black line in Figure D, Scope 1 and 2 emissions are projected to decrease by 74,664 metric tons (MT) by 2050, from a high in 2019 of 129,328 MT.

The reduction is based on the anticipated reduction in electricity grid emissions over time due to the retirement of coal plants and the increase of renewable energy. This trend is driven by the fundamental economics of low cost renewable energy, incentives from the IRA, and Colorado legislation requiring an 80% GHG emissions reduction by 2030, and 100% by 2050.[30] If these goals are achieved, Scope 2 emissions would be eliminated by 2050 and significantly reduced in the short term. However, Scope 1 emissions would persist, primarily due to use of natural gas by the campus central heating system and the buildings that are not connected to this system (e.g. Williams Village and East Campus).

[30] Colorado Senate Bill 19-236, Section 5.

Figure 9 also shows the SBT target line for Scopes 1 and 2, calculated for CU Boulder.

FIGURE 9: Baselines, BAU and Target for Scopes 1 and 2



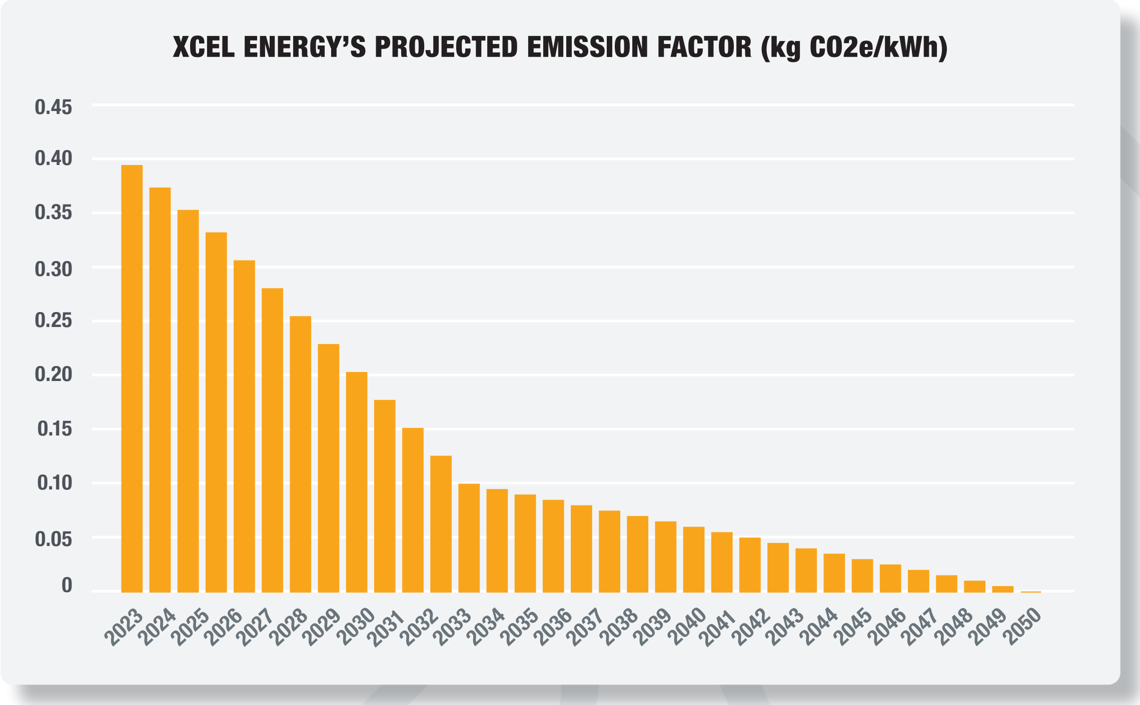
THE IMPORTANCE OF THE ELECTRIC UTILITY

The majority of CU Boulder's combined Scopes 1 and 2 emissions comes from purchased electricity. The emissions come from electricity generated by burning fossil fuels such as coal, natural gas, and oil at power plants. These plants release carbon dioxide (CO2) and other greenhouse gasses into the atmosphere during the combustion process. The electricity for Boulder, CO is supplied by a mix of renewable sources (like wind, solar, and hydroelectric power) and fossil fuels. By Colorado law, the energy mix is required to be converted to greater percentages of renewable sources, and gradually become 100% renewable by 2050. In November 2004, Colorado became the first state to legislate a legislated renewable portfolio standard by popular vote (see SB 19-236). This standard, now updated, requires the utility to secure 80% of its energy from carbon-free sources by 2030, and 100% by 2050.[31]

Electricity emissions for CU Boulder are estimated through multiplying the electricity consumed by an emissions factor, which is the quantity of CO2 equivalent released into the atmosphere for every unit of electricity produced. Therefore, as the value of the emission factor falls, associated GHG emissions will also fall. This is a critical assumption in this CAP, since many of the GHG reduction strategies listed below rely on replacing equipment that currently runs on fossil fuels with alternatives that run on electricity. Figure 10 shows the expected trend of emission factor values between now and 2050 for Xcel Energy, CU Boulder's electricity provider, based on company reports.

[31] Colorado's legislative renewable portfolio standard was the first state-wide ballot initiative approved by voters as Amendment 37, in November 2004. This standard requires the utility that provides electricity to the Campus (Xcel Energy) to secure 100% of its electricity from carbon-free sources by 2050. See Colorado SB 19-236: **https://leg.colorado.gov/sites/default/files/documents/2019A/bills/2019a_236_enr.pdf.**

FIGURE 10: Anticipated reduction in emissions from Xcel Energy per kWh produced



3. REDUCING SCOPE 1 AND 2 EMISSIONS

CORE GOAL 1

Achieve 50% reduction in Scope 1 and 2 emissions by 2030, from the baseline year of 2019, with a linear reduction to zero emissions no later than 2050. Do so without the use of purchased offsets or unbundled RECs.

Goals in four primary areas have been established to reduce on campus emissions, on the way to achieving campus targets:

1. Buildings: Improve building performance through efficiency and electrification
2. Heating system upgrades: decarbonize the campus heating system[32] and electrify all other building heating and domestic hot water systems
3. Renewable Energy: Support Xcel's and the State's transition to a decarbonized electrical grid through the development of onsite and offsite solar projects
4. Transportation: Transition campus fleet to electric vehicles (Note: reducing campus community vehicle miles traveled (VMT) in commuting to campus and the use of electric vehicles among the CU Boulder community is addressed under Scope 3 emissions)

[32] The projects at the central utility plant (which also cover significant infrastructure and upgrades at over 100 buildings) are part of an outside study that will not be completed in time for detailed inclusion in this CAP - it is due in 2024. Instead, estimates of carbon reduction quantities, implementation timeline and rough order of magnitude costs have been included in this analysis to show estimated timeline, costs, and benefits of GHG reductions.

Action Categories

BUILDINGS

Buildings are responsible for approximately 39% of global energy-related carbon dioxide emissions. Of this, about 28% comes from operational emissions, which include heating, cooling, lighting, and the use of appliances, and the remaining 11% came from embodied emissions associated with the construction and materials of buildings (see Scope 3). As a result, improvements in building efficiency and building electrification is one of the most cost-effective ways to reduce emissions, and a critical component of global strategies to combat climate change.

The campus will work towards upgrading existing buildings by implementing the CU Boulder Energy Master Plan. This includes lighting retrofits, envelope efficiency projects, retro-commissioning, and HVAC system upgrades. For decentralized buildings outside of the main campus district loop, such as East Campus, electrification of heating systems via heat pumps will be a key strategy. Optimizing space utilization can prevent energy from being wasted on empty classrooms and offices. Finally, updating new building standards will ensure that additional campus growth as described in the Campus Master Plan will have a reduced climate impact.

CO-BENEFITS

The built environment includes buildings where classes take place, where administrative offices are located, where events are held, and where students and families live. Building efficiency and electrification upgrades will support campus resilience to future climate impacts and improve overall indoor air quality and building comfort, by requiring less overall energy and reducing thermal energy sources. It has the potential to reduce energy burden (high percentage of household income going to utility bills) in housing.

Co-benefit opportunities: There is also a strong link between housing access, density, affordability, and transportation emissions. To increase the equity co-benefits related to buildings, future climate action should consider creating affordable housing access close to campus to support a higher percentage of the student body and employees who wish to live affordably and with the ability to bike, walk, and take transit for the majority of their needs. The climate action plan therefore recommends the continued development of dense, affordable, transit-oriented housing as a key emissions reduction strategy.

ANALYSIS

Building efficiency projects fall into the following categories: lighting retrofits, envelope improvements, re-commissioning, and HVAC system retrofits. Special attention was paid to laboratories, which represent 40% of the campus energy use and present special challenges. Examples of strategies include the addition of heat recovery ventilation systems, upgraded distribution or ventilation and heating and cooling, etc.

The following table illustrates the implementation timeline, first costs, first cost per building area, the life cycle cost including the social cost of carbon (SCC), measured in net present value (NPV), the GHG reduction potential, percent of emissions, and the cost per metric ton of GHG reduced (in CO2e). These measures represent the majority, but not the entirety of the measures listed in the Energy Master Plan (EMP), and the implementation and the CAP recommends the continued evaluation and implementation of all measures within the EMP.

The table below also includes an indication of the co-benefits associated with each strategy; namely, does a given strategy lead to co-benefits of equity, health resilience, an improved STARS rating or cost savings? While co-benefits are expected, it should not be assumed that they will be achieved without some effort and careful planning during strategy implementation. A full discussion of co-benefits is offered in Chapter 5.

TABLE 12: Key performance metrics of selected strategies

STRATEGY	IMPLEMENTATION TIMELINE	COST ($M)	COST/SF ($/SF)[33]	NPV ($M), INCL SCC	GHG REDUCTION (MTCO2e)	% OF 2050 EMISSIONS[34]	$/MT REDUCED[35]	CO-BENEFITS
Lighting retrofits	2024–2030	55.6	6.37	31.0	75,720	8.2%	$516	
Envelope improvements	2024–2040	23.7	2.72	-8.5	43,465	4.5%	$546	
Re-commissioning projects	2024–2030	3.6	0.41	31.9	132,551	5.5%	$130	
HVAC system retrofits	2024–2030	58.7	6.73	41.2	239,533	16.6%	$309	

[33] CU Boulder's square footage is assumed to be 11,239,756 Outside Gross Square Feet

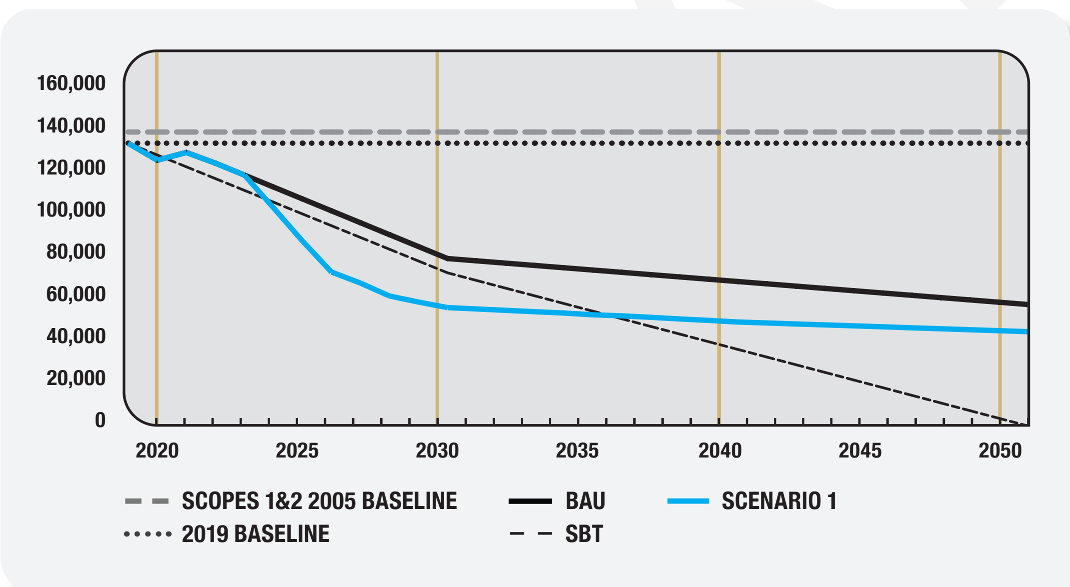
[34] Uses annual emissions for both the numerator (the strategy) and the denominator (baseline emissions)

[35] NPV (without SCC)/MTCO2e. This calculation allows for the project benefits, such as energy savings, to be counted. A positive number means a net return to the campus

To evaluate the impact of these building energy system upgrades, three scenarios were developed: the first, represented by the blue line in Figure G represents an evenly distributed investment approach in building efficiency, with an annual spend of approximately $9 million between now and 2040. Total cost is estimated at $104 million. The second and third scenarios, represented by the red and olive lines, accelerate the pace of investment.

Building efficiency projects are projected to achieve CU Boulder's 2030 Scopes 1 and 2 emission targets on their own. However, without further reductions in campus natural gas consumption, the gains from building efficiency eventually level out, and by 2035 the campus will fall behind these targets.

FIGURE 11: GHG savings from building efficiencies compared to BAU and other benchmarks



OPTIMIZE EXISTING BUILDING SPACE UTILIZATION

To ensure that the campus utilizes the building resources it already has, the CAP recommends a campus-wide space optimization program, including labs, which are the highest energy users.

HEATING SYSTEM UPGRADES

CU Boulder has a centralized steam system that uses natural gas to provide heat to most buildings on main campus. This system can operate in cogeneration mode, producing both electricity and steam using combustion turbines, or only steam through gas-fired boilers. Buildings outside of main campus (i.e. Williams Village and East Campus) use gas fired boilers on a building by building basis.

Combined, the campus heating system contributes 18.8% to the total University's carbon footprint, a number that would increase over time in a do-nothing scenario, as utility electricity becomes cleaner over time. To decarbonize the heating system, CU Boulder will use a phased approach that will ultimately transition the main campus to a higher performance system that will likely use electricity via heat pumps as the primary fuel.

NEW BUILDINGS

In order to ensure that new buildings do not increase campus emissions, they should embrace the principles of Zero Carbon building design. These include:

- Buildings should either be independently all-electric using heat pumps, other zero carbon technology, or should connect to the central heating system, which will be slated for decarbonization over time
- Establish an embodied carbon reduction standard (see Scope 3), targeting a 10-20% reduction (to be reevaluated for increased stringency every three years based on the development of new materials) for each building project, by procuring low carbon materials. CU adheres to the State's Buy Clean Colorado program, which will support these reductions.
- Establish low carbon refrigeration standards that align with LEED v4 Enhanced Refrigerant Management credit. This would require the use of low GWP refrigerants and / or the reduced use of refrigerants in buildings. Doing so will align with the Kigali Amendment to the Montreal Protocol.[36]
- Require energy efficiency to exceed current IECC (IECC 2021)[37] or latest ASHRAE[38] standards by an additional 20%.
- Use these certifications as a guide for sustainable building on campus:
  - Maintain the current requirement of LEED Gold Plus (which requires a 45% improvement over ASHRAE 90.1-2010), with reach goals for LEED Platinum
  - Pilot ILFI Net Zero Carbon certification and consider adopting this as the default certification instead of LEED.
  - Pilot WELL Building standard or Fitwel certification to optimize health outcomes

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[36] United Nations. 2019. Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer. https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXVII-2-f&chapter=27&clang=_en

[37] International Energy Conservation Code. 2021. https://codes.iccsafe.org/content/IECC2021P1.

[38] American Society of Heating, Refrigerating and Air-Conditioning Engineers. 2021. https://www.ashrae.org.

This transition will include converting the steam generation systems to produce low-temperature hot water using heat pumps, which are more efficient and use electricity, not fossil fuel. To implement this project, approximately 5 miles of distribution pipes will also need to be replaced, along with updates to the building systems that can use hot water instead of steam. This will likely require complex arrangements of building closures and space use adjustments.

The project will provide greater efficiency, lower life-cycle costs and added resilience relative to a decentralized building electrification approach.

Currently, there is a study underway evaluating how to replace the heating system at these two plants. (Refer to the Technical Appendix C for additional information.) In order to align the CAP reduction targets, this transition will need to be completed by no later than 2050, with interim phases completed as early as 2035, while early implementation is recommended to accelerate the reduction from the campus's largest source of emissions pending the availability of funding.

In addition, converting buildings outside of the main campus system to electricity is also recommended. Since these are decentralized with independent boilers, a conversion to heat pumps and the use of waste heat is technically feasible today and should be implemented prior to 2030. A cost-benefit analysis of these projects is recommended in the short term.

ANALYSIS

The main campus heating system upgrades will be the most expensive decarbonization project in the CAP, and may impact major portions of building operations across the campus. While the replacement of gas boilers with heat pumps is relatively expensive, the primary drivers of cost will be upgrades to the distribution system and the building-level modifications that need to be made in order to transition from a steam to low temperature hot water system. A rough estimate of the timing (and cost) of boiler replacement has been integrated into the analysis, but significant uncertainty will remain until the aforementioned study is completed. The following table provides an overview of the metrics associated with this project.

TABLE 13: GHG savings from building efficiencies compared to BAU and other benchmarks

STRATEGY	IMPLEMENTATION TIMELINE	COST ($M)	COST/SF ($/SF)[37]	NPV ($M), INCL SCC	GHG REDUCTION (MTCO2e)[38]	% OF 2050 EMISSIONS[39]	$/MT REDUCED[40]	CO-BENEFITS
Main campus heating system upgrade	Phased between 2029–2050	$650–$1,250	$74.48–$143.24	-$577	628,689	34.1%	-$1,899	
East Campus decarbonization	2030–2035	Not Yet Known	Not Yet Known	Not calculated	135,940	12.9%	Not known	
Williams Village decarbonization	2030–2035	$30–$50	$41.92–$69.87	Not calculated	56,439	5.3%	-$886	

As Figure 12 shows, the heating system upgrade alone will not enable CU Boulder to achieve the necessary reductions and would need to be done in conjunction with the additional measures outlined in this CAP.

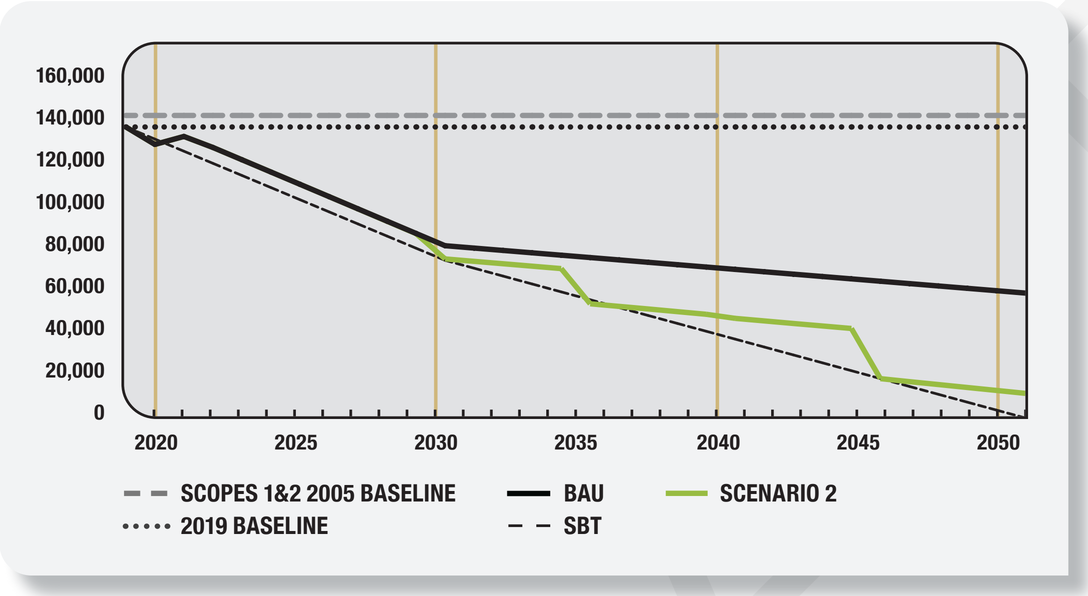
[37] CU Boulder's square footage is assumed to be 11,239,756 OGSF

[38] Cumulative over 20 years

[39] Uses annual emissions for both the numerator (the strategy) and the denominator (baseline emissions)

[40] NPV (without SCC)/MTCO2e. This calculation allows for the project benefits, such as energy savings, to be counted. A positive number means a net return to the campus

FIGURE 12: GHG savings from Main Campus Heating System Upgrade projects compared to BAU and other benchmarks



IMPLEMENTATION:

The CAP recommends the following interim steps for an implementation plan:

- Complete a detailed campus heating decarbonization plan for main campus by 2024
- Develop a district energy funding and financing plan by 2025
- Incorporate the social cost of carbon into investment decision making process
- Conduct pilot electrification projects for Williams Village and East Campus, e.g., utilizing geothermal and waste heat recovery as a strategy for electrification
- Implement the first phase of the main campus plan by no later than 2035.

RENEWABLE ENERGY: ON- AND OFF-CAMPUS SOLAR PV INSTALLATION

As noted above, this climate action plan is predicated on the Colorado grid decarbonizing at a rapid pace. The state has legislated this reduction and Xcel Energy has committed to delivering it. Any reductions associated with onsite or offsite PV will take place earlier in the project lifetime, since the clean energy produced early on will be offsetting high emissions electricity, but this will decrease over time. In addition, if CU Boulder participates in Xcel's Solar Rewards incentive program, which helps make commercial solar financially viable, the renewable energy credits are transferred to Xcel so they can use them to meet their state mandated requirements. Therefore, the reductions from onsite PV wouldn't be CU's, but CU would be supporting the larger grid decarbonization effort.

In addition, CU is in the process of subscribing to an offsite renewables program as part of a new state enabled virtual net metering (VNEM) program. This will expand solar for the campus by 5.9 MW in 2025 at no additional cost to the campus under a 20-year contract which also includes CU Boulder's ownership of the RECs.

EQUITY CONNECTION

COMMUNITY SOLAR: Community solar gardens (CSG) are another form of offsite solar development that exists in Colorado and can be used to connect electricity users without access to or sufficient amount of roof space, to subscribe to offsite solar where they then receive a credit on their electric bill. CU Boulder could explore the possibility of developing a CSG to then support renters and lower income households in subscribing to the CSG to effectively reduce their energy bills.[43]

[43] This could not be a part of the current climate strategy due to the fact that RECs would not belong to CU Boulder.

ANALYSIS

CU currently has 2.3 MW of installed solar on campus and receives approximately 3% of its electricity from this source. A recent, high-level spatial assessment of the campus demonstrated that CU Boulder could construct up to 10 MW of additional PV generation capacity on campus. Sites would include Main and East Campus roofs, carports, and open areas. In fact, the installation of additional PV will be required for the campus to achieve its 2030 target of generating 10% of its electricity from renewable on-site sources. However, installations have slowed because limits on incentive programs have made the business case for development more challenging. For this CAP the installation of 7 MW of solar PV at the most promising on-campus sites were studied. It was assumed that all installations occurred in 2025. The following table summarizes the key metrics associated with these projects:

TABLE 14:

STRATEGY	IMPLEMENTATION TIMELINE	COST ($M)	COST/SF ($/SF)	NPV ($M), INCL SCC	GHG REDUCTION (MTCO2e)	% OF 2050 EMISSIONS	$/MT REDUCED	CO-BENEFITS
Solar PV[42]	2025	N/A	N/A	-0.79	20,066	2.3%	-$141	

[42] Since the goal of the analysis focused on emissions reduction, several counterfactual assumptions were made: 1. All initial costs would be met by a developer under a power purchase agreement (PPA), and amortized in CU's electricity payments; 2. All RECs would be retained by the University (under current Xcel incentive program for net-metered solar, the utility would retain the RECs); 3. Off-campus capacity was not modeled.

FLEET ELECTRIFICATION

The CAP provides a systematic assessment of all campus operated vehicles, with the primary goals of identifying vehicle electrification opportunities, establishing an electrification timeline based on vehicle replacements, and determining the costs and emissions benefits of fleet electrification. Note that transportation emissions associated with driving to and from campus or flying for University related activities are included under Scope 3 (Chapter 4).

The fleet analysis assessed relevant vehicle data in the University's records including data provided by the University Facilities and Transportation Departments. Available data included vehicle makes, models, ages, purchase date and price, fuel type, usage and costs, and miles traveled. Quantitative data were supplemented by interviews with appropriate CU Boulder staff to better understand how vehicles are used and the anticipated future mobility needs of each department. This Assessment can be found as Appendix A and should be read in conjunction with the campus' Transportation Master Plan.

RESILIENCE CONNECTION

FUTURE MICROGRID: The Department of Energy defines microgrids as "a group of interconnected loads and distributed energy resources within clearly defined boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected and island-mode." The goal of a microgrid is to provide reliability and resilience in the face of grid outages and typically has the capability to support demand-side management to help control utility costs. The campus does not currently have a microgrid, but it does have a combined heat and power plant with 30 MW of electrical generating capacity (at WDEP) to provide power to isolate the main campus and portions of the east campus from the grid and many individual buildings have diesel powered generators to support critical needs. The current systems would have minimal climate impact if they only operate during outages, which is rare, since CU Boulder is connected to the grid through three independent electrical feeders, two feeders are required to support the campus power requirements and the third is for redundancy. This means that the campus already has two levels of electric redundancy (multiple feeders, diesel generators and existing gas-fired capacity).

Explore the feasibility of future strategies that may not require fossil fuel solutions. **Microgrids typically use multiple distributed energy resources to support a group of interconnected loads. Onsite solar, other renewable or clean energy sources coupled with energy storage and advanced controls has the ability to provide additional resilience to the CU Boulder Campus. The campus could then supplement the ability to "island" or be self-sufficient for a period of time, in the event of a grid outage. A microgrid at CU Boulder would be best intended to power a subset of loads, such as a building designated as a community center or other buildings designated as critical facilities. As other distributed clean energy and storage assets become more cost effective, and as the campus updates its resilience planning, a microgrid could become an important element of such subsequent plans.**

CO-BENEFITS

Prioritizing retirement of heavy-polluting buses decreases air pollution -- including particulates, NOx, and smog -- on CU Boulder's campus and in the surrounding community for passengers, pedestrians, cyclists and the region at large. It should be noted that there can be environmental downsides to EV adoption, though it is generally agreed that they are outweighed by the benefits.[45] Investments in electric vehicles should aim for transparency in sourcing and should endeavor to impose environmental and labor standards throughout their supply chain.

ANALYSIS

The entirety of CU Boulder's fleet was evaluated for electrification. After accounting for non-street legal assets (trailers, generators, etc.) and vehicles that are already electric, 452 out of 454 total vehicles owned by the University were studied. Of this subset, 81% can be replaced with equivalent electric vehicles that are currently commercially available, predominantly sedans, SUVs, pickup trucks, and campus buses. Most of the remaining vehicles (14% of 452) have potential electric candidates for replacement but challenges related to cost-effectiveness or operational requirements remain. About 4% of the vehicles provided do not have a potential candidate for electrification currently available or announced in the market. The analysis was accomplished by assuming an electric vehicle would replace an internal combustion vehicle at the end of its useful life. In total, the replacement schedule saves about 7,400 MTCO2e between now and 2050. The replacement schedule and resulting emission reduction curve are presented in Annex A.

RESILIENCE CONNECTION

The role of equity in fleet electrification:
The adoption of electric fleets contributes to improved air quality, particularly benefiting low-income communities often disproportionately affected by air pollution. Additionally, the reduced noise associated with electric vehicles enhances the quality of life for residents living near transportation routes.

On the other hand, the production of batteries for electric vehicles also raises human rights concerns, particularly in the extraction and processing of raw materials such as cobalt and lithium. Issues include child labor, environmental degradation, health and safety risks, forced displacement, economic exploitation, resource conflicts, and a lack of supply chain transparency. This CAP acknowledges these inequities and supports international frameworks to mitigate these impacts.

[45] Heavier electric vehicles may also create additional wear on paved streets, possibly requiring additional maintenance and paving. Further, used EV batteries, if not properly recycled, can lead to environmental harm due to the toxic materials they contain. Vehicle electrification also presents certain environmental challenges. However, when comparing the complete lifecycle emissions and the potential for future improvements in technology and infrastructure, it is generally considered a positive environmental choice, especially as part of a broader strategy to move towards a more sustainable and low-carbon future. See **The International Council on Clean Transportation.**

Figure 13 shows that buses, vans, pickups and SUVs have the highest emissions among current vehicles on the road. CU Boulder owns many such vehicles. Further, older vehicles tend to emit greater volumes of GHGs due to less restrictive emission requirements when they were made. Further, the larger the vehicle, the more expensive to replace, and therefore the longer it remains on the road. Therefore, buses, trucks and vans represent higher quantities of older stock, which corresponds to greater emission levels.

FIGURE 13: Shows GHG emissions by vehicle type and year

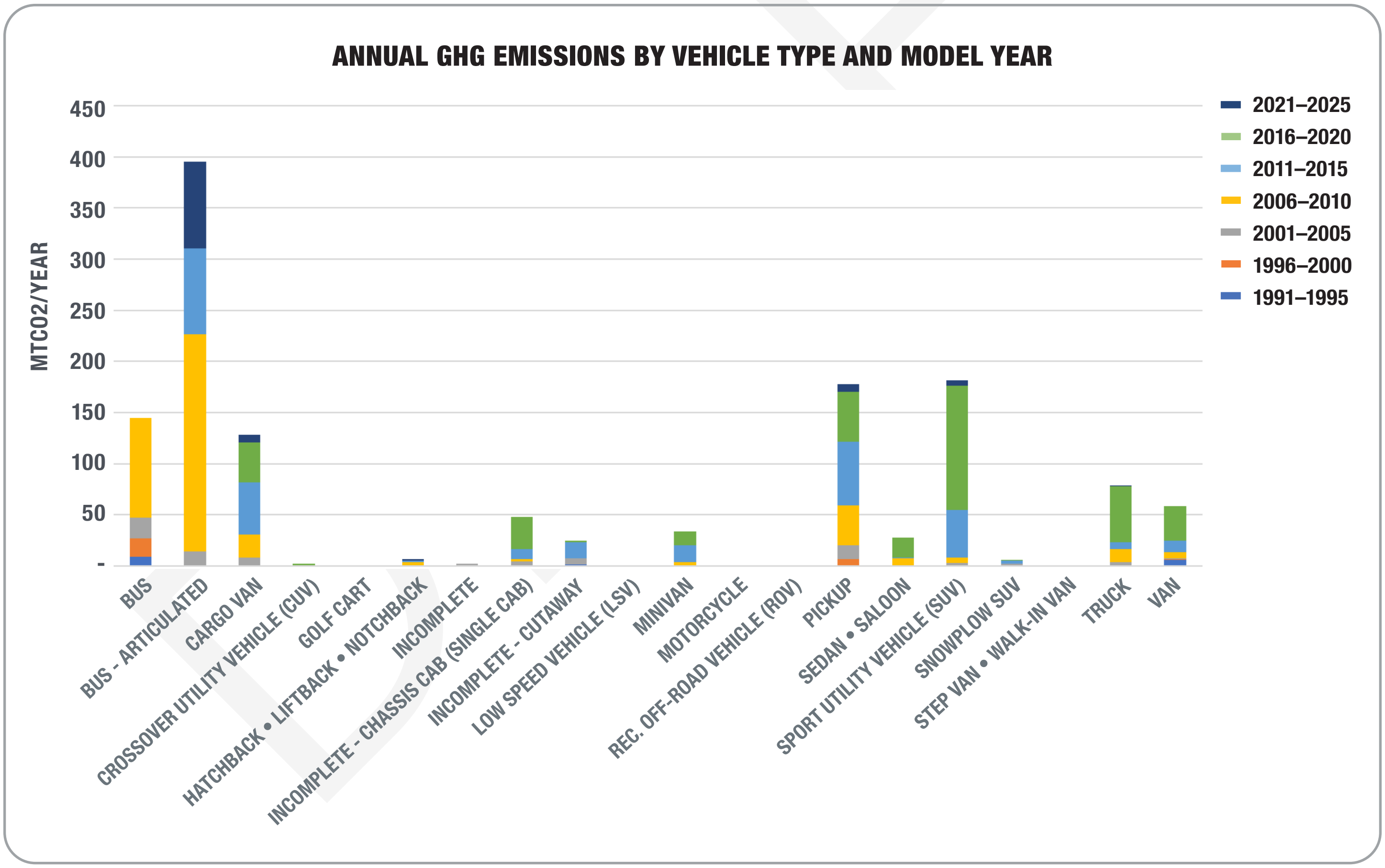
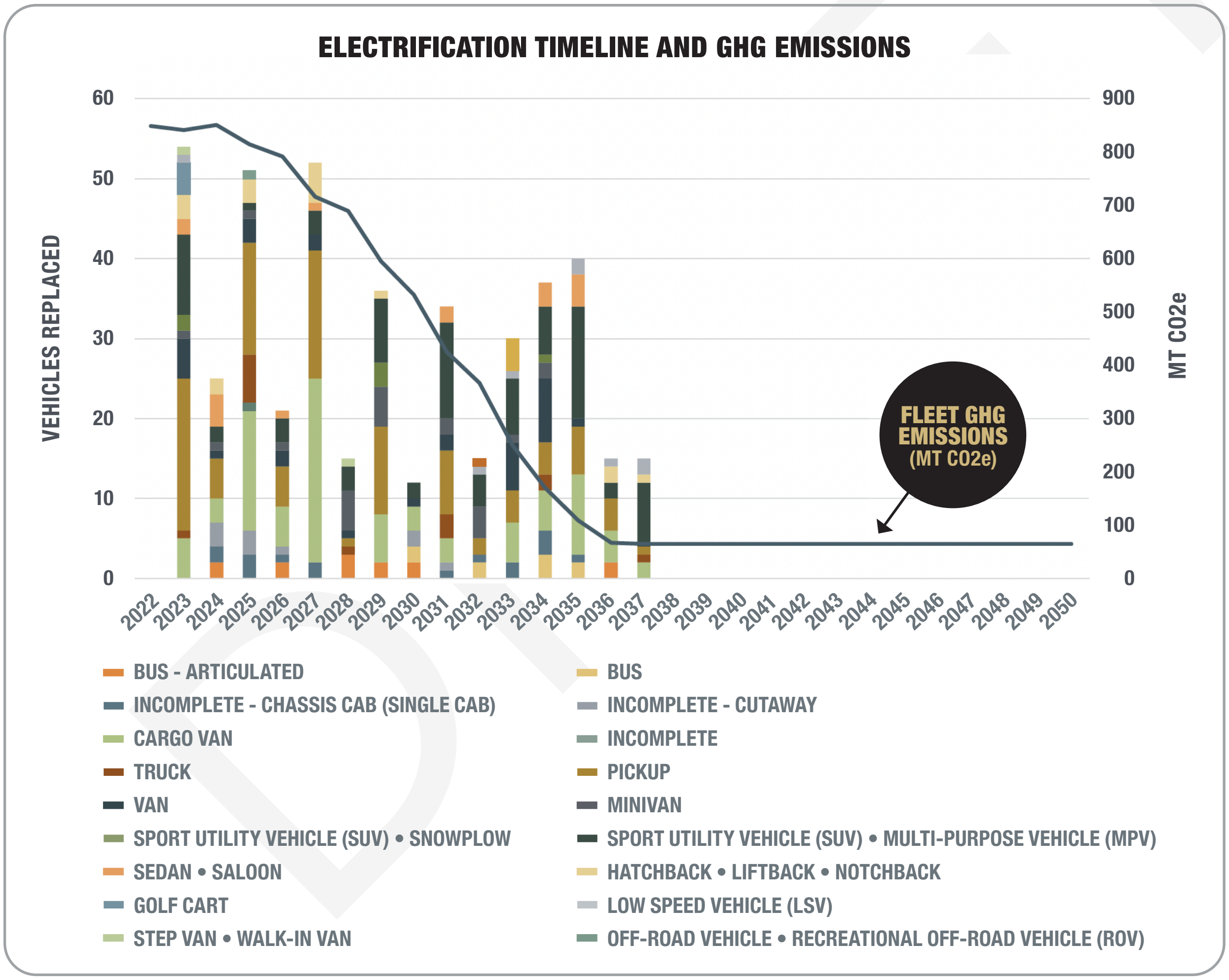


Figure 14 Shows the timeline of recommended vehicle replacements and the GHG emissions associated with those replacements.[46] Buses, vans, trucks and SUVs, along with several other fleet vehicle types were included in the analysis. Recommended replacements begin immediately, gradually transitioning nearly all vehicles to electric varieties.

FIGURE 14: Timeline of recommended vehicle replacements and the GHG reductions



[46] The CAP acknowledges supply chain issues and ordering backlogs associated with EV purchases that may present challenges.

TABLE 15: Summary of key metrics associated with the fleet electrification project:

STRATEGY	IMPLEMENTATION TIMELINE	COST ($M)	COST/SF ($/SF)	NPV ($M), INCL SCC	GHG REDUCTION (MTCO2e)	% OF 2050 EMISSIONS	$/MT REDUCED	CO-BENEFITS
Electrify campus fleet	2024–2050	$42.7	N/A	-33.2	13,352	0.63%	-$6,154	

While an EV replacement strategy may not contribute significantly to overall emissions, the strategy is being prioritized based on its significant co-benefits including noise pollution reduction, air quality benefits, reduced particulate emissions, and others.

IMPLEMENTATION:

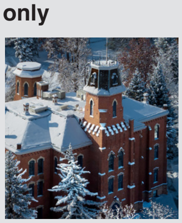
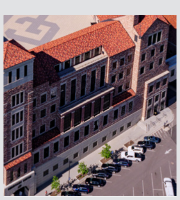
To transition campus fleet vehicles to electric over time, the following implementation steps are recommended:

- Implement university-wide procurement policy requiring EVs to be prioritized when purchasing new vehicles (include landscape and other equipment as well)
- Develop a charging infrastructure plan to determine the number, capacity, and location of charging stations across the campuses for fleet vehicles, as well as to support community charging.

GHG Reduction Scenarios (Scopes 1 and 2)

Following the analysis within the core areas of built environment, renewable energy, and transportation, combinations of the strategies were grouped into four scenarios based on strategy selection and timeline of implementation. The scenarios represent different strategic investment pathways toward the overall Scope 1 and 2 reduction goals. The three scenarios are summarized in Table 16.

TABLE 16: Key characteristics within each of the three scenarios, considerations for implementation and resulting, cumulative GHG emission reductions.

SCENARIO NAME	KEY CHARACTERISTICS	CONSIDERATIONS	SCOPE 1 + 2 IMPACT
SCENARIO 1: Efficiency and onsite solar without heating system upgrades. 	• Building energy efficiency (EE) • 7 MW of on and offsite solar PV by 2025 • 136 EVs by 2030, 271 EVs by 2040, 432 EVs in the fleet by 2050 • No Central Utility Plant projects	• Energy efficiency projects implemented by 2030 • Solar projects initiated at one time • Fleet replacement follows retirement of ICE vehicles at the end of their planned life	• Cumulative emissions savings of 479,173 MTCO2e, and reaching 61% reduction against 2019 baseline • Achieves CU's goals of 50% reduction by 2030, but not 100% reduction by 2050.
SCENARIO 2: Heating System Upgrades (HSU) only 	• Includes HSU projects only: electrification of gas boilers, new heat distribution piping, building-level modifications and fittings	• HSU projects add considerable expense (between $500 and $1250 million) over the CAP's time horizon. • Schedule follows phased investment of $250 m in 5-year increments	• Cumulative emission savings of 484,898 MTCO2e GHG, and reaching 91% reduction against 2019 baseline • Does not achieve CU's 2050 emission targets
SCENARIO 3: Combines all Scenario 1 strategies with HSU 	• Includes all strategies from Scenario 1: energy efficiency, solar PV, and fleet replacement • Includes all heating system upgrade projects and campus-wide heating distribution system retrofits		• Cumulative emission savings of 1,120,383 MTCO2e • Achieves CU's 2030 target of 50% reduction • Achieves zero emission target by 2050 • Maintains SBT targets

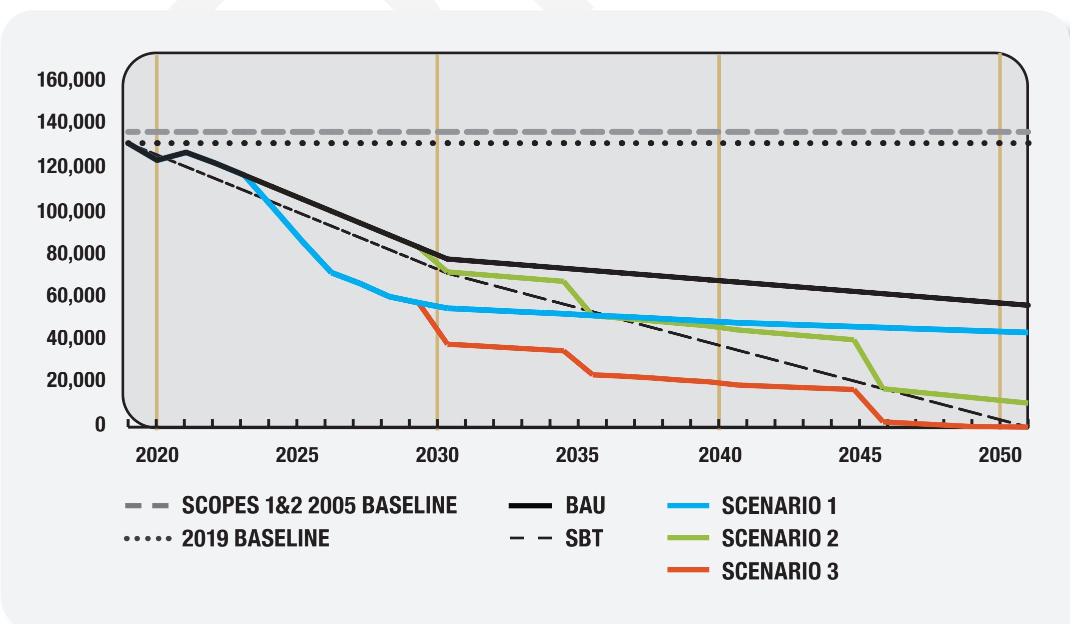
Scenario 1 (blue line)**:** Energy efficiency (EE), renewable energy (RE), and Fleet replacement. This Scenario considers over 300 energy efficiency projects (lighting, controls, envelope & HVAC), 7 MW of renewable energy installations, and the replacement of approximately 365 internal combustion campus fleet vehicles with electric vehicles. This combination of projects allows CU Boulder to achieve its short term goals, but not its long term goals.

Scenario 2 (green line)**:** Heating system upgrade (HSU); this is the phased conversion of Central Campus heating to an electrified, lower temperature hot water. This complex series of projects is currently being studied; results, including project schedule and costs, are expected in 2024. Decarbonizing the campus heating system is expected to contribute significant emission savings, but will not achieve zero emissions on its own.

Scenario 3 (red line)**:** Combines Scenarios 1 and 2. This combination of projects will achieve CU Boulder's short and long term goals, of 50% reduction by 2030 and 100% by 2050.

Figure 15 shows the investment timeline for all Scenarios. This illustrates that efficiency, onsite renewables, and steady vehicle electrification can put CU Boulder on a footing to reach the 2030 target of 50% Scope 1 + 2 emissions reduction, but that without addressing the campus central heating system, the campus would be unable to continue to meet the goals established in this CAP.

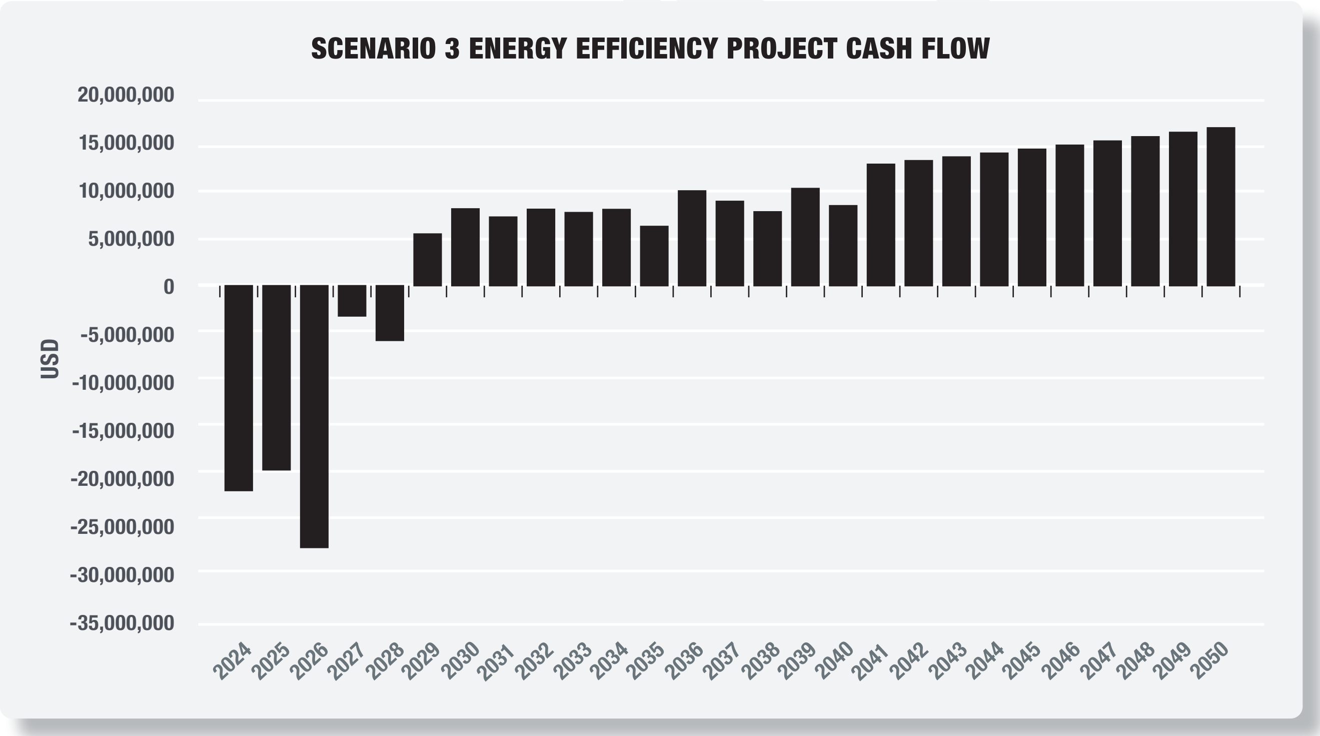
FIGURE 15: GHG savings from associated scenarios relative to the BAU, SBT, and baseline



COST SAVINGS:

Several of the strategies recommended by the CAP may save the campus money in nominal terms (against a baseline).[47] The most likely projects to do so are the energy efficiency projects described in Chapter 3, which create efficiency gains and reduce the demand for electricity, all else being equal. Using Scenario 3 as the implementation pathway, the graphic below shows expected cash flow over time for the recommended energy efficiency measures (which include lighting, commissioning, and HVAC retrofits plus envelope projects). The NPV of these aggregated projects is estimated at $12,490,174, indicating the potential for significant savings over time.

FIGURE 16: Scenario 3 Energy Efficiency Project Cash Flow



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[47] Other plans have also promised savings in these areas. However, increased utility rates can overcome these savings, leaving real expenses higher. This should not negate savings attributed to these projects, which is why electricity prices should be benchmarked at the time of installation.

LIFE CYCLE ANALYSIS

Table 17 shows additional metrics by which the scenarios can be compared. The first column shows cumulative saved GHG emissions in comparison to the BAU, while the second shows the capital investment cost of the scenario. The third column shows net present value (NPV)[48] of the scenario, and finally the fourth also shows the NPV but includes a value for the social cost of carbon ($185/MTCO2e).[49] The notable cost of the heating system decarbonization, which includes significant work to update campus infrastructure and buildings themselves, can be observed in the negative NPV values. It should be noted that the savings associated with this and other projects assume an energy savings in gas and a transfer of gas energy to more efficient use of electric energy, which is more expensive on a per-unit-energy basis. The life cycle cost analysis results will change if Xcel were to change their electric rate for the campus.

TABLE 17: Key metrics by scenario including total MTCO2e reduced, investment required, Scenario NPV, and Scenario NPV including the social cost of carbon.

	TOTAL* MTCO2E REDUCED (2023)	INVESTMENT REQUIRED ($ MILLIONS)	SCENARIO NPV[50] ($ MILLIONS)	SCENARIO NPV W/ SOCIAL COST OF CARBON ($ MILLIONS)
SCENARIO 1	479,173	$197	$2.7	$101
SCENARIO 2	484,898	$1,321	($664)	($575)
SCENARIO 3	1,120,000	$1,460	($611)	($404)

*Between 2024-2050

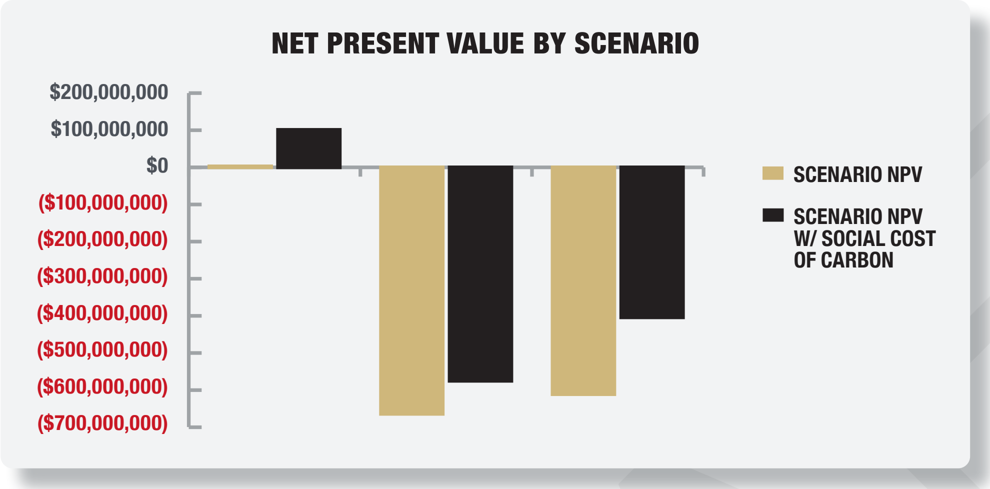
[48] The net present value (NPV) of a project is often used by decision makers to decide on whether to pursue a project, or in determining which project is the best from a competing list of projects. It is calculated as the sum total of expected cash flows - both incoming (positive) and outgoing (negative) - associated with the project; however, since money in the future is not as valuable as money today, future cash flows are discounted, using a discount rate.

[49] The Biden Administration has established a social cost of carbon of $51/MTCO2. However, recently the EPA has suggested an increase to $190/MTCO2, and is weighing public comments on that proposed price. (“Supplementary Material for the Regulatory Impact Analysis for the Supplemental Proposed Rulemaking, “Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review” available at: **https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf).**

The scientific basis for the $185/MTCO2e comes from Rennert in the journal Nature: Rennert, K., Errickson, F., Prest, B.C. et al. Comprehensive evidence implies a higher social cost of CO2. Nature 610, 687–692 (2022). **https://www.nature.com/articles/s41586-022-05224-9.**

[50] NPV uses a 4% discount rate. See technical annex for full description of costs and benefits.

FIGURE 17: Net Present Value by Scenario



As shown in Table 17, the capital costs to implement scenarios 1-3 are significant. The most significant capital outlays come from the heating system upgrade projects. The cost estimates from these projects are very rough estimates and more precise costs will come from the central plant study currently underway. Clearly, the most important aspect of this CAP is investigating a low cost pathway to implementing the central heating system projects, and identifying additional funding sources such as Federal and State incentives and grants, utility programs, and direct utility partnership.

TABLE 18: Summary and Timeline of Recommended Measures to Reach Scope 1 and 2 Reduction Targets

STRATEGY	IMPLEMENTATION TIMELINE	COST ($M)	NPV ($M), INCL SCC	% OF 2050 EMISSIONS[51]	CO-BENEFITS
Lighting retrofits	2024–2030	55.6	31.0	8.2%	
Envelope improvements	2024–2040	23.7	-8.5	4.5%	
Re-commissioning projects	2024–2030	3.6	31.9	5.5%	
HVAC system retrofits	2024–2030	58.7	41.2	16.6%	
Main campus heating system upgrade	Phased, 2029–2050	$650–$1,250	-$577	34.1%	
On-campus solar PV	2024–2050	NA	-0.79	2.3%	
Electrify campus fleet	2024–2050	$42.7	-33.2	0.63%	
New Building Design Standards	2024–2050	$0	$0	$0	
Existing Building Space Optimization	2024–2030	$0	$0	$0	

[51] Uses annual emissions for both the numerator (the strategy) and the denominator (baseline emissions)

4. REDUCING SCOPE 3 EMISSIONS

Achieve a 50% reduction from 2019 by 2030 for those Scope 3 emissions where accurate estimates can be established and which are within the University's influence and control. Further reduce these emissions to zero by 2050.

Globally, public and private entities are in the early phases of accounting for and managing Scope 3 emissions. Scope 3 consists of 15 distinct categories, and of these the campus has measured eight for this CAP. It also presents methodologies for more accurate measurement of all relevant categories in subsequent CAP updates. The campus has used documentation from the Science Based Targets Initiative (SBTi) to guide its process in evaluating Scope 3 emissions and setting targets (though it is not pursuing strict adherence to SBTi certification).

SBTi asks organizations to estimate their Scope 3 emissions, and if those emissions are greater than 40% of total emissions, the Initiative calls for reduction targets that are in line with goals to maintain a less-than 1.5°C temperature rise. CU Boulder has adopted these targets in currently measured categories and has plans to increase the number of measured categories as well as targets.

CU Boulder can influence off campus Scope 3 emissions by establishing policies and programs that help to incentivize those who sell to the university, those who are employed or attend classes, and those who otherwise partner with CU Boulder. Scope 3 emissions are those that result from activities and assets not owned or controlled by the campus, but that the campus indirectly impacts through its value chain. As with Scopes 1 and 2, the planning process begins with an inventory, then targets are established, and finally strategies are developed.

The first step in Scope 3 measurement and target setting is to take a high-level assessment of Scope 3 categories, to determine if they might contribute more than 40% of total emissions. During the process of developing emission totals for this CAP, it was determined that Campus Scope 3 emissions were contributing at least 55% to the overall total, and that a deeper accounting would be necessary. The Scope 3 inventory was presented in Chapter 2.

Scope 3 Categories

Scope 3 consists of 15 distinct categories of emissions as defined by the GHG Protocol. Seven of the categories have been included in this first Scope 3 inventory, some using significant assumptions given the lack of available data, and six of the categories have reduction targets. These six categories were selected following guidance from the Science Based Targets Initiative (SBTi):

"The nature of a Scope 3 target will vary depending on the emissions source category concerned, the influence a company has over its value chain partners and the quality of data available from those partners."[52]

These two conditions were used as criteria for whether to include the category in: a) the inventory, and b) the target.[53]

The one category that was estimated and included in the baseline inventory, but excluded from the targets is category 9, which considers out of state travel for those who are "consuming" CU Boulder's services (i.e. students flying to and from campus). This exclusion is due to the need for better underlying data and the limited sphere of influence the campus has on how and when people come and go from campus, per the SBTi guidance.

The seven categories that include targets together represent about 67%, or approximately two thirds, of the calculated scope 3 emissions. These targets reflect a 50% reduction by 2030 and a 7% annual reduction through 2050.

Regarding the remainder of the categories, categories 10-14 were considered not applicable given the University's operations (the University doesn't sell products, franchise or hold downstream leased assets).

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[52] SBTi has been leading the way in developing guidance for institutions in setting reduction targets for Scope 3 emissions. SBTi is a partnership between the Carbon Disclosure Project (CDP), the United Nations Global Compact, the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF). SBTi encourages companies and institutions to set targets for reducing greenhouse gas emissions in line with the latest climate science.

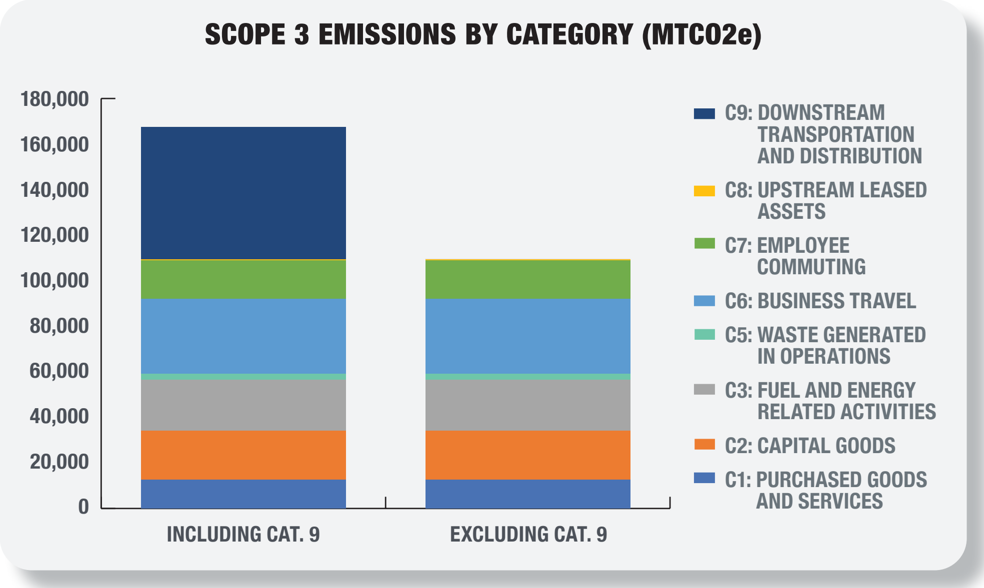
[53] Importantly, the University is not seeking to establish a science-based target at this time, nor is it seeking conformance with the GHG Protocol Scope 3 Standard. Neither are we seeking validation from SBTi on our inventory or target setting process. We have, however, sought guidance from the GHG Protocols and the Science Based Targets initiative (SBTi) to instruct our inventory and target setting process. This CAP is a "living document" in the sense that it will be updated on an annual basis with more refined data, accurate forecasts, and mitigation steps. This is the first time CU Boulder has attempted a Scope 3 inventory, time will allow future iterations to be more comprehensive. Please see Appendix D for additional information.

Per the GHG Protocol, Category 15 *"includes Scope 3 emissions associated with the reporting company's investments in the reporting year, not already included in Scope 1 or Scope 2. This category is applicable to investors (i.e., companies that make an investment with the objective of making a profit) and companies that provide financial services. Investments are categorized as a downstream Scope 3 category because the provision of capital or financing is a service provided by the reporting company."*

Investments for CU take place at the system level (not the Campus level) and are therefore not within the scope of the CU Boulder Campus CAP. The CAP provides a very rough indicative estimate of what the emissions impact of these investments might be in the Scope 3 Annex, but does not include that figure in the formal baseline or in reduction target setting.

Table 1 provides a summary of Scope 3 results and the decision making process for inclusion in the inventory and target. Each of the Scope 3 categories are numbered and listed on the left; the categories reflect those found in the GHG Protocols.[54] The third column provides the estimated emissions from each category tracked for this CAP. The fourth column provides a definition of the category according to the GHG Protocol, which is then contextualized for the university. Column five provides a note on data availability and quality for that category. The final column indicates the level of influence by CU Boulder to affect category emissions, with a value of 3 meaning significant influence, 2 meaning moderate influence, and 1 meaning limited influence. All "influence-values" of 2 or 3 have been included in the target.

FIGURE 18: Scope 3 Emissions by Category



[54] GHG Protocols

TABLE 19: Scope 3 categories, emissions (in MTCO2e), definitions, data availability/quality and CU Boulder's influence over each

#	CATEGORY	EMISSIONS	DEFINITION	DATA AVAILABILITY / SOURCE	INFLUENCE
1	Purchased goods and services	12,216	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company not otherwise included	Direct[55] spend data were obtained in 5 primary procurement categories	3
2	Capital goods	20,944	Extraction, production, and transportation of capital goods purchased or acquired	High-level estimates[56] of embodied carbon in buildings and fleet	3
3	Fuel and energy related activities (FERA) not included in 1,2	21,782	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company, not already accounted for: • Upstream emissions of purchased fuels • Upstream emissions of purchased electricity • Transmission and distribution (T&D) losses • Generation of purchased electricity that is sold to customers	High-level estimates of upstream emissions from electricity and gas T&D loss assumptions for both electricity and gas delivery; CU Boulder occasionally sells a small amount of electricity to the grid, these emissions are counted in Scope 1	2
4	Upstream transportation and distribution	Included in Category 1	Of products purchased between a company's tier 1 suppliers and its own operations (in vehicles not owned by company)	Data not available[57]	2
5	Waste generated in operations	2,595	Disposal and treatment of waste generated	Direct data obtained	3
6	Business travel	32,041	Transportation for business-related activities	High level data were available through CU travel booking partner; no survey for outside booking	3
7	Commuting	16,407	Transportation between home and work (includes daily faculty, staff and student commuting)	Survey data available, but small sample size	2
8	Upstream leased assets	532	Operation of assets leased by company (not in S1/S2)	Calculated from energy use intensity assumptions for office space	2
9	Downstream transportation and distribution	56,504	Use of "products" sold by the company between operations and the end consumer. For CU Boulder, out-of-state students and parents travel to and from campus to make use of university offerings (education, events, etc.)	High-level estimate of out-of-state student and parent travel to/from campus	1[56]
10	Processing of sold products	N/A	Processing of intermediate products by downstream companies	No raw or intermediate goods are sold by CU Boulder that enter processing	NA
11	Use of goods and services sold	N/A	End use of goods and services sold by the reporting company	There are no emissions necessarily associated with the "end use" of education	NA
12	End-of-life treatment of sold products	N/A	Waste disposal and treatment of products sold at the end of their life	Emissions calculated in Category 1[58]	NA
13	Downstream leased assets	N/A	Operation of assets owned by company, and leased to other entities, but not included in Scopes 1 and 2 of lessor (the reporting company); examples include retail entities leasing space from CU Boulder	These emissions are included in Scopes 1 and 2, or other Scope 3 categories	NA
14	Franchises	N/A	The operation of franchises, not included in S1/S2 of the lessor (applicable to operations that franchise)	CU Boulder is not a franchising entity	NA
15	Investments	See Scope 3 Annex	Operation of investments, including debt & equity, not included in S1/S2	High-level estimate; Data are not transparent at a University system level (University of Colorado)	1[59]

55 Direct data are data that were obtained directly from an on or off campus source, or from a University publication.

56 High-level estimates means that industry averages, or other heuristic methods were used in place of direct data.

57 The academic calendar is decided at the University system level (University of Colorado), CU Boulder does not directly control the calendar.

58 Category 1 includes lifecycle emissions of sold products, which includes end-of-life treatment.

59 Investments are managed at the University system level (University of Colorado), which further outsources to the CU Foundation. CU Boulder does not control or advise on the investment portfolio.

Category 1: Purchased goods and services. To calculate emissions, dollars spent on major categories of goods and services were multiplied by appropriate emissions factors. The primary categories of goods and services purchased by the campus were, 1) Computers and IT equipment, 2) Food and beverage service, 3) Paper and books, 4) Advertising and marketing, and 5) Clothing and apparel. Emission factors for these categories, and all listed below, are provided in the Scope 3 Annex.[60]

Category 2: Capital goods. These emissions include those produced in the extraction, production, and transportation of capital goods purchased or acquired. In the absence of a thorough record of all capital goods, the analysis included construction of CU building stock and campus fleet purchases. To calculate the embodied carbon in buildings and set an emission target for future construction, the first step was to calculate an average amount of embodied carbon found in building projects over the past 17 years (this was the period with the most reliable data). This figure became the baseline for embodied carbon in buildings, under a BAU scenario.

Similarly, vehicles in the campus fleet also contain embodied carbon. The campus purchases an average of 8 vehicles per year, and currently owns about 450 vehicles. Each annual vehicle purchase was multiplied by an appropriate emission factor, to arrive at an embodied carbon baseline for vehicles. Summing embodied carbon from buildings and from vehicles yields a total baseline for embodied carbon from capital goods.

Category 3: Fuel and energy related activities. Emissions counted under this category are those related to upstream processes from purchased electricity and purchased fuels. Emissions for generation of purchased electricity that is sold to end users isn't applicable in this case as CU operations don't include sales of electricity. Upstream emissions from purchased electricity was calculated by multiplying annual electricity consumption by 11%, and then by an emission factor.[61] Upstream emissions from purchased fuels include gasoline, diesel, and natural gas, each with a specific emission factor; these emissions include upstream natural gas leakage. As campus decarbonization efforts get underway, and fleet electrification is pursued, these emissions will eventually decline.

EQUITY CONNECTION

FOOD RECOVERY. Establish a food recovery program on campus for all catering and culinary events.

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[60] The calculation of emissions from purchased goods and services should include the quantification of emissions from all upstream suppliers to CU Boulder. This CAP was able to initiate a process with the campus procurement team that is expected to grow over time. For this CAP, only five spend categories were assessed, which may result in significant under-measurement. For additional detail, see Scope 3 Annex.

[61] Disclosure by VitalMetrics **https://sustainable.stanford.edu/sites/g/files/sbiybj26701/files/media/file/scope-3-emissions-from-fuel-and-energy-activities-march-2023.pdf**

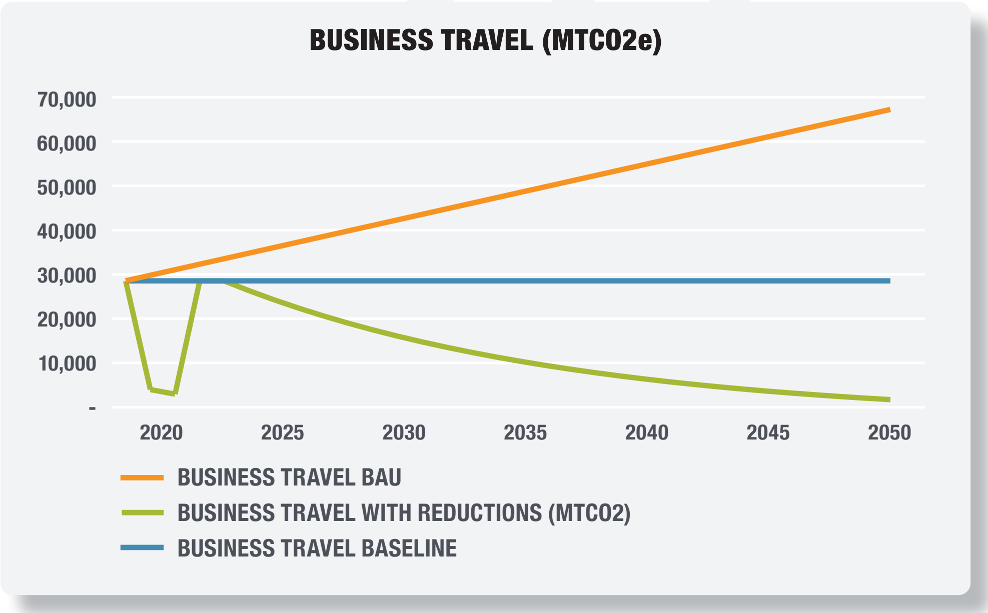
Category 5: Waste generated in operations. Data on two types of waste have been gathered: mixed solid waste (5,841 tons in 2019) and composted solid waste (1,265 in 2019).

Category 6: Paid business travel. These are emissions associated with any business travel that is paid for by the university and includes student study-abroad programs. The University travel department reports that over 56.7 million miles were flown under this category in 2019. This figure is up from 36.5 million miles in 2009, which indicates an average 4% growth rate year over year. This growth rate has been added to the Business Travel BAU line below. (While this fell off considerably during COVID-19, a return to similar numbers is expected.) Air miles have an emission factor , but an additional coefficient is applied due to the fact that these emissions occur higher in the atmosphere, and therefore have a greater impact on the climate. This coefficient is called the radiative forcing index. This factor has also been applied to yield the total emission value.

EQUITY CONNECTION

INCREASE REUSE ON CAMPUS:
This CAP recommends increasing clothing, furniture and equipment reuse events, as well as an online reuse listing platform and expanded education about the CU Waste Distribution Center. Greater access to reusable items can provide quality goods to the disadvantaged.

FIGURE 19: Business Travel Projected Emissions



Category 7: Employee & student commuting. Emissions from regular trips to and from campus are a significant part of Scope 3 emissions. To calculate emissions within this category, estimates of vehicle miles traveled (VMT) are made for faculty, staff and students. The Transportation department at CU makes regular estimates of these totals from survey data and occasionally from a more thorough approach through the use of professional consultancies. In 2019, total VMT from all three categories was nearly 50 million miles (VMT has remained lower than this even after the pandemic due to work from home policies and preferences). A VMT emission factor was used to calculate the total presented above.

Reducing VMT can have a significant impact on GHG emissions in and of itself; however, it requires both the enhancement of available TDM programs and strategies as well as building out behavioral change programs in order to realize these reductions which remain paramount to the efficacy of this strategy. CU Boulder finds itself in an interesting point in transportation history where COVID demonstrated that a downward trend in campus emissions is possible thanks to the increases in remote work in combination with improvements in video conferencing. Furthermore, an expansion of transportation options like electric bikes, ride share companies and app based ride matching that didn't exist just 10 years ago have made the car-free lifestyle more viable, prompting campus to consider focusing on VMT as a viable option for achieving transportation and sustainability goals.

Co-Benefits. This Scope 3 category has the highest co-benefits opportunity. Housing and transportation disparities within Boulder County influence access to sustainable transportation options, which has driven the University to work with local transportation authorities to improve infrastructure, accessibility, and connectivity for all residents. At CU Boulder, many students and staff commute from nearby cities to campus each day, due in part to the high cost of living in Boulder County. This highlights the need for sustainable and accessible transportation infrastructure to support emissions reductions while minimizing pollution in local communities and decreasing costs and challenges associated with public transportation. When considering equity and justice in the transportation sector, CU Boulder is focused on increasing ridership by reducing or eliminating price and accessibility barriers to vanpools, carpools, and last mile transport to and from campus. Beyond this, more inclusive approaches to transportation can provide additional opportunities to support the needs of the campus community by, for instance, including basic needs distribution for those participating in vanpools.

EQUITY CONNECTION

EXPAND THE ECO-PASS PROGRAM.

As the university approaches fleet electrification, there is an opportunity to encourage public transportation via expanding the EcoPass program to offer non-benefit eligible employees an annual subsidy and expanding the lime scooters and B-cycle sharing programs on campus. To help further with this transition, there will also be discussions around EV adoption and determining convenient locations for public-facing EV charging stations. There is a role that CU Boulder could play in creating charging rate structures to better support CU Boulder community members who lack access to charging at home, and to ensure key locations, such as family housing and high-traffic areas on campus have accessible infrastructure. The University may also consider distributing e-bikes to low-income students/staff through a sponsorship program to increase access and adoption.

Category 8: Upstream leases. This category includes emissions from office space that CU Boulder leases from other property owners. CU Boulder leases approximately 70,000 square feet of such space.[62] Emissions from this category have been estimated based on an assumed energy-use intensity (EUI) for office space, and that roughly 75% of energy use would be from electricity and 25% from gas. The EUI was multiplied by the square feet, in the appropriate proportions to estimate total electricity and gas use. These figures were then assigned an emission factor.

Category 9: Downstream transportation and distribution. Normally, this category reflects the use of products sold by the company between operations and the end consumer. For the university campus, the use of products sold can be considered the travel back and forth from campus to attend classes and other campus events. In this way students are using the product of education, while other campus visitors attend campus events such as graduation and parents' weekend. The CU campus has not monitored student and parent travel to and from the university; as a result, only very high-level estimations are available. To calculate emissions several rough estimates were made about average travel distances and frequency of trips (see scope 3 Annex).

[62] Office of Real Estate Services. 2023.

Targets

CU Boulder has selected seven categories in which to set targets: Purchased goods and services, Capital goods, FERA, Waste generation, Paid business travel and Commuting. These categories represent 67%, or approximately two thirds, of the calculated Scope 3 emissions. Within these categories, CU Boulder is seeking a 50% reduction by 2030, and a linear reduction to 100% by 2050.

SBTi guidance - used to inform CU Boulder target setting - does not provide a specific percentage reduction target for Scope 3 emissions. Instead, it recommends setting targets that are "ambitious, measurable, and aligned with the latest climate science." Globally, a 7% reduction year over year, for all entities, would cut global emissions 50% by 2050.[63] The following points summarize SBTi guidance for Scope 3 target setting:

- If a company has significant Scope 3 emissions (over 40% of total Scope 1, 2 and 3 emissions), it should set a Scope 3 target.
- Scope 3 targets generally need not be science-based, but should be ambitious, measurable and clearly demonstrate how a company is addressing the main sources of value chain GHG emissions in line with current best practice.
- The Scope 3 target boundary should include the majority of value chain emissions, for example, the top three emissions source categories or two-thirds (67%) of total Scope 3 emissions.
- The nature of a Scope 3 target will vary depending on the emissions source category concerned, the influence a company has over its value chain partners and the quality of data available from those partners.
- SBTs should be periodically updated to reflect significant changes that would otherwise compromise their relevance and consistency.

An absolute 7% year-over-year reduction goal for all targeted categories will allow the Campus to nearly reach its reduction targets of 50% by 2030 and 100% by 2050. At the end of this Chapter, a hypothetical scenario is provided, that shows the effect of this annual reduction goal on overall Scope 3 emissions.[64]

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[63] SBTi. 2020. Science-Based Target Setting Manual.

[64] When setting Scope 3 targets, SBTi recommends that the targets cover two-thirds of total Scope 3 emissions. CU Boulder's targets honor this recommendation, under the current measurements. As the CAP is updated, total Scope 3 emissions will change, and likely grow. At that point, targets will need to be reassessed.

Reduction Scenarios

Strategies to achieve these targets could include a variety of measures such as encouraging more remote participation in faculty business events, promoting use of public transportation, biking, or walking over private cars for commuting, implementing sustainable procurement policies, reducing waste, and making campus construction projects less carbon intensive.

For this CAP, strategies for reducing Scope 3 emissions remain at a high level, and are more directional than specific. The reasons for this are twofold:

1. Each of the categories involves a diverse set of stakeholder partners with whom the campus should engage. From external suppliers to faculty, staff and students, partners who "own" emissions from all the categories should be included to develop specific strategies.
2. Inventories for many of the categories are estimated using highly generalized figures and are therefore not appropriate for accurate benchmarking at this time. In these cases, additional resources and processes are necessary to determine more accurate emission figures.

While additional engagement and benchmarking are required to develop specific strategies, the following scenario provides annual percentage-based targets on the way toward the University's short term and long term goals:

- In terms of procurement strategies for goods and services, the campus would engage with suppliers, and seek those who are able to supply with reduced emissions, to the extent that a 7% annual reduction would be met.
- To reduce embodied carbon, moderate expectations are that emissions could be reduced by 15% per year, by using either sustainable NRMCA[65] or ILFI ZC methodologies.[66]

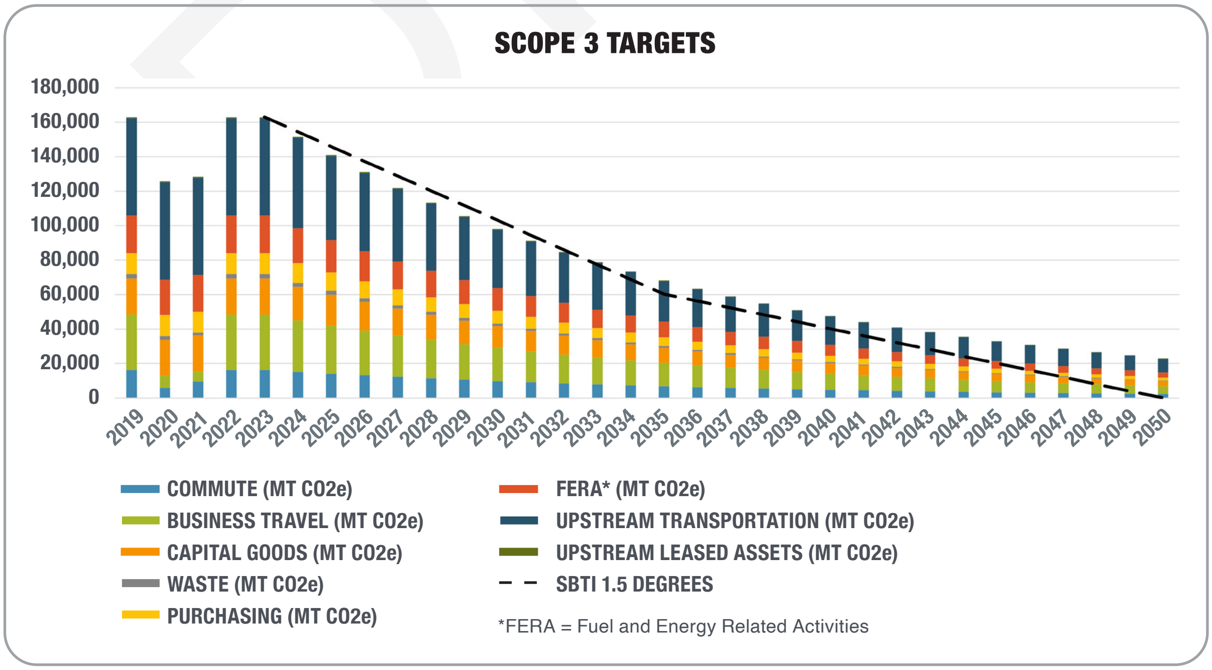
[65] The National Ready Mixed Concrete Association (NRMCA) is an organization representing the interests of companies that produce and deliver ready-mixed concrete in the United States. NRMCA advocates for several practices and initiatives to reduce embodied carbon within the concrete industry.

[66] The International Living Future Institute (ILFI) is an organization that promotes more sustainable buildings and communities. Their Zero Carbon (ZC) Certification is one of the most ambitious environmental certifications available, focusing on making buildings carbon neutral or net-zero in both operation and construction.

- Regarding commuter mileage and associated emissions, JD Power and Associates finds that current EV adoption rates are 8.6% nationwide, and ranks Colorado in the top ten. We have included a decrease in emissions of 7% per year in this category, though neither current nor projected adoption rates would achieve this total.
- To reduce paid air travel, some universities have adopted programs for faculty to voluntarily reduce their air miles. Leveraging this type of strategy, we have projected these emissions to fall by 7% per year as well.
- Finally, waste makes up 4% in the baseline year and by applying the above mentioned strategies, it may be realistic to reduce these emissions also by 7% per year.
- Finally, fuel and energy related activities are also projected to fall 7% per year within the scenario, through compliance by the utility with renewable energy supply rules and the campus's own decarbonization program.

If these reduction assumptions are applied, emissions from the targeted categories would fall by approximately from 105,964 MT CO2e to 57,877 MT CO2e by 2030, a reduction of 45.4%. Further, they would fall to 12,246 MT CO2e by 2050. Given CU Boulder's targets of 50% reduction in feasible categories, by 2050 and 100% by 2050, a commitment to robust emissions measurement, rigorous collaboration with Scope 3 "owners", and search for appropriate incentives will be required.

FIGURE 20: Selected Scope 3 Categories and Targets



Scope 3 Reduction Strategies

While the 15 categories above map directly to established carbon accounting protocols, it may be helpful to view strategies in a broader sense, by viewing them in the larger (and perhaps more familiar) categories of: 1) Transportation; 2) Embodied carbon; 3) Procurement, and 4) Circularity (or, waste management).

TRANSPORTATION EMISSIONS

Scope 3 transportation emissions are associated with business-related travel, commuting, and out of state student and parent trips to campus. This category is significant because these activities are critical to the mission of the university, but the emissions that result are not directly controlled by CU Boulder. Measures to reduce these emissions include engaging faculty and administration to establish and adhere to travel reduction targets, promoting the use of sustainable fuel options in business travel, and avoiding reliance on carbon offsets. For commuting, strategies involve the implementation of a comprehensive Transportation Demand Management Plan, which seeks to increase the use of environmentally friendly transit options like biking, carpooling, and electric vehicles. Additionally, efforts towards expanding and electrifying vanpool programs, developing e-bike and e-scooter strategies, and creating community shared electric vehicle (EV) programs, including EV charging plans with affordable rates. The goal is to reduce the carbon footprint associated with travel while fostering a more sustainable, efficient, and environmentally conscious approach to transportation within the organizational ecosystem.

EQUITY CONNECTION

Improved transportation services play a crucial role in creating equitable housing solutions by enhancing connectivity and accessibility. With efficient public transit options, people can live further from work or educational centers without facing prohibitive commuting costs or times. This accessibility opens up a broader range of affordable housing options, particularly in areas where housing costs are lower. Furthermore, robust transportation networks reduce the dependency on personal vehicles, which can be a significant financial burden for low-income households. By connecting more remote or less expensive areas to city centers and employment hubs, improved transportation systems can help bridge the gap between where people live and where they work or study, promoting greater social and economic mobility.

EMBODIED CARBON

Embodied carbon emissions refer to the greenhouse gasses emitted during the production and manufacturing of building materials. These encompass all the indirect emissions associated with the entire lifecycle of a building, from the extraction and processing of raw materials to the manufacturing, transportation, and eventual disposal of these materials. Addressing Scope 3 embodied carbon requires a shift towards more sustainable materials, efficient construction practices, and life-cycle analyses. This approach not only reduces the carbon footprint of new constructions and major renovations but also aligns with global efforts to combat climate change by minimizing the indirect environmental impact of built environments. Strategies such as updating building materials standards, setting goals to reduce embodied carbon by 10-20% per year, and prioritizing low-carbon construction techniques as they become available are all recommendations of this CAP.

PROCUREMENT

Scope 3 procurement emissions are those generated from the production and supply of goods and services purchased. For this CAP the category includes life-cycle emissions from food, IT equipment, merchandise, paper and books and marketing supplies. Managing these emissions requires the assessment and selection of suppliers based on their environmental performance, encouraging GHG inventories and reduction targets, and integrating sustainable procurement policies. This will require working with the Procurement Services Center to assess and implement carbon reduction strategies with suppliers, establishing a policy to screen products and vendors, favoring those with GHG inventories and reduction targets, and perhaps amending offer letters to researchers to emphasize sustainable practices. Establishing a food recovery program and increasing the purchase of locally-grown and plant-based foods will also reduce transportation associated with procured goods.

CIRCULARITY

This category refers to GHG from waste generated in operations and includes emissions from the entire lifecycle of products used by the organization, from production to disposal. By focusing on circularity, CU Boulder can minimize waste and maximize the reuse, recycling, and sustainable disposal of materials. Strategies include eliminating non-essential single-use plastics, sourcing products with sustainable packaging, establishing reuse centers for items like clothing and furniture, and promoting comprehensive waste management practices. Such efforts are not only environmentally responsible but also align with the growing global emphasis on sustainable development and resource conservation.

TABLE 20: Strategies for reducing Scope 3 emissions by category

#	CATEGORY	ESTIMATED EMISSIONS	STRATEGIES
1	**Purchased goods and services**	**12,216**	• Engage with the system Procurement Services Center (PSC) to identify opportunities to assess and implement carbon reduction strategies with suppliers • Determine an emissions policy to screen products and vendors across all campus facilities (i.e., favor vendors who perform GHG inventories and set reduction targets) • Establish a food recovery program on campus for all catering and culinary events, with program information available in multiple languages and formats • Increase percentage of locally-grown foods purchased and plant-based meals served • Change language of offer letters issued to prospective researcher to explicitly emphasize a commitment to conserving resources through methods like sharing lab equipment, reducing single-use disposables and other sustainable lab practice
2	**Capital goods (embodied carbon)**	**20,944**	• Report on the adoption of Sustainable Materials Purchasing Guidelines, a list of construction materials with low embodied GHG emissions • Update building design standards for new construction and major renovations • Perform whole-building Life Cycle analyses for new construction and major renovation projects • Set official goal to reduce embodied carbon by a minimum of 10% and targeting 20% against a baseline (using either NRMCA or ILFI ZC methodologies) • Prioritize low carbon construction techniques • Align with Buy Clean Colorado
3	**Fuel and energy related activities**	**21,782**	• As natural gas use is reduced and electricity sources become cleaner over time, emissions from this category will decline
5	**Waste generated in operations**	**2,595**	• Eliminate purchase of disposable or single-use plastics for nonessential uses • Further reduce package-related plastic waste by sourcing products with sustainable packaging • Establish a campus reuse center (for clothes, furniture, etc.) • Increase the number of furniture and equipment reuse events, grow the online reuse listings platform, and expand education around the CU Distribution Center • Write a Zero Waste plan to address construction and demolition, and strategies around compostables and food recovery efforts • Translate the results of a pre and post waste audit into an actionable waste diversion roadmap with expected annual reporting metrics
6	**Business travel**	**32,041**	• Engage a broader set of faculty and administration to establish reduction targets and develop strategies to reduce business travel • Provide incentives for traveling with airlines that promote sustainable fuel use, but not purchased carbon offsets
7	**Commuting**	**16,407**	• Institute a formal Transportation Demand Management Plan; include strategies aimed at increasing the use of transit, biking, vanpool, carpool, carshare, and micro mobility • Improve the VMT estimation process to ensure accuracy and replicability of the VMT number annually for sustainability reporting and program analysis. • Expand EcoPass program, an annual prepaid transit pass, to additional staff, and faculty that are affiliated with the University • Expand and electrify the vanpool program and explore options and innovations that will support employees working irregular schedules. • Develop a multifaceted E-Bike and E-Scooter strategy aimed at increasing mode shift and focuses on commuters living within 8-10 miles of campus • Centralize transportation services & consider aligning with Capital Improvement Budget • Follow the actions outlined in the University's Transportation Master Plan • Develop a community shared EV program • Develop a community EV Charging plan with affordable rates for off campus commuters • Host engagement sessions with campus community to determine how best to incentivize the use of electric vehicles • Create charging rate structures to better support renters and affordable charging access, who might not have access to charging at home • Ensure key locations, such as family housing and high-traffic areas on campus have accessible infrastructure. • Continue promotion of high-density affordable housing close to campus to reduce future commuting emissions.
8	**Upstream leased assets**	**538**	• Initiate dialogue w/ leasing agents to identify properties with Scope 1 reduction goals • Scope 2 targets will likely be met by reductions from the utility
9	**Downstream transportation and distribution**	**56,504**	• Initiate surveys to measure student travel during breaks and family visit air travel (currently this category is not well measured, and has been estimated using very high level assumptions and averages - see Annex XX) • Educate students and parents on emissions from air travel • Test programs that reduce the need for travel between Thanksgiving and Christmas breaks

5. CO-BENEFITS: EQUITY, HEALTH, RESILIENCE

Core Goal 3:

Utilize climate action to deliver to the CU Boulder community the co-benefits of equity, health, and resilience.

Co-benefits of taking climate action are positive outcomes that arise from efforts to reduce emissions. These benefits can occur across various sectors, including economic, social, and environmental. Three primary co-benefits have been identified within this CAP: Equity, health and resilience. Many of the Tier 2 and 3 strategies have been developed in support of these co-benefits.

Equity

Climate change affects people differently. Marginalized and frontline communities are disproportionately exposed to hazards from pollution, poor air quality, extreme heat, flooding, drought, and other climate-related hazards. Accordingly, advancing both climate mitigation through emissions reductions, and advancing actions that reduce this inequity are key goals of this CAP. Equity, as a co benefit, is achieved when the University's strategies to reduce greenhouse gas emissions also have direct benefits to these marginalized and frontline communities, include decision-making processes and communication strategies that prioritize the voices of marginalized and frontline communities, and/or remove historical barriers and systemic injustices that negatively affect marginalized and frontline communities. An example is air quality. Colorado has a long history of inequitable and unjust patterns of air pollution, often associated with urban and industrial activity, oil and gas production, and inequities in access to high-quality housing design and construction.[67] These histories and inequities require CU Boulder to commit to monitoring and improving air quality, implementing emission reduction strategies, and collaborating with constituents to address disparities.

Given the scope and scale of the CAP, it is difficult to meaningfully evaluate equity for each goal and emissions reduction strategy. Accordingly, the guiding principles of the plan are meant to ensure that equity is centered in decision-making during plan development and implementation. Here we provide more concrete definitions and principles for guiding climate action implementation on and off campus. In developing and implementing this plan, we rely on two key definitions related to climate and environmental justice.

"Climate Justice recognizes the disproportionate impacts of climate change on low-income communities and communities of color around the world, the people and places least responsible for the problem." - University of California[68]

"Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." - US EPA

[67] https://apnews.com/article/politics-colorado-climate-and-environment-us-environmental-protection-agency-pollution-04eb8c47fccbc32789c1499186651d77

[68] https://ucop.edu/carbon-neutrality-initiative/_files/uc-framework-for-ejcj-in-climate-action_final-4.21.22.pdf

In alignment with these definitions and the broader goal of increasing equity in climate action, we build on past work by other institutions, including the University of California and Second Nature's Climate Leadership Network, to provide guidance on "best practices" for understanding and addressing the equity and justice outcomes of the CAP.We encourage those responsible for implementing the CAP[69] to consider the following:

- In oversight and decision-making, ensure inclusive representation along with equitable compensation (e.g, through awards, honoraria, additional pay, adjustment of responsibilities, etc.) and recognition where possible
- When taking climate action, consider the distribution of costs and benefits and if the action may have disproportionate negative outcomes for any group, especially marginalized and frontline communities
- If a proposed action potentially worsens existing inequity or introduces inequity, consider strategies to mitigate this through, for example, compensation, increased communication and engagement, and/or alternative approaches
- Where possible, prioritize actions that have direct material benefits for marginalized and frontline communities
- Where possible, collaborate with community-based organizations, local businesses, and other external constituents to align the University's climate action with the needs and priorities of local communities, especially marginalized and frontline communities
- Throughout the process of plan implementation, ensure accessible and transparent communication and engagement, prioritizing the input of those most impacted by the University's climate actions

By consistently reflecting on the principles of equity and justice and keeping these guidelines in mind, the CAP and those responsible for implementing it, can not only address the immediate impacts of climate change but also work towards building more equitable and climate-resilient communities.

[69] Implementers of the CAP include University staff, faculty and students, and includes roles such as project decision-making, finance, evaluation, procurement, design, execution, volunteers, and more. While some projects will necessitate senior leadership decision-making, others will be decided and executed at the department level.

Community Health

While the focus of climate action is driven by the need to protect the planet and the health of all life supported by the planetary ecosystem, some initiatives can also improve community health for students, faculty, and staff, through better air quality, reduced particulate pollution, and the reduction of noise. CU Boulder is a large and dense hub of activity, with a significant impact on air quality. Vehicles, generators, and heating systems emit harmful pollutants, and indoor air quality may be compromised due to poor ventilation. Taking the steps outlined in this Plan to reduce emissions by investing in energy-efficient buildings and upgrading HVAC systems can significantly improve indoor air quality with a direct impact on the health and well-being of the campus community. Further, by adopting clean energy, building and transportation options, CU Boulder also improves outdoor campus and city air quality.

Reducing noise pollution is another co-benefit. Noise pollution can negatively impact concentration, academic performance, and overall well-being. However, the promotion of practices such as carpooling and encouraging the use of electric transport, can further minimize noise pollution.

The co-benefits of climate action extend beyond environmental protection and public health. By adopting sustainable practices, universities can create a more pleasant and enjoyable learning environment for students. For example, green spaces, such as gardens, courtyards, and bike paths, not only enhance the aesthetic appeal of the campus but also provide opportunities for relaxation, recreation, and stress reduction. As another example, reducing food waste through recovery programs, and providing sustainable dining options, such as locally sourced, organic food, can promote healthy eating habits among students, contributing to their overall well-being and academic performance. This is in addition to the carbon savings that can accrue to food waste programs by reducing the significant amounts of emissions associated with nitrogen fertilizer used to grow food, and fuel to transport it long distances. Finally, providing opportunities for students to engage in hands-on sustainability projects and programs can instill a sense of environmental responsibility and civic engagement.

Climate action on university campuses is not just an environmental imperative; it is also a powerful tool for improving the quality of life for students, faculty, and staff. By taking steps to reduce emissions, universities can create a healthier, more peaceful, and environmentally conscious learning environment. These co-benefits, in turn, can enhance student well-being, promote academic success, and attract top talent to the university community.

Resilience

Climate resilience is the ability of people, communities, and systems to withstand, adapt to, and recover from the impacts of climate change. It is a key component of climate action, helping to reduce the vulnerability of people and the environment.

There are many ways to build resiliency, including climate adaptation, reducing GHG emissions, and strengthening social structures. The University of Colorado is committed to all three. Many of the strategies in the CAP serve as adaptation steps, even as they also reduce emissions. It is also a priority of the University to strengthen social resilience, increasing our ability to cope with shocks and stresses. This includes CU's efforts in developing disaster preparedness plans and building social networks that can provide support during difficult times.

The following presents several ways by which CU Boulder can improve its own resilience and provide resiliency services to the community.

Climate event preparedness. In the aftermath of a climate event, CU Boulder can play a vital role in helping the broader community recover. The university's resources and capabilities can be used to provide shelter, food, and other essential services to those affected by the event. CU can also provide assistance with damage assessment, recovery planning, and mental health support. By strengthening and modernizing critical energy infrastructure, diversifying the energy portfolio with renewables, and improving the resilience of the campus electric grid in the face of extreme weather events and other potential disruptions, CU Boulder can become a stronger resource to the local community in the event of such disruptions. Here are some specific examples of how CU has served as a post-event resiliency location:

- After the 2013 floods in Boulder, CU opened its facilities to displaced residents and provided food and other supplies.

- After the 2017 wildfires in Colorado, CU helped with damage assessment and recovery planning.
- After the 2020 Marshall Fire in Boulder County, CU provided shelter, food, and other essential services to those affected by the fire.

Demand response. The cogeneration facility currently in operation provides another type of resiliency to the broader community. During periods of peak demand for electricity, the utility calls on CU Boulder to generate its own power, reducing the amount of utility power needed for the City of Boulder and surrounding communities. By reducing peak demand for the utility, CU Boulder is helping to reduce the need to serve that demand through power plants that are used only at peak times. These power plants - called peakers - are often high-emitting generators that can be turned on at short notice. By operating its cogeneration plants, CU Boulder is reducing the need for peakers and their emissions, even though it is burning natural gas to do so. The net effect may be positive emission savings if the peakers used produce more emissions than CU Boulder's cogen plant. CU Boulder performs this demand response about fifteen times per year. In return for taking this action, CU Boulder receives a reduction for all energy purchased, enabling it to save considerably all year round. While this CAP calls for the full electrification of the Main Campus heating system, the demand response role played by the campus is a consideration from both an emissions and financial perspective.

Resiliency can be enhanced through implementing the strategies in this Plan. To further complement the resilience component of Core Goal 3 the following specific strategies are recommended.

- Strengthen campus and community resilience planning, project development, funding, and operations
- Promote campus as a resilience hub in the time of climate emergencies
- Mobilize faculty, staff, students to help with recovery efforts
- Provide valuable assistance in assessing damage, developing recovery plans, and providing support to those affected by the event, using campus expertise
- Work with the surrounding community to build resilience.
- When called to deliver peak power, CU should continue to deliver to the grid.
- Increase the percent of staff, faculty and students trained in emergency preparedness to support self-efficacy when responding to an emergency situation

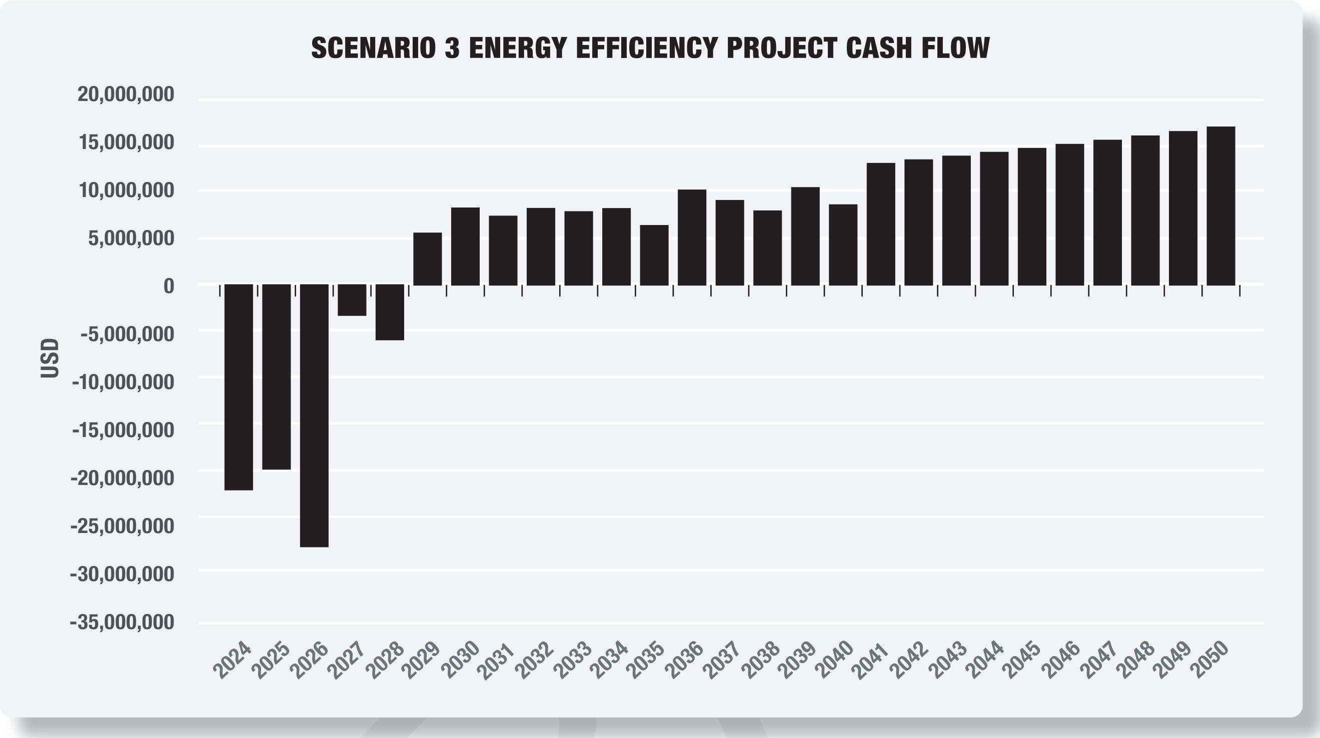
Additional co-benefits may be realized beyond equity, health and resilience. Many of the climate actions recommended by this CAP will also advance CU Boulder's broader sustainability efforts and accelerate it toward a coveted Platinum STARS rating. Further, several of the energy efficiency projects have the potential to save the campus money, in comparison to a baseline of energy costs.

Help achieve a Platinum STARS rating. Implementing a climate action plan will help the university achieve a Platinum STARS rating by systematically addressing key environmental impact areas and aligning with rigorous sustainability standards set by the STARS framework. This Plan contains comprehensive strategies for reducing greenhouse gas emissions, promoting renewable energy usage, enhancing waste management protocols, and integrating sustainability into both the curriculum and campus culture. With a strong focus on measurable outcomes, it will ensure continuous monitoring and reporting of progress, providing transparent and actionable data. This approach not only aligns with the specific criteria for achieving a Platinum rating but also fosters a campus-wide ethos of environmental responsibility and innovation, setting a precedent for sustainability in higher education.

Cost Savings. Several of the strategies recommended by the CAP may save the campus money compared to what would have been spent without the strategies.[70] The most likely projects to do so are the energy efficiency projects described in Chapter 3, which create efficiency gains and reduce the demand for electricity, all else being equal. Using Scenario 3 as the implementation pathway, the graphic below shows expected cash flow over time for the recommended energy efficiency measures (which include lighting, commissioning, and HVAC retrofits plus envelope projects). The NPV of these aggregated projects is estimated at $12,490,174, indicating the potential for significant savings over time.

[70] Other plans have also promised savings in these areas. However, increased utility rates can overtake these savings, leaving real expenses higher. This should not negate savings attributed to these projects, which is why electricity prices should be benchmarked at the time of installation.

FIGURE 21: Scenario 3 Energy Efficiency Project Cash Flow



6. IMPLEMENTATION: GOVERNANCE, ENGAGEMENT, REPORTING & FINANCE

Core Goal 4

Strengthen internal and external management and accountability structures to ensure the campus achieves the goals outlined in the plan.

Core Goal 5

Build a Community Engagement Strategy to integrate communication, feedback, and reporting and achieve an increasing level of transparency with campus and the Boulder community.

A CAP is only as strong as the structures that support its implementation and accountability. Inclusive and equitable governance helps to strengthen the success of a CAP by engaging a range of constituents over time, ensuring diverse representation across leadership and decision-making (along with equitable compensation, when appropriate), and establishing structures for accountability through policies, protocols and working groups. By communicating our successes and failures, the campus aims to foster trust and accountability among stakeholders and demonstrate our commitment to meaningful change.

Implementing the CAP will require CU leadership to execute the actions and report progress. Many of the actions will be dependent upon the allocation of staff time and resources, and budget prioritization.

Implementation of the CAP will be overseen by the Chancellor's appointed Sustainability Council and supported by an ongoing CAP Steering Committee composed of staff, faculty, and students. The Executive Council on Sustainability, established in December 2023 under the leadership of the Executive Vice Chancellor and Chief Operating Officer will also play a key role in successful CAP implementation.

Some strategies contained in the CAP have begun already and/or can start immediately, while others such as capital investments involve a long term series of steps from project scoping, fundraising and procurement, to planning, design, and construction.

Implementation will not necessarily be easy or work perfectly the first time, and perseverance will be important. It will also be important to maintain flexibility in implementing the strategies of the CAP while maintaining a clear eye on achieving the goals and targets within the CAP. As technologies, business models, and political agendas across all levels of government evolve, CU Boulder will need to remain flexible in "when" and "how" it implements the actions in this plan. As costs and feasibility change, the campus will periodically evaluate and adjust as necessary. Similarly, as progress towards key targets is tracked, CU Boulder may need to scale up or down its efforts, depending on the results observed. The campus should update the CAP every five years beginning in 2029, and report every year on greenhouse gas emissions and progress towards their goals. The campus will also remain focused on capturing GHG emissions data across all 15 categories of Scope 3.

Governance

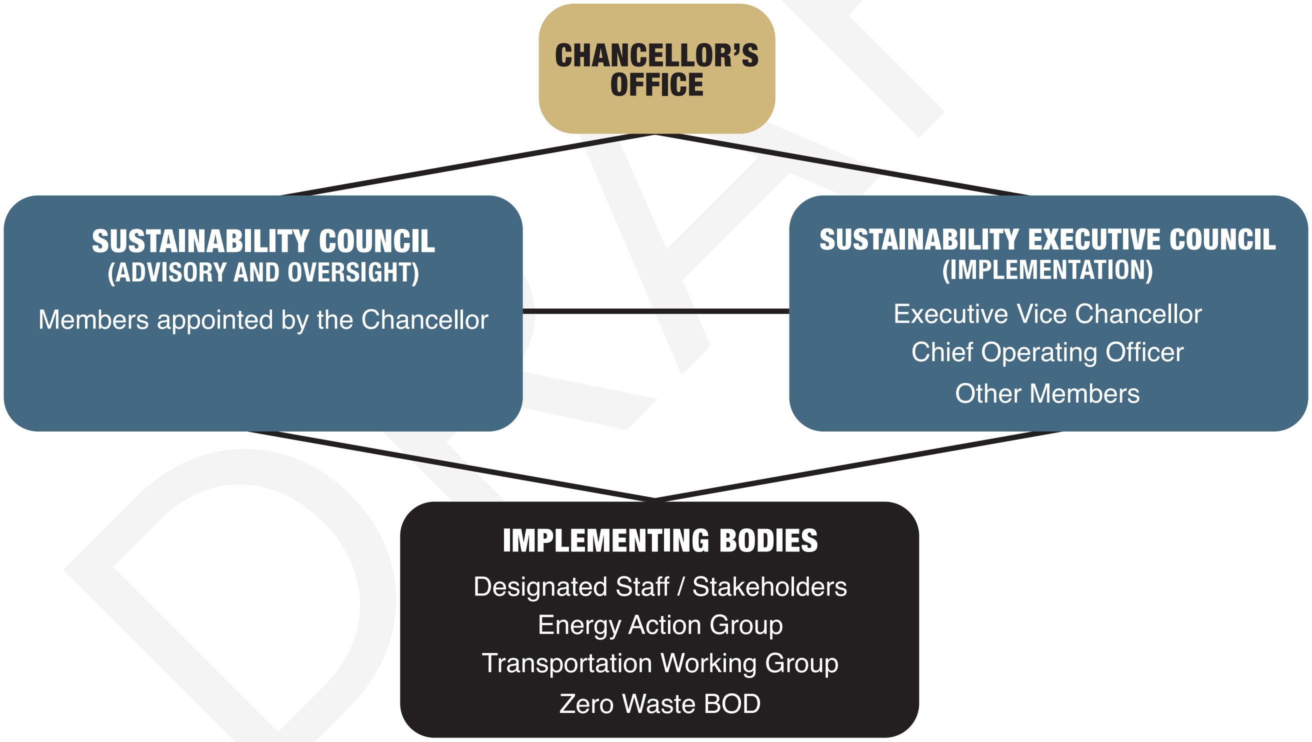
CU Boulder staff and faculty recognize that the campus has many discrete departments and stakeholders that will be required to implement various aspects of the CAP. Therefore, departments and groups will need to begin working together under a common reporting and communication structure. Oversight and monitoring of CAP implementation will reside with the Chancellor's appointed Sustainability Council, and with the Executive Council on Sustainability, led by the Executive Vice Chancellor and Chief Operating Officer.

Designated staff will have specific duties regarding implementation. This will include, but not be limited to oversight and coordination of the actions, programs etc. associated with implementing the CAP; coordination of and response to the CAP Steering Committee; maintenance and updating of the dashboard; response to all inquiries; and preparation of progress reports for the leadership bodies vested with responsibility for successful implementation. All parties will be aided by the Climate Action Tracker, an updateable online list of projects used to track progress over time.

The Chancellor's Sustainability Council will receive a briefing three times each year, from staff on progress (or lack thereof) being made and course corrections that should be considered. The Chancellor's Sustainability Council will then have the option of making course correction proposals to the Executive Council on Sustainability or to the Chancellor's cabinet, or to both as needed.

The Sustainability Council will ratify a working plan to monitor implementation progress using implementation and monitoring tools and will report to campus leadership and to the system office on annual progress. As part of annual progress reports, the CAP Steering Committee will evaluate the effectiveness of each strategy to ensure that anticipated emissions reductions are occurring. In the event that reductions do not occur as expected, recommendations can be made to the Council and campus leadership by the CAP Steering Committee to modify and add policies or actions to ensure the target is achieved.

FIGURE 22: Governance Organizational Flow Chart



Reporting and Accountability

Ongoing Engagement: CU Boulder recognizes that the voices and perspectives of marginalized communities are often overlooked or underrepresented. Through ongoing and inclusive engagement, the University will actively seek input and feedback from these communities, ensuring that a diverse range of concerns and needs are incorporated into the decision-making process necessary for implementing the plan.

Constituents: The CAP prioritizes the needs and well-being of all constituents, with a particular focus on marginalized and vulnerable populations. By actively involving these communities in the development and implementation of the plan, the University can ensure that their voices are heard, their experiences are considered, and action is taken to address their specific challenges. In order to realize these goals, the campus will strive to engage these stakeholders in a way that doesn't unjustly overburden them.

Informed Decision-making: The approach to climate action planning and implementation is rooted in data and research, and a deep understanding of the systemic inequalities present within our society. By collecting, integrating, and sharing data across a range of topics (environmental conditions, emissions targets, demographic trends, ongoing disparities, etc.), the University can make informed decisions that address injustice and inequity while mitigating the impacts of climate change.

SMART Indicators: The University will establish specific, measurable, achievable, relevant, and timely (SMART) indicators to track progress and hold ourselves accountable for the goals outlined in the CAP. These indicators will enable the campus to monitor the distribution of costs and benefits, and they will ensure that actions contribute to the reduction of environmental disparities. Linked with the above elements, these goals and our progress towards them should be shared across the campus community and beyond to ensure transparency.

Scope 3 Emission Reporting: Recognizing that marginalized communities are often disproportionately affected by indirect emissions (Scope 3), the campus will enhance reporting and accounting practices to capture these impacts accurately and implement strategies accordingly. In this way, the University can contribute to broader efforts that promote a more just and sustainable future. Specific areas for improved reporting include student travel to and from campus, emissions associated with purchased goods and services, and inequitable waste management practices.

Collaboration with Curriculum and Faculty Training: To promote climate and environmental justice, CU Boulder will collaborate with faculty to integrate these topics into the curriculum and provide training opportunities. By equipping students with the knowledge and skills to understand and address environmental inequities, the University can foster a future generation of change-makers committed to justice and sustainability.

Regular and Transparent Reporting: The University is committed to regular and transparent reporting on our progress, including the specific actions taken to address climate and environmental justice. By communicating our successes and failures, the campus aims to foster trust and accountability among stakeholders and demonstrate our commitment to meaningful change.

Tools. Several tools have been developed as part of the development of the CAP. These have been designed to facilitate ongoing and collaborative decision making among stakeholders. The first is the CESA tool, which can provide leadership with ongoing decision making analysis. The second is the Climate Action Tracker, which is designed to keep track of strategies as they are executed. The third tool is an online dashboard that has been created to serve as a public communication piece that showcases the impact of various actions on CU Boulder emissions.

1. The **Climate and Energy Scenario Analysis (CESA) tool** can be used as a benefit-cost analyzer to track the progress of project implementation. As projects are executed, CESA keeps track of GHG reductions, costs, and can be used to re-prioritize projects if needed. CESA can also be customized to keep track of cost savings that accrue from efficiency gains. CESA is capable of creating multiple scenarios that provide visuals to do an apples-to-apples comparison over many project pipelines.

2. The **Climate Action Tracker** combines stakeholder feedback with strategy development to determine and clearly identify what additional gaps in data or funding is needed. The Tracker functions like a workbook and serves as the single point for planning, reporting and ongoing performance monitoring. The Tracker: (1) establishes a "starting point" for future comparisons; (2) tracks strategies and actions identified in the CAP; (3) records contributions and actions of multiple campus leaders; and (4) summarizes results and impacts. The Climate Action Tracker can be used to assign various action and reporting items to key departments responsible for reporting. The Tracker is additionally designed to feed information into Second Nature's annual reporting of GHG emissions and the Sustainability Tracking Assessment & Rating System (STARS).

3. An **online dashboard** has been created that will act as a public facing online progress reporting mechanism. The dashboard provides both summary graphs of total emissions against the GHG reduction targets, as well as itemized charts where users can dive into the data in more detail. In addition to monitoring emissions, the dashboard also reports the campus energy usage and fleet electrification status. On each page of the dashboard, key performance indicators provide an overall snapshot of Boulder's performance and progress towards the emissions reduction targets.

TABLE 21: Supportive communication strategies

REPORTING AND ACCOUNTABILITY	
STRATEGY	**ACTION STEPS**
Update campus policies and expand communication to support the goals, strategies, and actions identified in this CAP.	The Sustainability Councils will be tasked with regularly reviewing and recommending policy updates or adjustments as deemed appropriate. Many system-wide policies may be out of the Council's direct control, however, the Council will monitor and advocate for policy alignment. • Review policies and procedures to ensure they are created with a lens on environmental, fiscal, and social considerations annually by the Sustainability Councils • Ensure an environmental justice lens is being used
Institute a formal training and assessment framework that will be adopted by the Sustainability Council.	The Sustainability Council will create a framework that will be approved by the Executive Sustainability Council. The Sustainability Council will help to guide and report on progress made by implementing units. This framework will be reviewed and adjusted annually as the campus moves the CAP's implementation timeline forward. • Build a Train-the-trainer model that will be implemented by the Environmental Center • Suggest a student-facing "activism" Train-the-Trainer opportunity - look at successful models on other campuses • Offer training for lab users and graduate student orientation on sustainable practices annually • Establish a Train-the-trainer model to disseminate sustainability information from department managers to specific purchasing personnel

Engagement

Engagement and regular communications about all aspects of the CAP are critical to its success. In the development of the Plan, CAP constituent engagement events have included survey reports, focus group discussions, workshops, and a town hall. A non-unanimous decision-making process decided whether participants' comments and suggestions were integrated into the plan. The feedback received has developed and refined the strategies, in addition to providing guidance on equity implication statements, climate justice projects, and new opportunities. As the CAP is implemented, collaboration between the university and campus and community constituents will remain essential. A summary of the steps taken to engage stakeholders is presented below.

To promote long-term and continued engagement, the Sustainability Council will organize ongoing meetings, surveys, and an online reporting dashboard that will allow the community to give feedback and contribute to the ongoing development of all aspects of the CAP. Climate justice projects should be kept as a primary aim. Campus leadership—working in concert with the Sustainability Council and shared governance leadership via the COO-led Sustainability Executive Council announced in December 2023—will regularly communicate and engage campus and community stakeholders on progress, synthesize feedback received, and determine what the appropriate next steps are to achieve stated goals.

Stakeholder engagement in developing this CAP included feedback from members of the campus and Boulder community. Input was solicited through the following:

- The 2022 Annual Campus Sustainability Summit allowed participants to reflect on positive and negative experiences on campus linked to sustainability, suggestions for future action, and creative communication
- Tabling opportunity with the Latino Chamber of Boulder County
- Meetings with community groups including Boulder Housing Partners, Climate Justice Collaborative of Boulder County, and the Boulder County Latino Coalition
- A 2023 stakeholder engagement luncheon where attendees used sticky notes and pens, color-coded with university affiliation, to share feedback on the draft plan, suggest additional strategies, and identify what should be added to the plan. Resources were provided in Spanish and English, Participants also ranked which goals they would want to prioritize in the plan
- A CAP town hall in 2023, where participants reviewed prioritization and equity implication statements and provided feedback and suggestions
- A CAP Survey deployed in 2023 focused on student input. 151 responses were received and synthesized. Respondents provided feedback on the goals of the plan, equity considerations, their individual sustainability actions, and related topics
- A community-wide public comment period in early 2024 to review Final Draft of the CAP
- A CAP website both informed stakeholders of the content and progress, as well as gave all a portal through which to ask questions and make suggestions

Finance

Determining pathways for finance was a key consideration of this CAP. Outside of the CAP Steering Committee weekly meeting, the Committee met monthly with the Director of Capital Finance to review ongoing cost, implementation and financing scenarios. A goal has been to explore cost effective and economically attractive financing pathways that address both one-time and ongoing costs, and that achieve the maximum benefits (including health, equity, resilience, life cycle, local economic development).

The funds to successfully implement this Plan will be unprecedented, requiring an openness to innovation, new partnerships and dynamic leadership. Realizing these plans will mean the campus must think differently about many of its operations, behaviors and business models. Creativity and tenacity will be essential. An initial list of capital availability includes both traditional and emergent sources. For example, sources can include operating and capital budgets, as well as cash accounts that are being held for future use. Additionally, grants from government agencies, foundations and the private sector that support climate-related projects are also possible. As an important current government example, the 2022 Inflation Reduction Act (IRA) is a new federal source of funding that is unprecedented in size and will allow public entities to receive direct payments in support of certain investments in clean energy and vehicles.

Bond issuances and state-level appropriations are a traditional way that universities can fund large expenses (usually projects of $10 million or more due to the costs of securing the funds). Another funding strategy for large projects, and even multi-project programs, is through some form of public-private partnership (PPP). Through this type of strategy, the University would partner with a private sector third party to develop and help finance climate-related investments. PPPs range in complexity and focus. For example, ESCOs tend to be narrowly focused on energy efficiency projects, such as lighting and building mechanical system upgrades, building envelope improvements and solar projects. Other privately funded alternatives can provide complex ownership arrangements, long term deals and significant amounts of up front capital that may be used for a variety of funding needs, which are then paid back over time. Finally, a special endowment fund could be pursued via fundraising. This would involve the Office of Advancement prioritizing climate when engaging donor networks to ask for contributions to establish a fund dedicated to sustainability projects. More detail on funding strategies can be found in Annex E.

FIGURE 23: Cumulative Cash Flow by Year

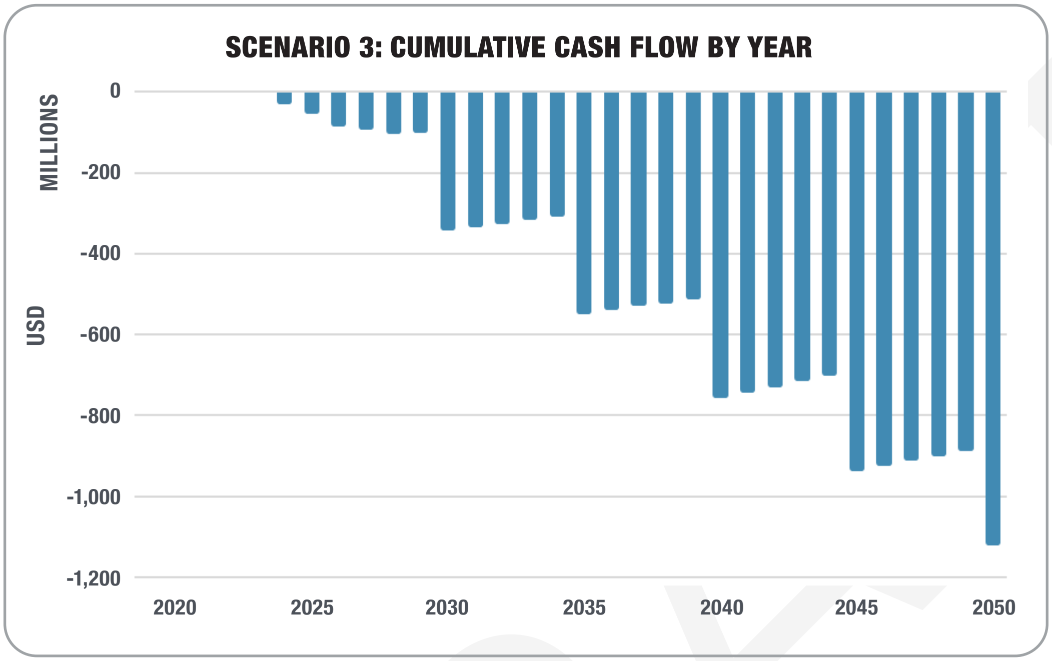


TABLE 22: Funding Suggestions per strategy[71]

FINANCE	
STRATEGY	**FUNDING SUGGESTIONS**
General	• Prioritize federal, state, and utility incentives and grants • Follow the implementation plan within the CESA tool, updating annually • Explore a more robust Green Revolving Fund, that can be partially replenished through dedicated reinvestment in the Fund from the savings derived, especially from energy efficiency projects.
Renewable energy	• The Inflation Reduction Act (IRA) allows public entities a cash reimbursement payment of up to 30% for initial investments in new RE installations. • Green bonds may be available, with extended payback times. • C-PACE. Under Colorado Revised Statutes § 32-20-104 public entities are eligible. • Third party solutions such as Energy Service Companies (ESCOs) and Infrastructure as a Service (IAAS), are also options.
Vehicle Fleet and Infrastructure	• IRA also contains a provision for a Commercial Clean Vehicle Tax Credit and charging infrastructure. • Colorado's Green Business Loan Fund offers loans ranging from $10,000 to $500,000 with interest rates typically below market rates • The Clean Fleet Vehicle Technology (state) Grant Program, offered by Clean Fleet Enterprise (CFE), is designed for eligible light-, medium-, and heavy-duty fleet vehicles. • The EPA's Clean Heavy Duty Vehicles are grants and rebates available for up to 100% of the costs associated with clean heavy-duty vehicles. • Charge Ahead Colorado, provides grant funding for community-based Level 2 (L2) and DC Fast-Charging (DCFC) electric vehicle (EV) charging stations • Colorado's Fleet Zero-Emission Resource Opportunity (Fleet-ZERO) is a grant program aimed at supporting EV charging infrastructure. • Internal campus funds may be an option, since EVs would take the place of existing vehicles at the time of end of life.
Energy Efficiency	• The Department of Energy's Renew America's Nonprofits, provides grants for developing energy efficiency projects in nonprofit buildings. • Section 179D of the U.S. tax code provides a tax deduction for implementation of energy-efficient improvements in commercial buildings. • Self-funding through cash (i.e. money currently saved for a long-term expense) or a Green Revolving Fund may be possible, if savings are captured against a baseline. • C-PACE can be used for energy efficiency projects • Colorado's Public Building Electrification Program, provides public buildings with funding to explore and implement building system electrification measures and infrastructure upgrades • Colorado's High Efficiency Electric Heating & Appliances (HEEHA) Program (May '23), supports community efforts to switch to high efficiency electric heat & appliances
Central Utility Plant	• Third party solutions may be the best alternative for financing these large and expensive projects. These arrangements may allow for financiers to own other aspects of the University's operations in order to create more positive cash flows. These include ESCOs (which would need to limit their investments to energy-related projects) IAAS, and other public-private partnerships. • Green bonds, and an • Special endowment raised specifically for this purpose.

[71] The programs listed in the Table are explained in greater detail in Annex E.

Roadmap

Table 23 provides a possible implementation roadmap for the strategies. This timeline will be revisited in an annual monitoring of the CAP. During the implementation process, dates may need to be changed due to unforeseen circumstances, and some strategies may require revisions. The timeline has been created based on…

TABLE 23: Strategy List with Generalized Timeline[72]

TIER	SCOPE	SCOPE 3 CATEGORY	STRATEGIES	GENERALIZED TIMELINE
1	1+2	NA	Re-commissioning projects	2024–2030
1	1+2	NA	HVAC system retrofits	2024–2030
1	1+2	NA	Envelope improvements	2024–2040
1	1+2	NA	New Building Efficiency Design Standards	2024
1	1	NA	Main campus heating system upgrade	2030–2050
1	2	NA	Lighting retrofits	2024–2030
1	2	NA	On-campus solar PV	2025–2030
1	3	2	Update building materials standards for new construction and major renovations	2024
1	3	7	Institute a Transportation Demand Management Plan encouraging mode shifting	2026
1	3	7	Develop an affordable community EV Charging plan	2030
1	1	NA	Electrify campus vehicle fleet	2024–2037
2	3	1	Identify opportunities to assess & implement carbon reduction with suppliers	2025
2	3	2	Reduce embodied carbon by >10% and target 20% for new construction and major renovation projects; align with Buy Clean CO	2024–2030
2	3	5	Institute a construction waste diversion policy	2025
2	3	6	Facilitate discussion on options to reduce business travel emissions	2025
2	3	6	Incentivize use of airlines that promote sustainable fuel use, but not purchased carbon offsets	2026
2	3	7	Develop a community shared EV program	2028
2	1+2	NA	Optimize Existing Building Space	2026
2	3	3	Reduce upstream gas leakage (will result from decreased gas use)	2024–2045
3	3	1	Establish a food recovery program on campus for all catering and culinary events	2030
3	3	1	Increase percentage of locally-grown foods purchased and plant-based meals served	2029
3	3	5	Eliminate purchase of disposable or single-use plastics for nonessential uses	2030
3	3	5	Establish a campus reuse center (clothes, furniture, etc.), and online reuse platform	2028
3	3	5	Write a Zero Waste plan to address construction and demolition, and strategies around compostables and food recovery efforts	2030
3	3	5	Translate the results of a pre- and post-waste audit into an actionable waste diversion roadmap with expected annual reporting metrics	2032
3	3	7	Host engagement sessions with the campus community to determine best incentives for the use of electric vehicles and e-bikes. Consider distributing e-bikes to low-income students/staff through a sponsorship program.	2032
3	3	7	Improve the VMT estimation process to ensure accuracy and replicability of the VMT number annually for sustainability reporting and program analysis	2025
3	3	7	Expand staff vanpools to make them available to more low-income staff	2026
3	3	9	Initiate surveys to measure student travel during breaks and family visit air travel	2027
3	3	9	Educate students and parents on emissions from air travel	2027
3	3	9	Explore options, along with CU system partners, to reduce travel related emissions during holiday breaks	2027

[72] Each strategy within this CAP is prioritized into three Tiers: Foundational (Tier 1), Supportive (Tier 2) and Complementary (Tier 3). Foundational strategies are those that directly reduce emissions and are drawn out as immediate priorities. Supportive strategies are ranked next and indicate strategies that have less of a direct GHG reduction potential but are still critical elements in reducing climate impacts. Complementary strategies are focused on educational and engagement areas that create durability and wider-reaching impact.

CONCLUSION

Conclusion

CU Boulder's 2024 Climate Action Plan (CAP) is a comprehensive and ambitious blueprint for driving significant greenhouse gas emission reductions, while promoting equity, health, and resilience within the university community and beyond. It is anchored in a clear understanding of current emissions across Scopes 1, 2, and 3, and sets forth a strategic and multifaceted approach to achieve a 50% reduction in emissions by 2030 and carbon neutrality by 2050. The Plan's integration of equity considerations ensures that climate action at CU Boulder is not only environmentally sound but also socially responsible, taking into account the varying impacts on different community segments. By committing to this proactive and inclusive strategy, CU Boulder hopes to set a precedent for academic institutions globally and contribute significantly to the fight against climate change. The challenges ahead are considerable, yet the CAP's combination of targeted emissions reduction strategies, internal governance, community engagement, and robust financial planning, positions CU Boulder to meet these challenges head-on, positioning the university as an example in sustainable and equitable climate action.

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Annex A: Fleet Electrification Strategic Plan

Annex B: Renewable Energy Methodology & Assumptions

Annex C: Technical Annex: GHG emissions inventory and forecasts

Annex D: Scope 3 Measurements, Targets and Future Plans

Annex E: Financing Possibilities

OTHER RESOURCES

1. **Boulder Racial Equity Plan**
   https://bouldercolorado.gov/media/4167/download?inline
2. **Climate, Ecosystems, and Community**
   https://bouldercolorado.gov/media/561/download?inline
3. **Colorado climate change vulnerability study**
   https://dnrweblink.state.co.us/cwcb/0/doc/202146/Electronic.aspx?searchid=f02d65b3-001a-4eb5-ae79-f08bab6ac37c
4. **A Framework for Incorporating Environmental & Climate Justice into Climate Action (University of California)**
5. **ICLEI: Equity first steps guide**
   https://icleiusa.org/wp-content/uploads/2022/09/Equity_-First-Steps-Guide.pdf
6. **Climate equity indicators**
   https://www.cincinnati-oh.gov/sites/oes/assets/File/Climate%20Equity%20Indicators%20Report_2021.pdf
7. **Equity indicators**
   https://www.equitymap.org/_files/ugd/4aef44_048801f07d164e0c82d10290afadf27d.pdf?index=true
8. **Glossary**
   https://docs.google.com/spreadsheets/d/1hhDKfneTCl0LqGhFJ7YpK9_BVmMtyszeOVZ46de1Qiw/

ACRONYMS

APUPCC - American College & Universities Presidents Climate Commitment

BAU - Business as usual

BIPOC - Black, Indigenous, and People of Color

CAP - climate action plan

C&D - construction and demolition

CESA - Climate and Energy Scenario Analysis tool

CFE - Clean Fleet Enterprise

CNAIS - Center for Native American and Indigenous Studies

CO2 - carbon dioxide

CSG - Community solar garden

CP - capital projects

C-PACE - Colorado Commercial Property Assessed Clean Energy

CPCN - Conceptual Plan for Carbon Neutrality

CU Boulder - University of Colorado Boulder

CUP - central utility plant

DCFC - DC Fast Charging

DEI - Diversity, Equity, and Inclusion

EE - energy efficiency

EMP - Energy Master Plan

EPA - Environmental Protection Agency

EPR - Extended Producer Responsibility

ESCOs - energy service companies

ESG - environmental, social, and governance

EUI - energy use intensity

EV - Electric Vehicle

FEMA - Federal Emergency Management Agency

FLOWS - Foundation for Leaders Organizing for Water and Sustainability

GHG - Greenhouse Gas

GWP - Gross warming potential

HEEHA - High Efficiency Electric Heating & Appliances

HSU - Heating system upgrade

HVAC - heating, ventilation and air conditioning

IAAS - Infrastructure as a Service

ICE vehicles - internal combustion engine vehicle

IECC - International Energy Conservation Code

ACRONYMS

ILFI ZC methodology - International Living Future Institute's Zero Carbon Methodology

IRA - Inflation Reduction Act

kW - kilowatt

kWh - kilowatt hours

LEED - Leadership in Energy & Environmental Design

M&E - monitoring and evaluation

MRF - Materials Recovery Facility

MT - metric tons

MTCO2e - metric tons of carbon dioxide equivalent

MW - megawatt

MWh - Megawatt hours

NGO - non-government organization

NOx - Nitrous oxide

NPV - net present value

NREL - National Renewable Energy Laboratory

NRMCA - National Ready Mixed Concrete Association

OGSF - outside gross square feet

PPP - public-private partnership

PSC - Procurement Services Center

Solar PV - photovoltaic solar

RAPT - resilience analysis and planning

RE - renewable energy

RECs - Renewable Energy Certificates

RPS - Renewable Portfolio Standards

SBT - Science based targets

SBTi - Science Based Targets Initiative

SCC - Social cost of carbon

SMART - specific, measurable, achievable, relevant, and timely

SMEs - Subject Matter Experts

STARS - Sustainability Tracking Assessment and Reporting System

SUV - Sport utility vehicle

TRN - transportation

UN - United Nations

UMC - University Memorial Center

VMT - vehicle miles traveled

VNEM - Virtual net metering

TOOLS

FEMA NATIONAL RISK INDEX

https://hazards.fema.gov/nri/map

ENERGY ACCESS

LEAD

Climate and economic justice screening tool

Egrid power profile (clean energy access)

PUBLIC HEALTH

Tree equity score

Parkserve

INFRASTRUCTURE

RAPT (resilience analysis and planning)

EPAs smart location mapping

All transit

ECONOMIC PROSPERITY

US Census

EPA EJ screen tool

CO environmental justice mapping tool

ANNEXES

University of Colorado Boulder
FLEET ELECTRIFICATION STRATEGIC PLAN

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Appendix A: Comprehensive vehicle database & tco comparisons
Appendix B: fleet electrification pro forma

Acronyms

BEV	Battery Electric Vehicle (See also *EV* & *PEV*)	**kWh**	Kilowatt hour
DCFC	Direct Current Fast Charge (DC Fast Charger)	**PHEV**	Plug-in Hybrid Electric Vehicle
EV	Electric Vehicle	**TCO**	Total Cost of Ownership
EVSE	Electric Vehicle Supply Equipment (EV Charger)	**V**	Volt
ICE	Internal Combustion Engine	**ZEV**	Zero-Emissions Vehicle
kW	Kilowatt		

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EXECUTIVE SUMMARY

This report provides a systematic assessment of all University of Colorado Boulder (CU Boulder) operated vehicles with the primary goals of identifying vehicle electrification opportunities, establishing an electrification timeline based on vehicle replacements and the University's goals of 50% reduction of Scope 1 and 2 carbon emissions by 2030 and determining the costs and emissions benefits of fleet electrification. The analysis assessed relevant vehicle data in the University's records including data provided by the University Facilities and Transportation Departments. Available data included vehicle makes, models, ages, purchase date and price, fuel type, usage and costs, and miles travelled. Quantitative data was supplemented by interviews with appropriate CU Boulder staff to better understand how vehicles are used and the anticipated future mobility needs of each department.

After accounting for non-street legal assets (trailers, generators, etc.) and vehicles that are already electric, 452 out of 454 total vehicles provided by the University were studied for electrification. Of this subset, 81% can be replaced with equivalent electric vehicles that are currently commercially available, predominantly sedans, SUVs and pickup trucks. Most of the remaining vehicles (14% of 452) have potential electric candidates for replacement but challenges, primarily related to cost-effectiveness or operational requirements, remain. About 4% of the vehicles provided do not have a potential candidate for electrification currently available or announced in the market.

KEY FINDINGS

- 368 vehicles in CU Boulder's fleet can be replaced with equivalent electric vehicles that are currently commercially available and likely to be cost-effective (categorized in the analysis as "Best Fit for Full Electrification"). At current vehicle costs, excluding incentives, electrifying the subset of these vehicles coming due for replacement from present to 2050 will cost approximately $30,736,075 over the lifespan of the vehicles, approximately a 92% increase in operating costs. This estimate does not include the cost of installing and maintaining EV chargers.

- The carbon emissions reductions corresponding with replacement of the University's Best Fit vehicles is an estimated 713 $MTCO_2$ (46%) from 2021 levels by 2030 and 171 $MTCO_2$ (87%) by 2050. If the University expands its electrification efforts to include vehicles that are Potentially Electrifiable, it can achieve carbon emissions reductions of 698 $MTCO_2$ (47%) from 2021 levels by 2030, and 65 $MTCO_2$ (95%) by 2050.

- Following the replacement schedule detailed in this report, CU Boulder can electrify 29% of its light-duty vehicles by 2030 and 100% by 2050 (under the Best Fit Electrification Scenario).

- Electric vehicle range is not a barrier to vehicle electrification for the University. For 100% of the vehicles assessed, the recommended EV option could satisfy 100% of the existing vehicle's historical driving behavior.

EXECUTIVE COSTS SUMMARY

SITE	2030				2040				2050			
	# OF EVs (% OF TOTAL)	# OF PORTS	CHARGER CAPITAL COSTS*	VEHICLE CAPITAL COSTS*	# OF EVs (% OF TOTAL)	# OF PORTS	CHARGER CAPITAL COSTS*	VEHICLE CAPITAL COSTS*	# OF EVs (% OF TOTAL)	# OF PORTS	CHARGER CAPITAL COSTS*	VEHICLE CAPITAL COSTS*
HFOC / HSSC (3500 MARINE ST.)	28 (36%)	2 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	$262,716	$2,293,275	47 (61 %)	2 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	$0	$1,892,363	77 (100 %)	2 x 6.6 kW 6 x 11.5 kW 2 x 25 kW	$54,196	$3,671,785
REGENT GARAGE (LOT 436) / PDPS	13 (18%)	2 x 6.6 kW 4 x 11.5 kW	$162,911	$998,299	44 (61 %)	4 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	$108,615	$1,280,859	72 (100 %)	4 x 6.6 kW 8 x 11.5 kW 2 x 25 kW	$158,200	$1,729,926
FOLSOM GARAGE (LOT 391)	4 (17%)	2 x 6.6 kW 2 x 11.5 kW	$110,004	$107,000	10 (43 %)	2 x 6.6 kW 4 x 11.5 kW	$60,420	$457,632	23 (100 %)	2 x 6.6 kW 4 x 11.5 kW 1 x 25 kW	$54,196	$1,006,964
STADIUM LOT	53 (37%)	4 x 6.6 kW 6 x 11.5 kW 2 x 25 kW	$403,826	$5,609,187	94 (66 %)	4 x 6.6 kW 6 x 11.5 kW 2 x 25 kW 1 x 200 kW	$272,645	$3,762,595	142 (100 %)	4 x 6.6 kW 8 x 11.5 kW 4 x 25 kW 2 x 200 kW	$466,098	$5,279,915
SEEC LOT	22 (45%)	2 x 6.6 kW 2 x 11.5 kW 3 x 25 kW 6 x 200 kW	$1,907,264	$13,431,940	34 (65 %)	2 x 6.6 kW 4 x 11.5 kW 3 x 25 kW 6 x 200 kW	$60,420	$3,873,486	49 (100 %)	2 x 6.6 kW 4 x 11.5 kW 3 x 25 kW 12 x 200 kW	$1,575,407	$14,774,498

MACKY LOT	1 (25%)	1 x 6.6 kW	$57,181	$53,500	(50%)	1 x 6.6 kW	$0	$53,500	(100%)	6 kW 2 x 25 kW	$145,034	$312,000
LOT 306 / LOT 319	5 (20%)	2 x 6.6 kW 2 x 11.5 kW	$158,200	$398,866	16 (64%)	2 x 6.6 kW 4 x 11.5 kW	$0	$364,532	25 (100%)	2 x 6.6 kW 4 x 11.5 kW	$60,420	$830,132
UMC DOCK / SERVICE LOT N (1045 18TH ST)	4 (25%)	2 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	$110,004	$399,566	12 (75%)	4 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	$60,420	$354,800	16 (100%)	4 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	$0	$464,400

*includes incentives

Introduction

The purpose of this report is to document the analysis of each fleet asset studied, and include the following research elements:

1) Fleet baseline summarizing vehicles studied, fleet composition and categorization of fleet by electrification potential
2) Explore appropriate vehicle needs of each department to guide fleet electrification, including a schedule and recommendation for electrification of each analyzed vehicle, or category of vehicle.
3) Analysis of Total Cost of Ownership and capital budget needs associated with fleet electrification
4) Analysis of potential carbon emissions reductions associated with fleet electrification

Challenges of Vehicle Electrification Planning in a Dynamic Market

CU Boulder can only make fully informed electric vehicle purchase decisions regarding the information on currently available EV models. The University can also make preliminary plans for purchasing vehicles based on product announcements by the automotive industry, but specific information on purchase prices and dates of availability remain speculative. Beyond 2025, limited actionable information is available on product offerings, but the market dynamics indicate that the University can safely assume that zero-emission vehicle offerings will be available for most vehicle categories by 2030 and prepare for that eventuality.

In the last few years, multiple electric models that are viable options for fleets, beyond standard light-duty sedans, have become commercially available, including the Ford F-150 Lightning, Ford eTransit, and Mustang Mach E, and this trend is expected to continue and expand beyond the light-duty segment. According to the International Energy Agency's 2022 EV Outlook, the EV market share in the United States had been relatively lower than other major markets internationally, but EV sales increased in 2021 to 630,000 cars sold (more than 2019 and 2020 combined). In total, the United States has over 2 million EVs on the road.[1] Additionally, the availability of medium- and heavy-duty electric vehicles is expanding globally, including in the United States, although the total number of models available in China and Europe still outpaces the U.S.

As options expand, costs are continuing to fall, mostly related to continued decline in battery costs.[2] In light of the rapidly changing market, this analysis attempts to include at least one electric option, even if that option may not be cost-effective, to provide the University with the most up to date view of potential electric options and ensure that the charging infrastructure needs modeling informed by this analysis is considering energy demands that reflect a completely electrified fleet.

[1] Global EV Outlook 2022, International Energy Agency
[2] International Council on Clean Transportation, Update on electric vehicle costs through 2030: https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

PART I

VEHICLE STUDY & REPLACEMENT PLAN

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Fleet Composition

This section describes in further detail the data sources used in this report and summarizes the composition of CU Boulder's vehicle fleet.

Data Sources

As one of the first steps of this project, CU Boulder's fleet data were gathered from various data sources and a comprehensive database was compiled for further analysis. The data sources used in this project include the following:

- **University Fleet Inventory**: This database served as the primary data source for this project. The University Fleet Inventory is an Excel-based database maintained by the University's Transportation Department that contains information on each vehicle, such as equipment ID, make, model, year, fuel type, power train, department, odometer reading, purchase year and purchase price. During the project, this database was updated in collaboration with University Transportation Department staff to remove vehicles that had been recently retired and add vehicles that had been recently purchased but not added to the inventory prior to project kick-off.

- **National Highway Traffic Safety Administration (NHSTA) Vehicle Identification Number (VIN) Decoder**: To supplement vehicle information included in the University Fleet Inventory, the NHSTA VIN Decoder, an online software tool that interprets VINs and provides an extensive list of characteristics corresponding to that VIN, was used to gather additional vehicle characteristics. Specifically, it was used to gather the Gross Vehicle Weight Rating (GVWR) and Body Type of each vehicle.

In addition to the above-mentioned data sources, qualitative data was collected through discussions with University Transportation and Facilities Management staff, such as vehicle duty cycles and emergency response requirements. In all, the data collection efforts described above led to the creation of a comprehensive fleet database, attached to this report as **Appendix A**, which served as the basis for all further analyses.

Fleet Composition and Characteristics

Summary of Fleet Assets

This section provides descriptive statistics to understand the current condition and composition of CU Boulder's fleet. The final fleet database included a total of 452 units, including light-, medium-, and heavy-duty vehicles. After reduction of the 19 vehicles that were not studied, 433 were included in the electrification analysis and are represented in the figures below.

Figure 2 depicts the breakdown of the fleet by vehicle type. Over half of the analyzed fleet falls under three vehicle categories: Pickup, Cargo Van, and Sport Utility Vehicle (SUV). The "Pickup" category includes light- and medium-duty vehicles ranging from smaller pickups such as the Ford Ranger to larger pickups such as the Ford F-350.

Figure 2. Entire Fleet – Composition

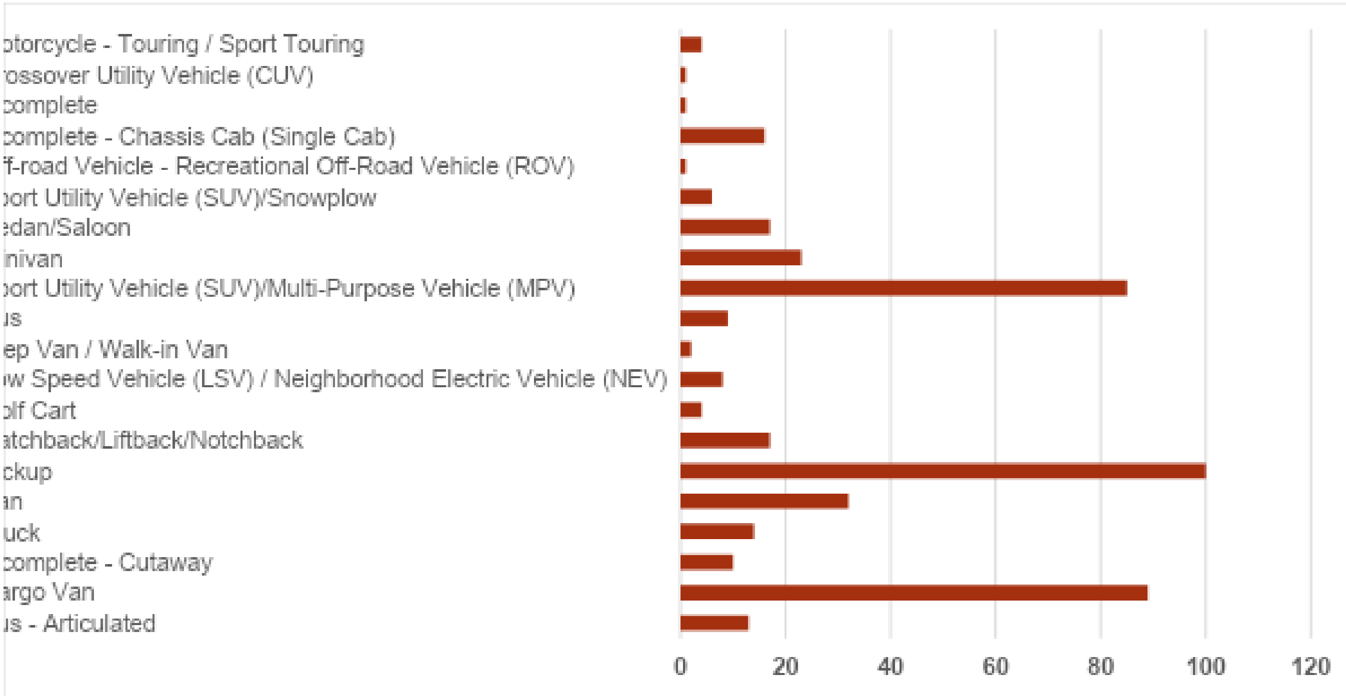
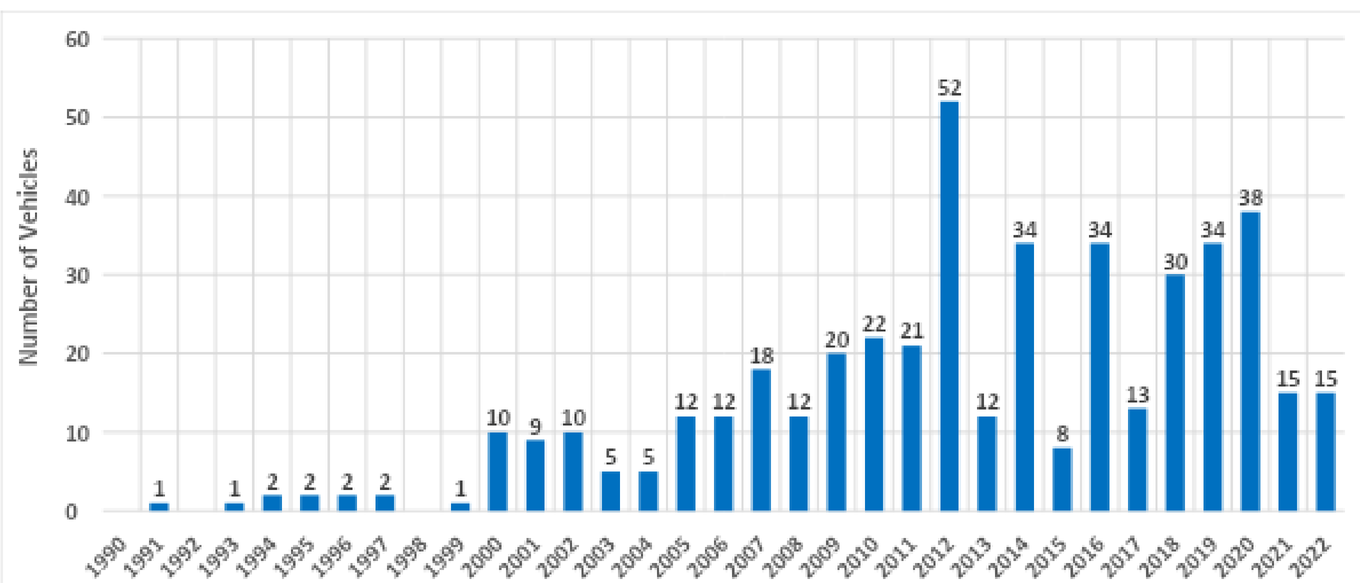


Figure 3 shows a count of all vehicles by their model year. Newest model years are shown first, followed by progressively older model years from left to right.

Figure 3. Entire Fleet – Age by Model Year



In terms of the powertrain, the large majority (96%) of the studied fleet are internal combustion engines (ICE). Split out by fuel type in **Figure 4**, the majority (85%) of the fleet use only unleaded gasoline, followed by biodiesel (11%), and electricity (4%).

FIGURE 4: STUDIED FLEET - DETAILED FUEL TYPE

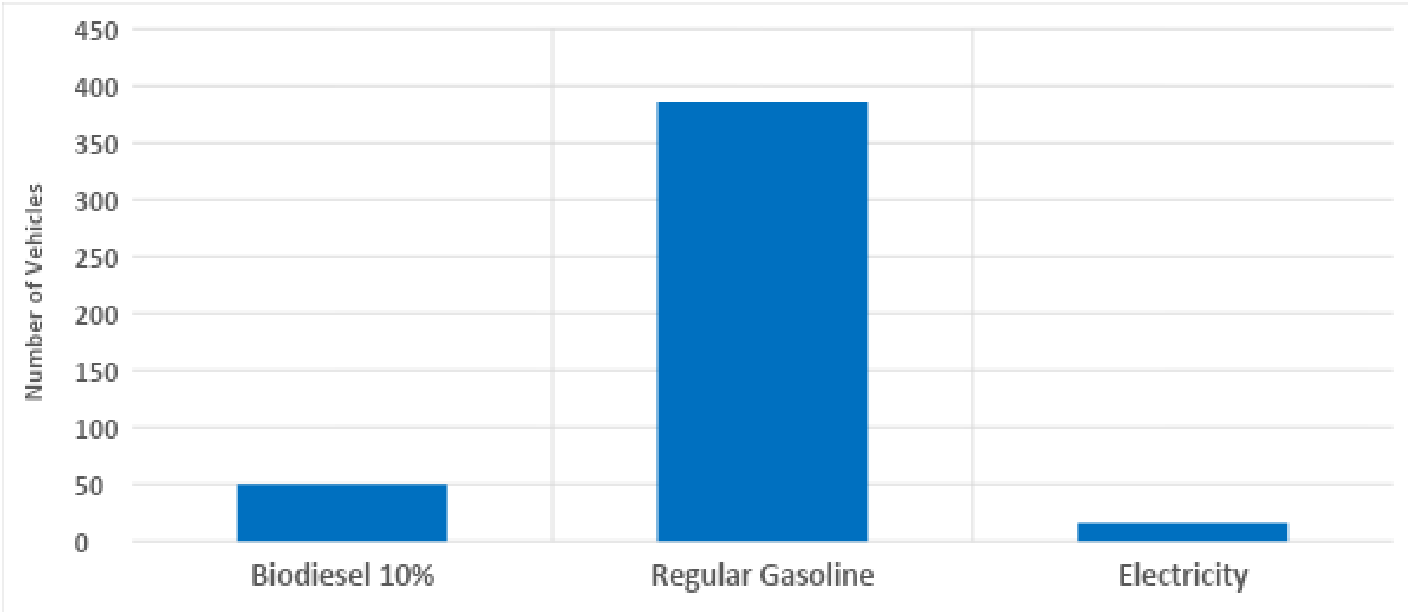


Table 1 summarizes the entirety of the University's fleet and includes the number of assets in each University department, total annual mileage, and average annual vehicle mileage by department. Among the University's various departments, the Facility Management Department has the largest fleet with 142 vehicles, followed by Housing Department (66 vehicles) and Safety (53 vehicles).

TABLE 1: FLEET SUMMARY BY DEPARTMENT AND ANNUAL MILEAGE DRIVEN[3]

Department	Number of Assets	Total Annual Miles Traveled	Annual Miles per Asset
Facility Management	142	303,640	2,138
Housing	66	179,044	2,713
CU Book Store	2	1,155	577
Parking	15	45,415	3,028
Distribution Services	5	12,185	2,437
Transportation Services	33	316,859	9,602
Security	4	9,312	2,328
Safety	53	234,728	4,429
CUCS OPERATIONS	3	8,384	2,795
Athletics	27	26,245	3,281
Ecology	1	12,874	12,874
Mailing Services	7	34,500	4,929
INSTAAR- ECOSYSTEMS	4	22,363	5,591
SOFO SMCOSTCTRS- ENVIRON CTR	3	5,647	1,882
Dining Services	12	30,107	2,509
IT	4	6,953	1,738
IRISS GRAND CHALLENGE	5	23,464	4,693
Animal Resources	2	6,625	3,313
LASP	3	7,843	2,614
Men's Sports	5	39,811	7,962
Support Services	11	13,874	1,261
Theatre + Dance	3	14,708	4,903
DIRECTOR ES	1	3,621	3,621
INSTAAR- MOUNTAIN RSCH STATION	3	6,856	2,285
Property	3	8,089	2,696
OIT-COMMUNICATION AND SUPPORT	4	6,064	1,516
Rec Center	3	11,317	3,772
CIRES-DIRECTOR	1	2,770	2,770
Women's Sports	4	9,973	2,493
Operations	3	5,245	1,748
UMC- NIGHT RIDE / NIGHT WALK	10	55,934	5,593
IBS-CTR STUDY & PREVENTION VILNC	1	3,519	3,519
ICS-ADMINISTRATION	1	3,002	3,002
UMC- BLDG O&M	1	454	454
Residence Halls	1	651	651
PAOS-PGMS ATMOS & OCEAN SCI	1	330	330
Libraries	2	13,752	6,876
Integrative Physiology	2	39	19
Psychology	1	1,490	1,490
Total	**452**	**1,488,840**	**-**

[3] Total and average annual usage are calculated from lifetime vehicle usage according to the University's fleet inventory

Vehicle categorization

As previously mentioned, the fleet inventory provided by the CU Boulder consists of 454 assets. For this study, the database was further categorized into the following groups, as depicted in **Figure 5** and described below.

Studied Fleet

433 vehicles were studied in detail. However, not all of these vehicles can be fully electrified based on currently available technologies. Therefore, based on the vehicle body type (as will be discussed later), these fleet vehicles were further categorized into sub-categories:

- **Best Fit for Electrification:** 368 vehicles that can be fully replaced with an equivalent EV available on the market today. Specific considerations related to vehicle selection for these departments are included under **Electric Vehicle Selection**.
- **Potentially Electrifiable:** 64 vehicles are potentially electrifiable using EVs available on the market today, but questions remain around cost-effectiveness, vehicle-specific operational and outfitting requirements and whether vehicle replacements that are not "like for like" are supported by internal stakeholders. Further analysis by University staff is needed prior to a purchasing decision being made. This category is further summarized below:
  - There are 23 medium-duty single chassis cabs or cutaways that have equivalent EV options available, but options may not be cost effective based on the current market prices.
  - There are 19 vehicles that have potential "like for like" vehicle options but may be cost prohibitive. Examples include electric medium duty vans, (e.g. Ford E-Transit or SEA MT55 EV-on Freightliner MT55 with SEA-DRIVE® Power System), medium-duty trucks (e.g., SEA Electric Isuzu NPR), and heavy-duty trucks (e.g., Volvo Trucks FE Electric). Equivalent EV options may be available using a chassis conversion from a 3rd-party provider (e.g., Motiv eMotors or SEA).
  - There are 22 buses in the Transportation Services Department that have electric options available (e.g., New Flyer XE60) but may be cost prohibitive.
- **No Electric Option:** Typically, heavy-duty specialty vehicles are found to have no electric option under current market conditions. The University's fleet was found to have all studied vehicles as best fit for full electrification or potentially electrifiable. If there are vehicles added to the fleet in the future under this category, other short-term emissions reduction options can be considered, such as switching to renewable diesel, and long-term electrification is likely to be possible as the market develops.

Exclusions

21 units were excluded from the detailed analysis. These exclusions were applied in cases where there was no need for further study because the unit was a non-street legal asset or because the vehicles were part of the Athletics Department and not included in the scope of the analysis. This category includes two trailers (units DGC237 and ROR127) and 19 Athletics Courtesy vehicles.

VEHICLE ANALYSIS METHODOLOGY & RESULTS

After the initial assessment of the fleet and identification of the studied vehicles, the next step in the analysis was to analyze the data to identify specific electrification opportunities. The fleet electrification methodology consisted of the following major steps:

- **Step 1 - Electrification Timeline**: An electrification timeline was established based on expected replacement years for each vehicle provided by the University Facility Management and Transportation Departments and incorporated the University's climate action goal of 50% reduction of Scope 1 and 2 carbon emissions by 2030.
- **Step 2 - Electric Vehicle Selection**: Identification and selection of electrification options, either for complete replacement of vehicles based on the availability of equivalent EVs, or other electrification options such as partial electrification, powertrain replacement, or renewable diesel.
- **Step 3 – Range Suitability:** Analysis of miles driven by existing vehicle to determine whether each proposed EV has a sufficient battery range to meet existing driving needs.
- **Step 4 - Total Cost of Ownership Analysis for a Fully Electrified Fleet**: A calculation of the total cost of ownership (TCO) that compares the conventional ICE vehicle replacement with potential EV models, comparing a combination of capital costs (vehicle purchase price) and operating costs over the expected lifespan of the vehicle for each replacement option.

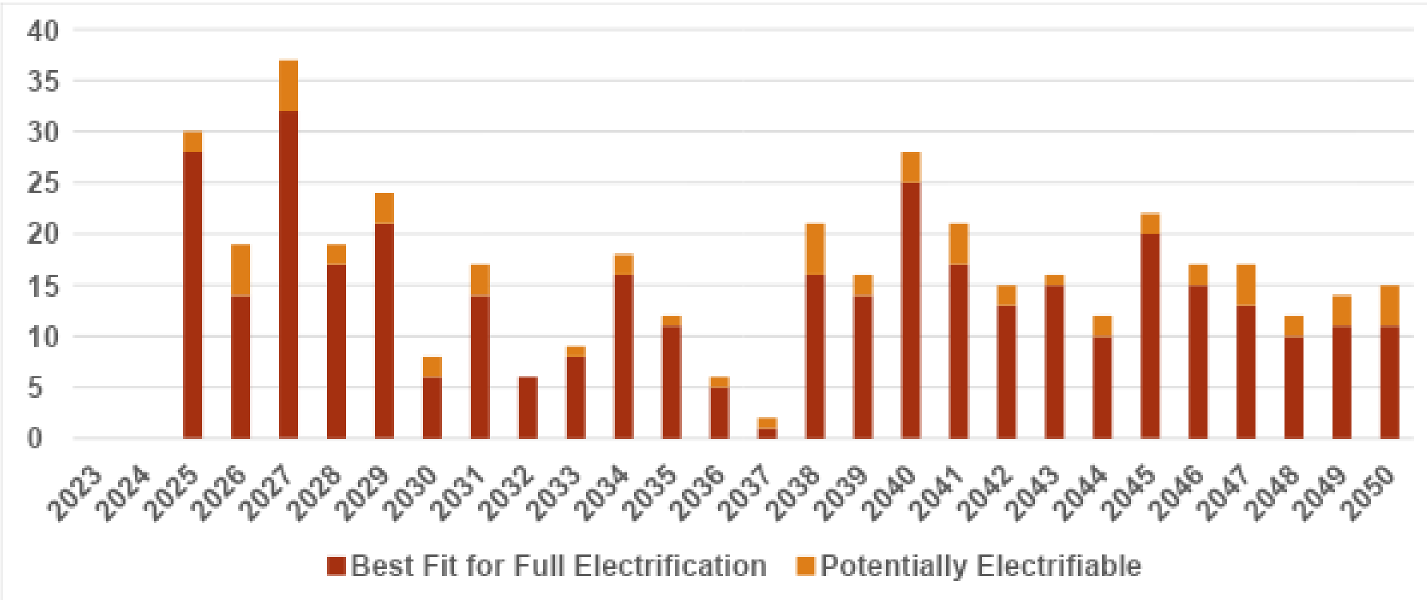
While the Fleet Electrification Methodology is presented as a linear process, in order to have the highest confidence in its procurement decisions and to adapt to an evolving market, it is recommended that Step 2 and Step 3 (above) are completed each year as the vehicles in the electrification timeline come up for replacement and the University begins implementing fleet electrification.

ELECTRIFICATION TIMELINE

Figure 8 depicts the electrification timeline and the number of vehicles to be replaced and electrified each year over the next 27 years. Vehicles are split by the electrification potential categorization described under the **Vehicle Categorization** section**.** All vehicles analyzed are expected to be replaced by 2050.

It is important to note that the University can accelerate or delay this timeline based on available budget.

FIGURE 6. FLEET ELECTRIFICATION TIMELINE



As electrification options for medium- and heavy-duty vehicles become increasingly available, the number of vehicles eligible for full electrification will increase. The potential impacts of this trend are demonstrated in **Figure 14** under the "Complete Electrification Scenario".

ELECTRIC VEHICLE SELECTION

To balance the diverse composition of the CU Boulder fleet, the types of electric vehicles currently available and the University's objectives of reducing costs and carbon emissions, this analysis attempted to assign at least one potential EV option to each existing vehicle in the University's fleet, while clearly defining which vehicles had Best Fit options and which had more uncertainty surrounding the suitability of the available EV options. The following discussion provides additional information on the current and expected market availability of EV options for various vehicle sizes, giving context to the limitations of the analyses presented in this report and future opportunities that may enable the University to determine a clearer path toward electrification of its medium- and heavy-duty vehicles. A summary of all vehicles, ICE and Electric, included in the analysis can be found in **Appendix B.**

LIGHT-DUTY VEHICLE SELECTION

Sedans, SUVs & Light Duty Vans

As of 2023, there are a range of battery-powered vehicles suitable for fleets currently priced in the range of $35,000 to $45,000 with a range greater than 100 miles. The most common choices are the Nissan Leaf or Chevrolet Bolt, both of which were considered as potential EVs for CU Boulder's fleet. Other light-duty electric vehicles available for immediate fleet purchase include the Chevrolet Bolt EUV, Tesla Model Y, Ford Focus, Honda Clarity Electric, Hyundai Ioniq and Kona, and Kia EV6 and EV9. The EV models selected for inclusion in this analysis prioritized models and OEMs with which the University is familiar, which are easily purchased through existing procurement processes and attempted to standardize across vehicle types in support of the University's efforts to standardize its fleet at large around preferred OEMs.

CU Boulder also operates 144 light-duty vans, ranging from smaller Ford Transit to Dodge Caravans to Ford T-350s. The 2023 Ford eTransit is currently available and would be an appropriate replacement vehicle for this group of existing vehicles. An estimated 126 miles of range is more than sufficient for the daily driving needs of the University's vehicles. Ford is offering three different vehicle weights of the eTransit, as well as chassis cab and cutaway options, which make the eTransit an appropriate option to replace the larger light-duty vans, as well as potentially a portion of the medium-duty vans in the University's fleet.

Pickup Trucks

The University fleet includes 97 light and medium duty pickup trucks, mostly Chevrolet Colorado's, Dodge Dakota, Ford F-150, and Ford F-250. When considering electrification of the smaller pick-up trucks (1/2- and 3/4-ton trucks such as the F-150 and F-250), recent all-electric options have come to market including the Ford F-150 Lightning and Lordstown Endurance. With 10,000 pounds of towing capacity, range of 230-300 miles and a price point of $55,000 to $70,000, the Ford F-150 Lightning is a good option for fleets and was included as the primary option in this analysis.

Medium- and heavy-Duty vehicles

Medium-duty and heavy-duty electric vehicle offerings are generally limited to OEM options approaching production but not yet available or semi-custom, electrified or hybrid versions of commercially available vehicle platforms such as the Ford and Izuzu chassis conversions Motiv, SEA and Lightning. Today's limited offerings will be augmented by increasingly numerous commercially available medium- and heavy-duty electrified vehicle platforms by manufacturers like AVEAI, Mitsubishi, Daimler, and Tesla. In effect, numerous zero emission replacement options will be available for a significant percentage of diesel and gas-powered fleet components before 2030, though the timeline is difficult to accurately predict beyond manufacturers' announcements within the next two production years.

Medium- and Heavy-Duty Trucks & Chassis Cabs

The University fleet has 64 vehicles (Class 3 or higher) that range from buses to flatbed trucks to specialty heavy duty vehicles, operating primarily in the Transportation Services and Facility Management departments.

There are a limited number of all-electric options for medium- and heavy-duty trucks offered by OEMs and chassis conversion companies. Options included in the analysis offered by OEMs include the SEA Electric Isuzu NPR and Volvo Trucks FE Electric. The purchase price of the EV options ($300,000-$500,000) and low mileage of the existing vehicle precludes the EV options from being cost-effective, but the University could decide to purchase these vehicles to achieve emissions reductions. Options included in the analysis from chassis conversion providers include SEA NPR EV, Lightning Motors Ford F550 and Motiv E450 Utility Truck. Motiv offers two different bodies, a box truck and a work truck, fit on a Ford E-450 chassis. Any chassis conversion option can require long lead times for ordering and are often significantly more expensive to purchase.

Overall, for the University's heavy-duty municipal fleet vehicle use cases, cost-effective EVs are likely still five-to-ten years away, even when accounting for incentives.

Analysis Process

In order to assign EV alternatives to existing vehicles, each existing vehicle was assigned a label based on its GVWR and Body Type (e.g., "MD Van"). One ICE replacement possibility and up to 3 EV alternatives were assigned to each vehicle label for analysis and the selected replacements were applied to every vehicle with that label. Considering all the vehicle type and department specific considerations above, individual vehicles were updated manually to ensure that only relevant models were included in the comparison and a single model was designated as the primary option and used to inform that TCO and capital budget need calculations completed later in the analysis.

RANGE SUITABILITY

For every EV option assigned to an existing vehicle during the Vehicle Selection process, the **"EV Range Viability"** was calculated, comparing the range and battery capabilities of the EV option to the driving patterns of the existing vehicle. **"EV Range Viability"** is determined by doubling the average daily distance driven by each vehicle and confirming the EV replacement range exceeds the maximum daily distance. All of CU Boulder's Best Fit and Potentially Electrifiable vehicle recommendations (433 total assets) boast viable ranges based on the vehicles historical driving, which means that EV range is not a major barrier to electrification for the University's fleet.

TOTAL COST OF OWNERSHIP (TCO) ANALYSIS

TCO METHODOLOGY

Total cost of ownership (TCO) refers to a calculation of adding capital and operating costs of an asset to determine the total cost of that asset over its lifespan. As part of the analysis, the TCO for two different scenarios of vehicle replacement was calculated: (1) an existing vehicle is replaced with an equivalent ICE vehicle, and (2) that same existing vehicle is replaced with the equivalent, or nearly equivalent, EV determined the vehicle selection process. Given the age of some of the University's vehicles, the changing availability of vehicle models in the market and to simplify the analysis, a representative ICE vehicle replacement for each vehicle body type (e.g., Ford Escape for SUV) was used as the equivalent ICE replacement vehicle to create the scenarios in the TCO analysis. The "Representative ICE Replacement" was determined in collaboration with the University's fleet staff. For heavy-duty vehicles, the ICE replacement vehicle was deemed to be identical to the existing model. *It is important to note that the replacement ICE vehicle choice presented here is used to represent the approximate cost of replacing an existing vehicle with a new ICE vehicle and may not perfectly reflect the University's actual procurement choice to replace an existing vehicle.*

For both scenarios, the TCO is the sum of the following cost components:

- **Total purchase price**: The sum of the Manufacturer Suggested Retail Price (MSRP) and any auxiliary equipment.

  Available incentives (e.g., Inflation Reduction Act Tax Credit) were not included in the base TCO analysis but the impacts of these incentives on the cost of electrification can be observed using the Fleet Electrification Pro Forma provided to the University. For heavy-duty vehicles, purchase price for the ICE replacement vehicle was calculated using the purchase price of the existing vehicle and adjusting for inflation.

- **Annual fuel cost**: This was calculated based on the estimated annual mileage of the studied vehicle. For this

  calculation, the gas price was assumed to be \$3.04 per gallon of unleaded and \$5.58 per gallon for biodiesel based on today's price of fuel for the University. Annual fuel cost for EVs was calculated using the cost of electricity at the domicile facility of the ICE vehicle being replaced. This cost was determined to be \$0.098/kWh according to the University's electricity rate from Xcel Energy and does not include costs from any potential increase in demand charges. The potential impacts of escalations in fuel costs (liquid fuel and electricity) can be observed in the Fleet Electrification Pro Forma.

- **Annual Operations and Maintenance (O&M) cost**: The University of Colorado Boulder provided life-to-date maintenance costs for each vehicle in the fleet. For the TCO comparison, an average cost of 60% maintenance savings per mile was used for EVs.

The TCO calculations did not include the cost of Electric Vehicle Supply Equipment (EVSE), as that is being addressed in subsequent sections. All components included in the TCO calculations were calculated over the expected lifespan of the existing vehicle, which ranges from 6 to 20 years depending on the vehicle type.

Resale Value
The resale value of the vehicle at the end of its lifecycle was not considered in the TCO analysis and was set to zero for both ICE vehicles and EVs. Due to the relatively short amount of time that EVs have been on the market, there is not robust data on the resale value of an EV in use for 10 years.

TCO By Department & Electrification Category

To summarize the TCO calculations across the entire fleet, a summary of TCO by department is included below. Given the large number of vehicles analyzed, detailed TCO calculations for each vehicle are presented in **Appendix A**.

The following figures summarize the TCO for all expected vehicle electrification purchases by University departments over two time periods, from near (2025-2035) to long-term (2035-2050). These figures only include University departments that are projected to have vehicle replacements in the given period.

Under each period, there are figures representing two scenarios. The first figure provides a TCO comparison for only the vehicles included in the Best Fit for Full Electrification category and the second figure provides a TCO comparison for all vehicles with a Potential Electrification option. Since this second scenario includes EV options that may not be cost effective, the TCO of the electric vehicles is generally higher than for the ICE vehicles.

The time periods segment vehicle purchases by purchase year, but the costs displayed include operating costs expected over the lifetime of the new vehicle stretching from the purchase date through the end of its lifespan. For example, an EV purchased in 2023 with a 10-year life span realizes annual savings for the University through 2033, compared to the alternative scenario of purchasing an ICE vehicle. Those savings are aggregated in the figures below. Dollar amounts are provided in nominal dollars.

Figure 7: TCO of Near-Term Vehicle Purchases (2025-2035) – Best Fit

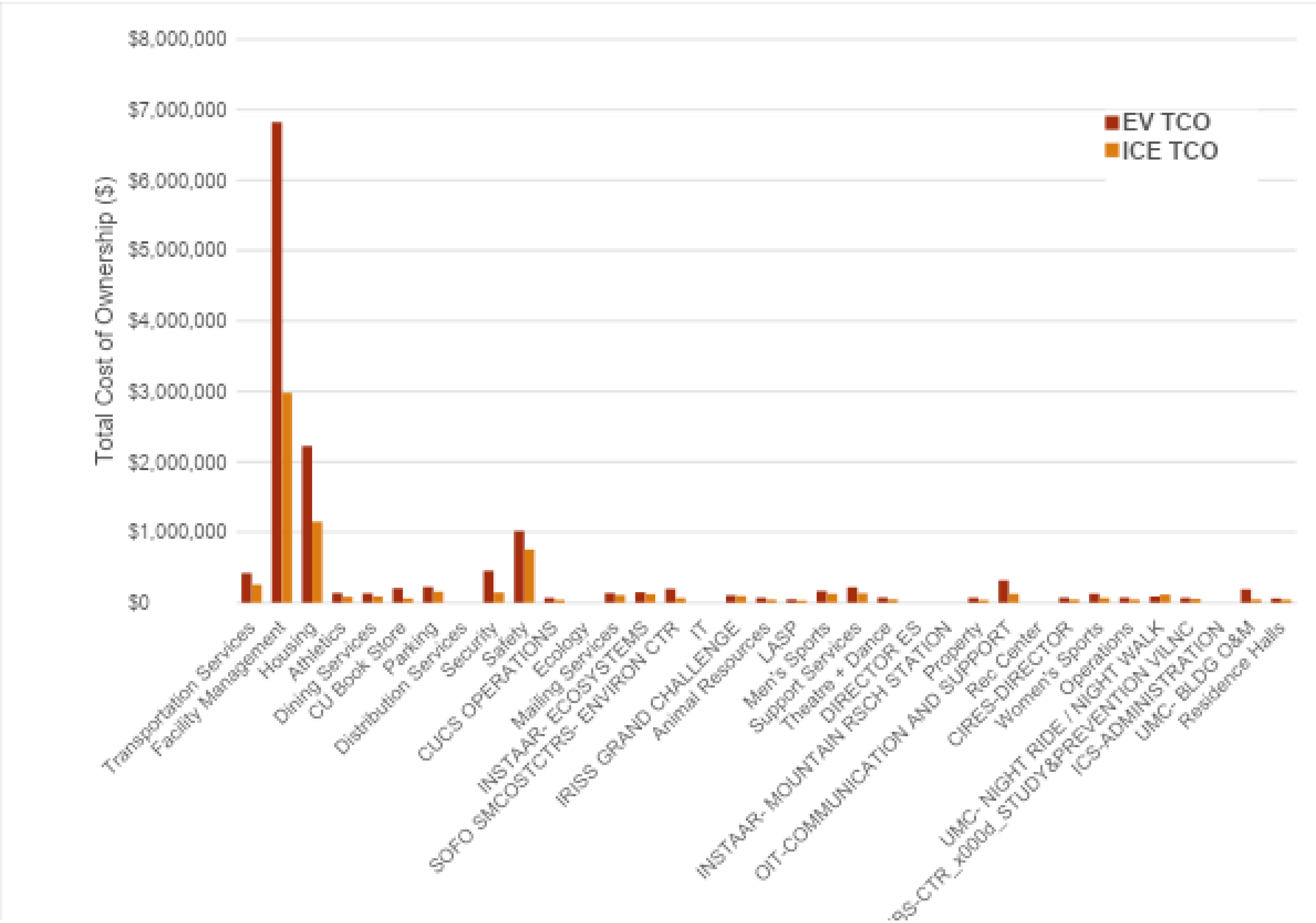


Table 2: TCO of Near-Term Vehicle Purchases (2025-2035) – Best Fit

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)
TRANSPORTATION SERVICES	$420,226	$257,715
FACILITY MANAGEMENT	$6,822,970	$2,979,778
HOUSING	$2,221,925	$1,149,159
ATHLETICS	$136,698	$82,338
DINING SERVICES	$132,149	$86,881
CU BOOK STORE	$205,672	$60,023
PARKING	$223,263	$155,827
DISTRIBUTION SERVICES	$0	$0
SECURITY	$453,820	$145,179
SAFETY	$1,015,909	$752,602
CUCS OPERATIONS	$67,143	$38,758
ECOLOGY	$0	$0
MAILING SERVICES	$136,215	$107,020
INSTAAR- ECOSYSTEMS	$147,834	$121,333
SOFO SMCOSTCTRS- ENVIRON CTR	$195,939	$65,088
IT	$0	$0
IRISS GRAND CHALLENGE	$103,536	$94,275
ANIMAL RESOURCES	$69,340	$42,129
LASP	$45,836	$30,322
MEN'S SPORTS	$165,611	$125,568
SUPPORT SERVICES	$219,138	$133,872
THEATRE + DANCE	$72,395	$45,951
DIRECTOR ES	$0	$0
INSTAAR- MOUNTAIN RSCH STATION	$0	$0
PROPERTY	$68,936	$37,324
OIT-COMMUNICATION AND SUPPORT	$317,112	$125,533
REC CENTER	$0	$0
CIRES-DIRECTOR	$71,254	$43,591
WOMEN'S SPORTS	$126,297	$65,262
OPERATIONS	$70,966	$42,705
UMC- NIGHT RIDE / NIGHT WALK	$87,994	$115,738
IBS-CTR STUDY&PREVENTION VILNC	$67,846	$53,211
ICS-ADMINISTRATION	$0	$0
UMC- BLDG O&M	$189,273	$44,399
RESIDENCE HALLS	$60,230	$40,815
PAOS-PGMS ATMOS&OCEAN SCI	$0	$0
LIBRARIES	$0	$0
INTEGRATIVE PHYSIOLOGY	$0	$0
PSYCHOLOGY	$0	$0
TOTAL	**$13,915,526**	**$7,042,395**

FIGURE 8: TCO OF NEAR-TERM VEHICLE PURCHASES (2025-2035) – POTENTIAL ELECTRIFICATION

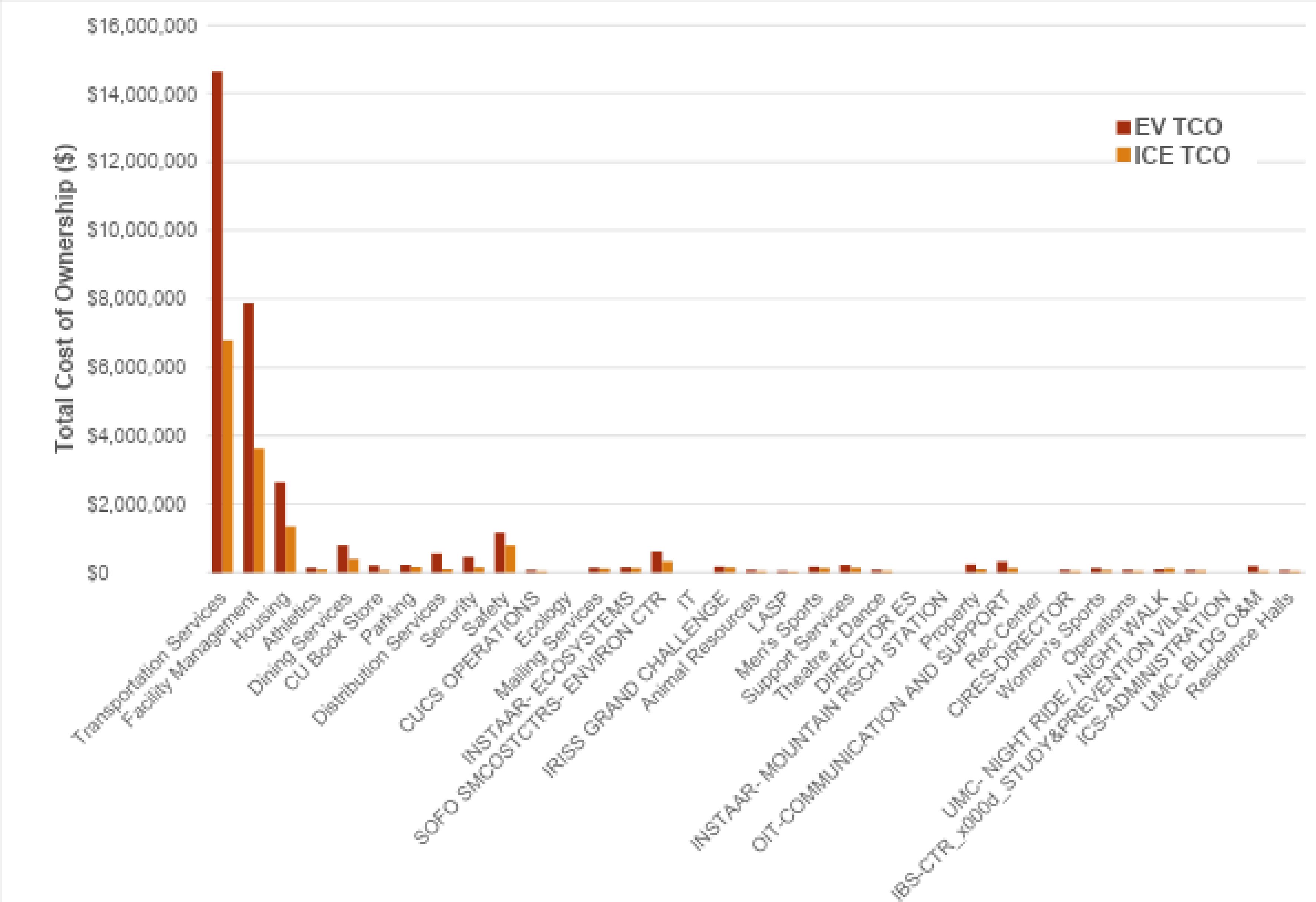


Table 3: TCO of Near-Term Vehicle Purchases (2025-2035) – Potential electrification

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)
TRANSPORTATION SERVICES	$14,652,810	$6,783,446
FACILITY MANAGEMENT	$7,867,827	$3,638,839
HOUSING	$2,640,994	$1,342,818
ATHLETICS	$136,698	$82,338
DINING SERVICES	$798,898	$389,003
CU BOOK STORE	$205,672	$60,023
PARKING	$223,263	$155,827
DISTRIBUTION SERVICES	$556,842	$92,060
SECURITY	$453,820	$145,179
SAFETY	$1,174,428	$793,097
CUCS OPERATIONS	$67,143	$38,758
ECOLOGY	$0	$0
MAILING SERVICES	$136,215	$107,020
INSTAAR- ECOSYSTEMS	$147,834	$121,333
SOFO SMCOSTCTRS- ENVIRON CTR	$609,518	$320,168
IT	$0	$0
IRISS GRAND CHALLENGE	$166,751	$142,940
ANIMAL RESOURCES	$69,340	$42,129
LASP	$45,836	$30,322
MEN'S SPORTS	$165,611	$125,568
SUPPORT SERVICES	$219,138	$133,872
THEATRE + DANCE	$72,395	$45,951
DIRECTOR ES	$0	$0
INSTAAR- MOUNTAIN RSCH STATION	$0	$0
PROPERTY	$232,005	$91,544
OIT-COMMUNICATION AND SUPPORT	$317,112	$125,533
REC CENTER	$0	$0
CIRES-DIRECTOR	$71,254	$43,591
WOMEN'S SPORTS	$126,297	$65,262
OPERATIONS	$70,966	$42,705
UMC- NIGHT RIDE / NIGHT WALK	$87,994	$115,738
IBS-CTR STUDY&PREVENTION VILNC	$67,846	$53,211
ICS-ADMINISTRATION	$0	$0
UMC- BLDG O&M	$189,273	$44,399
RESIDENCE HALLS	$60,230	$40,815
PAOS-PGMS ATMOS&OCEAN SCI	$0	$0
LIBRARIES	$0	$0
INTEGRATIVE PHYSIOLOGY	$0	$0
PSYCHOLOGY	$0	$0
TOTAL	**$ 31,634,008**	**$ 15,213,489**

Figure 9: TCO of long-Term Vehicle Purchases (2035-2050) – Best fit

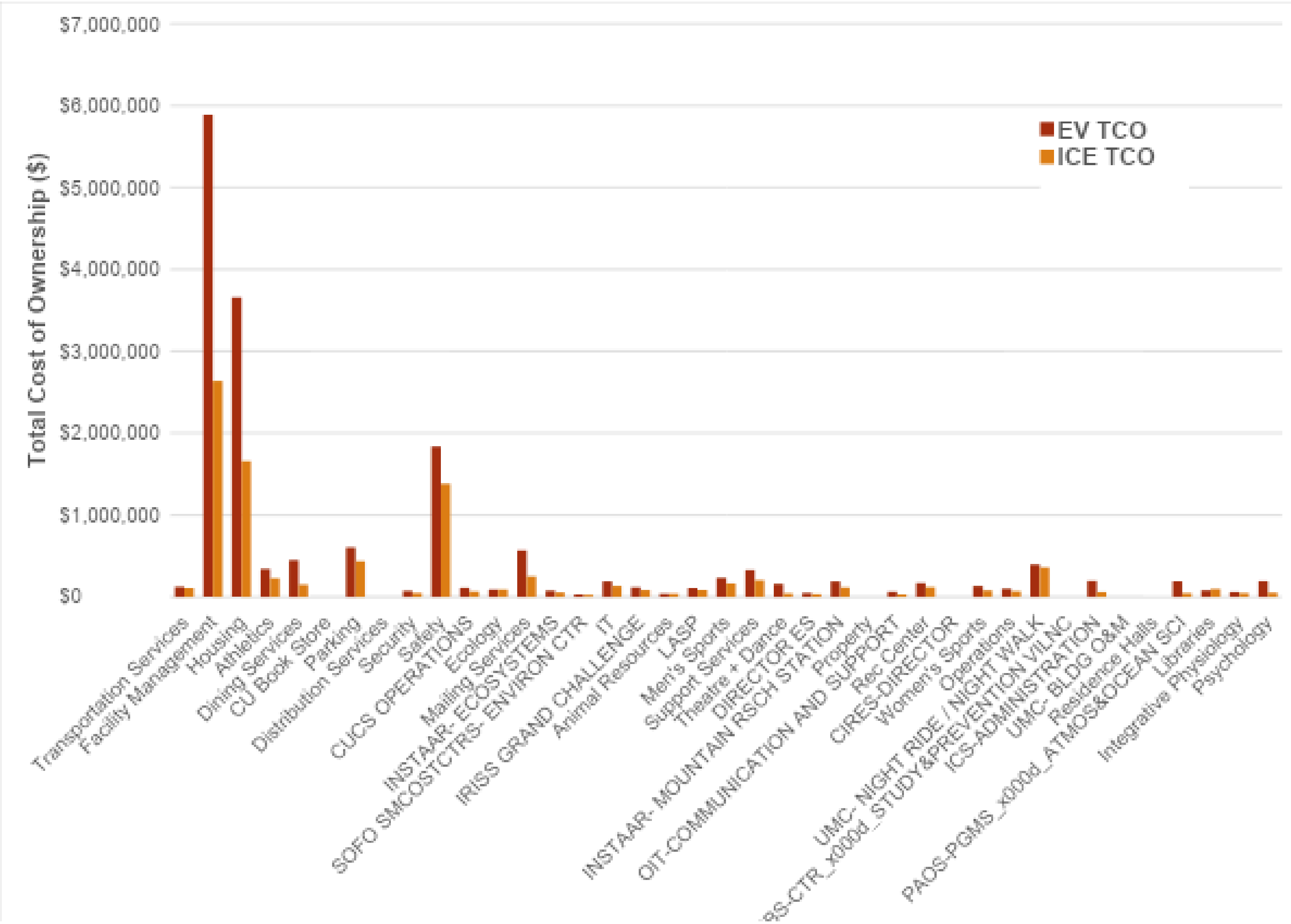


TABLE 4: TCO OF LONG-TERM VEHICLE PURCHASES (2035-2050) – BEST FIT

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)
TRANSPORTATION SERVICES	$124,257	$109,821
FACILITY MANAGEMENT	$5,888,950	$2,637,381
HOUSING	$3,659,995	$1,660,078
ATHLETICS	$339,191	$226,246
DINING SERVICES	$447,279	$149,889
CU BOOK STORE	$0	$0
PARKING	$601,374	$434,860
DISTRIBUTION SERVICES	$0	$0
SECURITY	$72,091	$45,839
SAFETY	$1,836,772	$1,379,384
CUCS OPERATIONS	$111,990	$64,305
ECOLOGY	$88,566	$89,344
MAILING SERVICES	$566,962	$251,405
INSTAAR- ECOSYSTEMS	$74,900	$53,377
SOFO SMCOSTCTRS- ENVIRON CTR	$29,826	$24,122
IT	$188,164	$134,493
IRISS GRAND CHALLENGE	$117,953	$82,024
ANIMAL RESOURCES	$37,742	$38,277
LASP	$109,774	$83,399
MEN'S SPORTS	$232,621	$164,122
SUPPORT SERVICES	$326,654	$201,238
THEATRE + DANCE	$158,639	$40,858
DIRECTOR ES	$46,629	$32,935
INSTAAR- MOUNTAIN RSCH STATION	$187,843	$116,168
PROPERTY	$0	$0
OIT-COMMUNICATION AND SUPPORT	$61,379	$29,737
REC CENTER	$168,423	$119,561
CIRES-DIRECTOR	$0	$0
WOMEN'S SPORTS	$134,190	$77,369
OPERATIONS	$100,998	$67,430
UMC- NIGHT RIDE / NIGHT WALK	$396,570	$359,041
IBS-CTR STUDY&PREVENTION VILNC	$0	$0
ICS-ADMINISTRATION	$193,616	$57,878
UMC- BLDG O&M	$0	$0
RESIDENCE HALLS	$0	$0
PAOS-PGMS ATMOS&OCEAN SCI	$189,062	$43,746
LIBRARIES	$78,553	$96,833
INTEGRATIVE PHYSIOLOGY	$58,546	$45,126
PSYCHOLOGY	$191,039	$49,879
TOTAL	**$ 16,820,549**	**$ 8,966,163**

Figure 10: TCO of long-Term Vehicle Purchases (2035-2050) – POTENTIAL Electrification

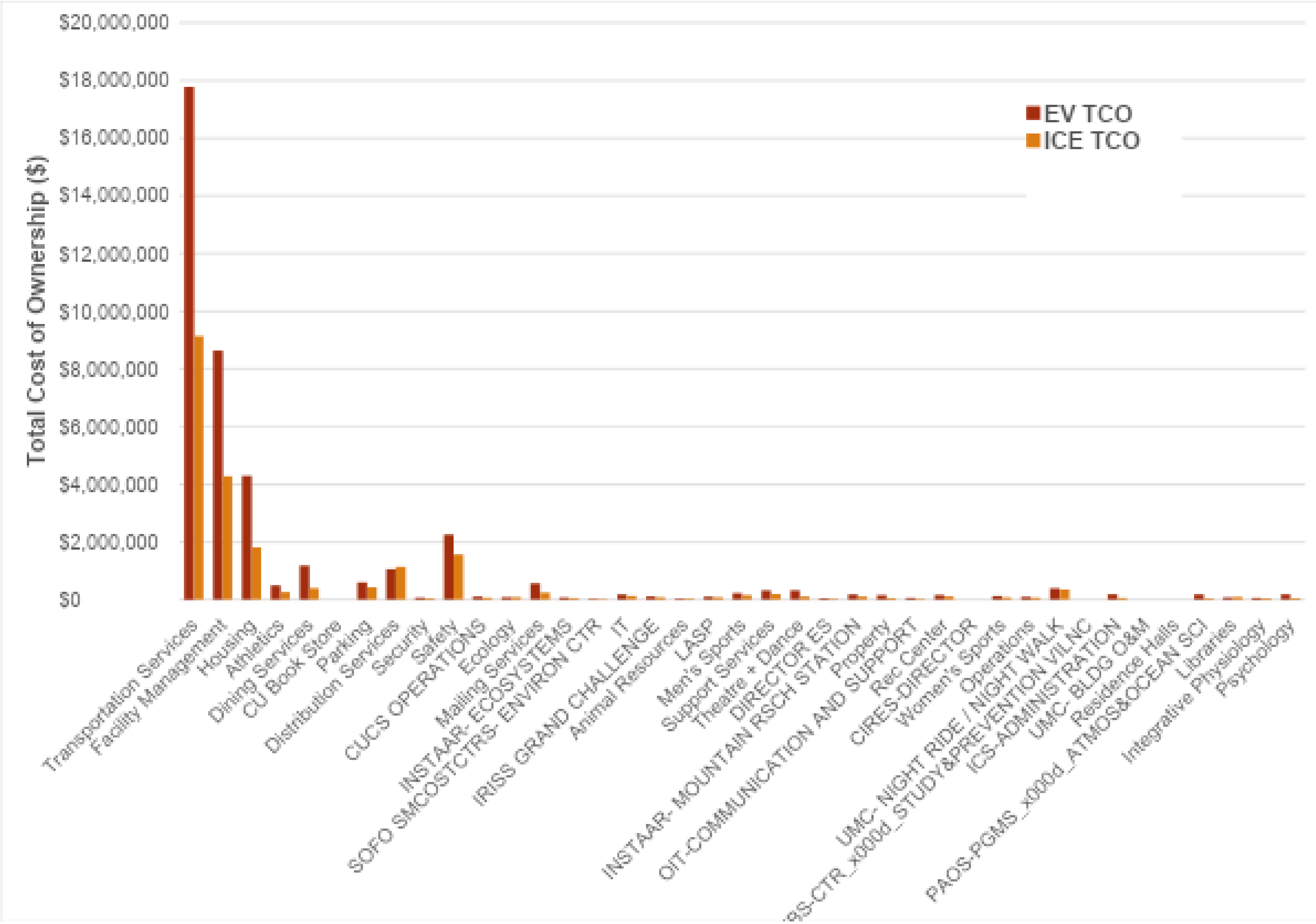


TABLE 5: TCO OF LONG-TERM VEHICLE PURCHASES (2035-2050) – POTENTIAL ELECTRIFICATION

DEPARTMENT	TOTAL EV TCO ($)	TOTAL ICE TCO ($)
TRANSPORTATION SERVICES	$17,775,471	$9,138,855
FACILITY MANAGEMENT	$8,640,054	$4,279,603
HOUSING	$4,295,571	$1,815,222
ATHLETICS	$498,007	$267,639
DINING SERVICES	$1,178,261	$404,469
CU BOOK STORE	$0	$0
PARKING	$601,374	$434,860
DISTRIBUTION SERVICES	$1,055,090	$1,134,322
SECURITY	$72,091	$45,839
SAFETY	$2,255,647	$1,570,889
CUCS OPERATIONS	$111,990	$64,305
ECOLOGY	$88,566	$89,344
MAILING SERVICES	$566,962	$251,405
INSTAAR- ECOSYSTEMS	$74,900	$53,377
SOFO SMCOSTCTRS- ENVIRON CTR	$29,826	$24,122
IT	$188,164	$134,493
IRISS GRAND CHALLENGE	$117,953	$82,024
ANIMAL RESOURCES	$37,742	$38,277
LASP	$109,774	$83,399
MEN'S SPORTS	$232,621	$164,122
SUPPORT SERVICES	$326,654	$201,238
THEATRE + DANCE	$328,333	$115,059
DIRECTOR ES	$46,629	$32,935
INSTAAR- MOUNTAIN RSCH STATION	$187,843	$116,168
PROPERTY	$162,771	$53,320
OIT-COMMUNICATION AND SUPPORT	$61,379	$29,737
REC CENTER	$168,423	$119,561
CIRES-DIRECTOR	$0	$0
WOMEN'S SPORTS	$134,190	$77,369
OPERATIONS	$100,998	$67,430
UMC- NIGHT RIDE / NIGHT WALK	$396,570	$359,041
IBS-CTR STUDY&PREVENTION VILNC	$0	$0
ICS-ADMINISTRATION	$193,616	$57,878
UMC- BLDG O&M	$0	$0
RESIDENCE HALLS	$0	$0
PAOS-PGMS ATMOS&OCEAN SCI	$189,062	$43,746
LIBRARIES	$78,553	$96,833

INTEGRATIVE PHYSIOLOGY	$58,546	$45,126
PSYCHOLOGY	$191,039	$49,879
TOTAL	**$ 40,554,673**	**$ 21,541,884**

When only considering the Best Fit scenario, over the lifespan of the vehicles purchased, near-term electrification is estimated to increase costs for the University ($6,873,131 more) without incentives and long-term electrification has the potential to cost the University about $7,854,386 without incentives. Under the Potential Electrification scenario, near-term electrification is estimated to cost the University about $16,420,519 over the lifetime of the vehicles and long-term electrification is expected to cost the University about $19,012,788. The Potential Electrification scenario is more expensive for the University primarily due to the current cost differences between ICE and EV heavy-duty options. TCO calculations in the long-term do not include any assumptions for reduced purchase prices of EV models over the next 10 years, which are likely to change the financial outlook. There are a few uncertain factors that could impact these savings estimates, as described below:

- If purchased EVs last longer than current ICE vehicles, the estimated savings will increase
- If purchased EVs last less than current ICE vehicles, the estimated savings will decrease
- If it is determined that EV Police pursuit vehicles can consistently outlast the expected 6-year lifespan of ICE pursuit vehicles, savings in the Police department could increase significantly

Overall, falling MSRPs of long-range EVs, lower fuel costs and lower maintenance costs combine to enable EVs to provide cost savings, as well as emissions reductions, to the University’s fleet. This is particularly true for vehicles with high mileage where high fuel and maintenance costs represent additional room for cost savings. In departments where vehicles have low usage, EVs are unlikely to show TCO savings under current costs.

ESTIMATED CAPITAL BUDGET NEEDS FOR VEHICLE REPLACEMENT

Despite the potential for TCO savings resulting from vehicle electrification, in most cases, based on current market prices, replacing an existing vehicle with an electric option will require higher upfront capital costs than replacing the same vehicle with an ICE option. **Figure 11** and **Figure 12** include estimated annual capital budget required to purchase EVs for the University's fleet. It is important to note that the budget needs included in **Figure 12** include EV options that may not yet be in full production or are chassis conversions requiring custom building, both of which increase purchase costs.

FIGURE 11: ESTIMATED CAPITAL BUDGET NEEDS – BEST FIT

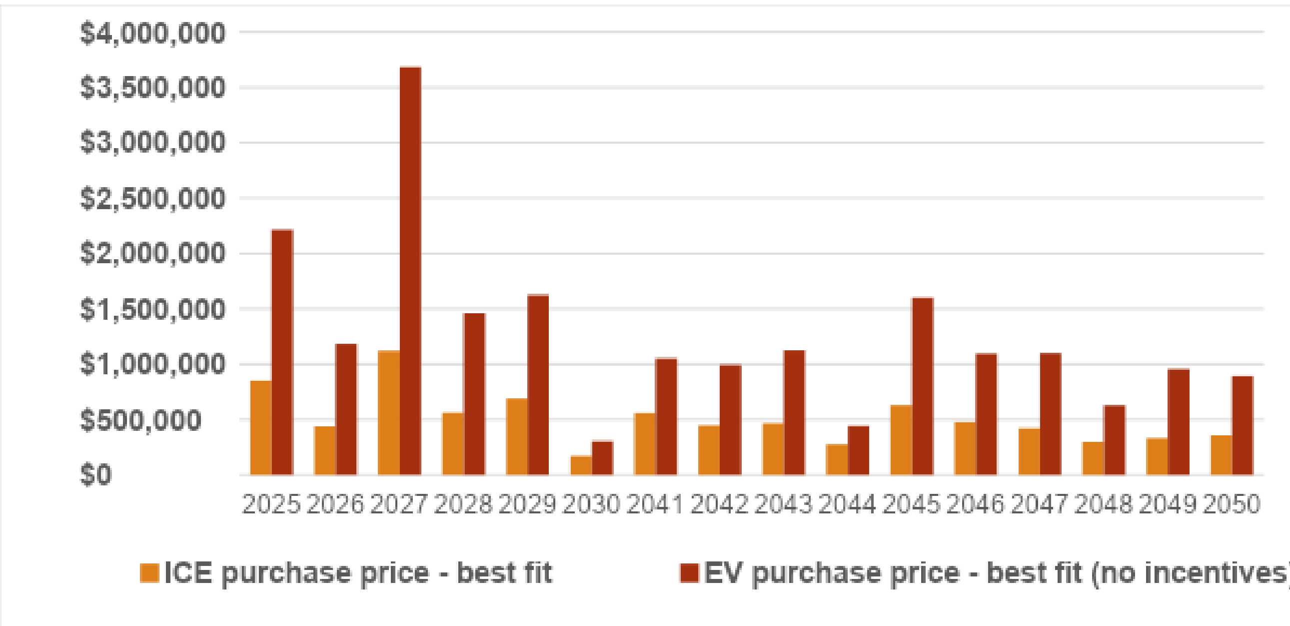
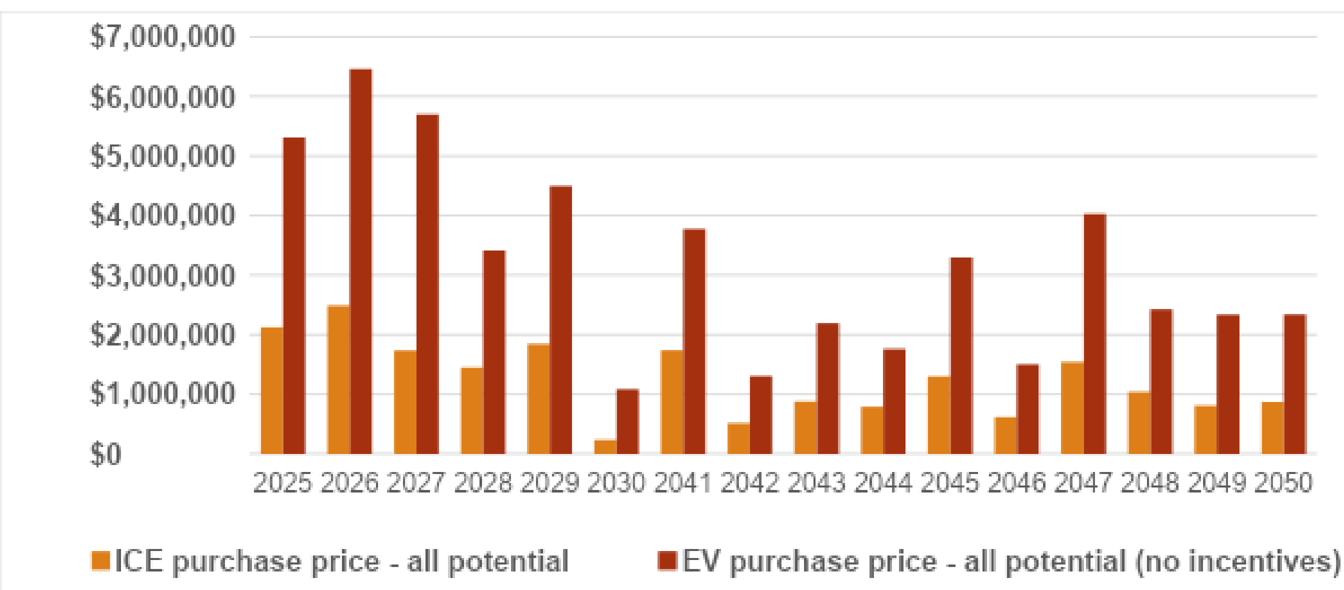


FIGURE 12: ESTIMATED CAPITAL BUDGET NEEDS – POTENTIAL ELECTRIFICATION



Discussion of Ownership Models: Owned vs Leased

The University traditionally purchases fleet assets and that is the ownership structure that was assumed throughout this analysis. CU Boulder should continue to purchase and own vehicles because it is the most cost-effective approach for the fleet. Leasing electric vehicles, particularly light-duty options, is an increasingly available ownership model with the potential to further reduce TCO for EVs. Leasing opportunities for fleets are offered through Sourcewell and the Climate Mayors EV Collaborative.[4]

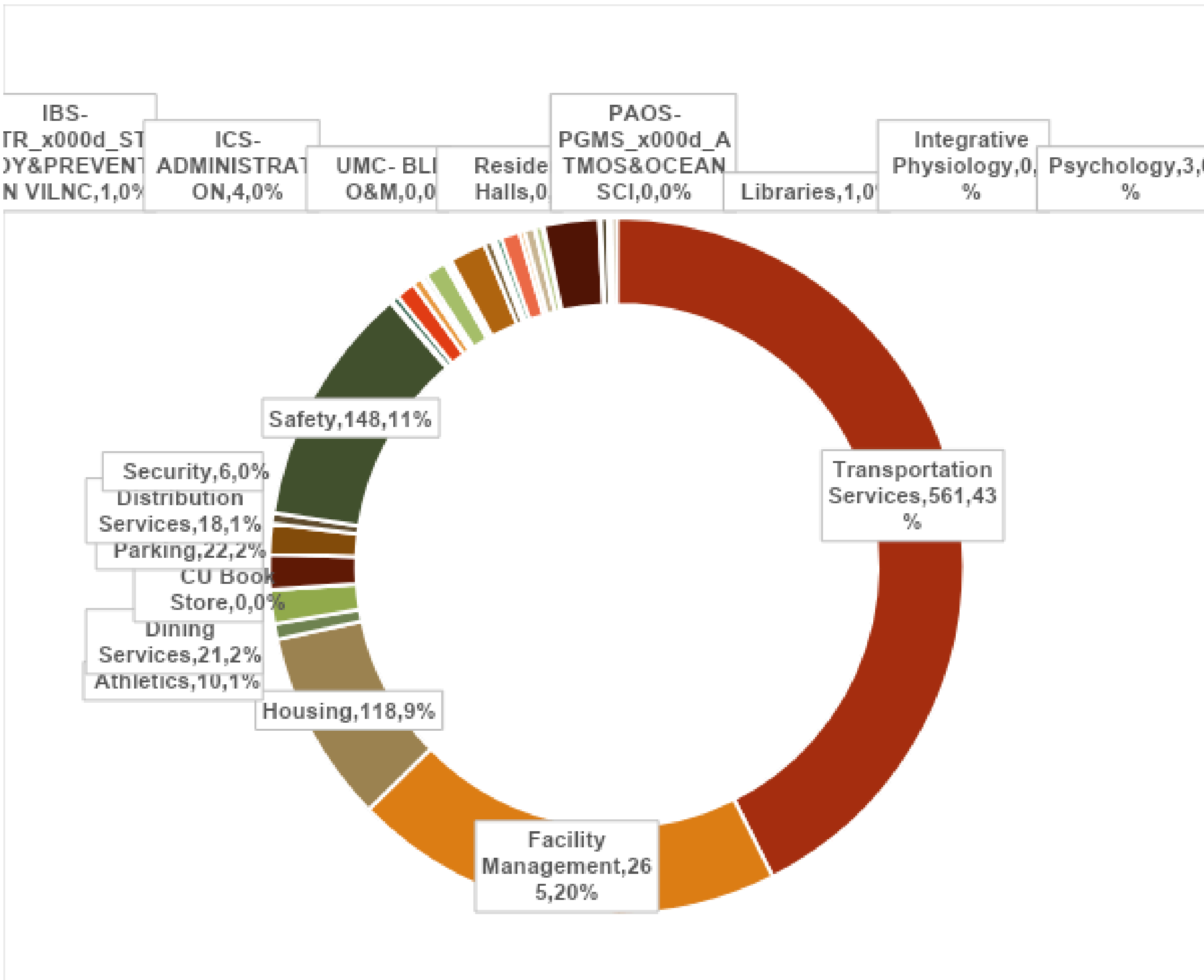
There are two common types of leasing: fleet leasing or lease financing. Fleet leasing refers to a contract the enables vehicle leasing, often a large number of vehicles, that encompasses maintenance costs, fuel costs and other services. It is appealing for fleets that do not have in-house maintenance operations and are interested in outsourcing a significant portion of fleet management. Lease financing refers to a contract that provides a vehicle without fleet management services and is similar to the structure of a lease for a personal vehicle. Within lease financing, there are two common types: closed- and open-ended leases. Closed-ended leases have a set term, after which the University returns the vehicle. Closed-ended leases enable fleets to phase new vehicle models into their fleet quickly and monthly payments are often lower than other options, but the University does not retain ownership of the asset at the end of the lease.[5] Open-ended leases are essentially a financing mechanism allowing the University to pay down the cost of a vehicle over the term of the lease, often down to a $1 buy out, enabling the University to maintain ownership of the asset at the end of the lease term.

[4] https://driveevfleets.org/wp-content/uploads/2018/09/NCL_OneSheet_ClimateMayors.pdf
[5] Saving Money with Electric Vehicle Leasing: A Case Study of University Fleets, Electrification Coalition, November 2020

Carbon reductions From Fleet Electrification

Figure 13 summarizes total, annual carbon emissions from the University's fleet by percent contribution of each department. Average annual vehicle mileage was used to calculate baseline carbon emissions. The total carbon emissions associated with the University's fleet is 1318.5 $MTCO_2$.[6]

Figure 13: Annual Carbon Emissions OF VEHICLE FLEET BY DEPARTMENT- 2022

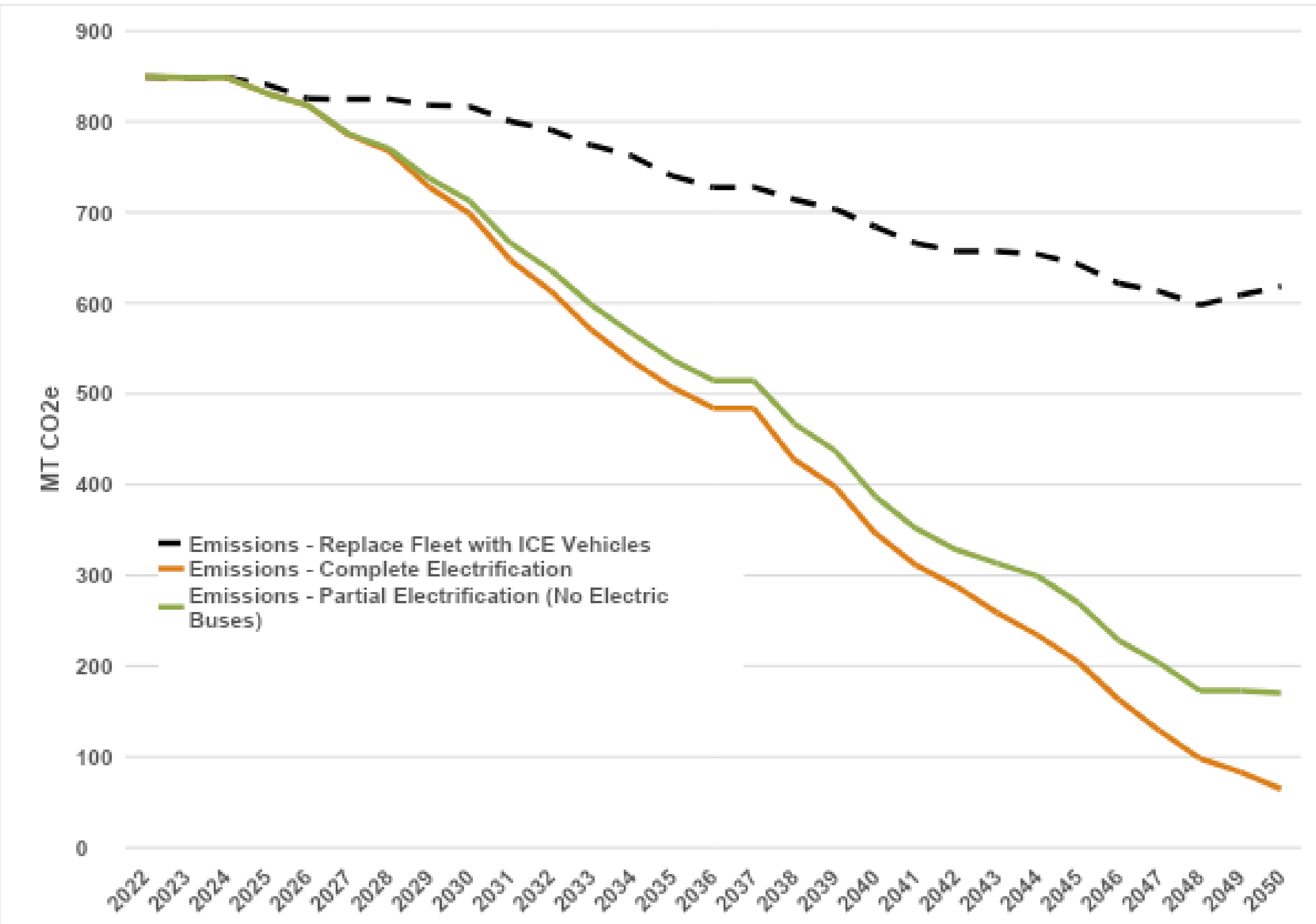


The expected carbon reductions from fleet electrification are presented below based on the Fleet Replacement and Electrification Timeline. **Figure 14** includes projected carbon reductions under three electrification scenarios matching those discussed previously in this report.

[6] 22 vehicles did not have fuel usage provided and estimated annual GHG emissions were calculated based on vehicle mileage or the vehicles were excluded from the studied fleet.

- **Best Fit for Full Electrification:** The first scenario considers the electrification of only vehicles that can be fully electrified based on current technology (i.e., those vehicles categorized as Best Fit for Full Electrification).
- **Potential Electrification:** This scenario considers the electrification of all Best Fit vehicles as well as the Potentially Electrifiable vehicles.
- **Complete Electrification**: The final scenario includes all vehicles in the previous scenarios as well as the full electrification of all vehicles identified as having no electric option currently available in the market, including full electrification of vehicles that are currently only candidates for partial electrification via an ePTO. *This is included as a representative scenario and does not specify vehicle models/technologies used to achieve electrification but assumes sufficient technology advancement to electrify every vehicle that comes up for replacement through 2050.*

FIGURE 14: EMISSION REDUCTION SCENARIOS THROUGH 2040



By 2030, the **Complete Electrification** scenario (orange line), above, represents an 18% reduction in carbon emissions, the **Partial Electrification** scenario (green line) represents an 16% reduction in carbon emissions. By 2040, the carbon emissions reductions are 59% and 54% respectively, and by 2050, 92% and 80% respectively.

INCREMENTAL COST OF CARBON REDUCTIONS

To provide guidance for the University's budget towards the most cost-effective vehicles for emissions reductions, the following tables summarize the marginal cost, or savings, of vehicle electrification on a capital cost and total cost of ownership basis, the associated carbon reductions and the cost of carbon abatement on a dollar per ton basis for five departments with the highest vehicle counts. The incremental cost of carbon reductions is calculated for 2025-2050 under the Best Fit and Potential Electrification scenarios described above.

TABLE 6: INCREMENTAL COST OF CARBON REDUCTION – BEST FIT SCENARIO

Department	# of Vehicles	Carbon Reductions ($mtCO_2$)	Marginal Capital Costs ($)	Marginal Total Cost of Ownership ($)	Cost of Abatement – Capital cost ($/$mTCO_2$)	Cost of Abatement – TCO ($/$mTCO_2$)
2025 – 2035 Vehicle Replacements						
FACILITY MANAGEMENT	69	96	$3,747,571	$3,376,192	$38,660	$34,829
HOUSING	27	36	$1,031,432	$869,766	$27,895	$23,523
SAFETY	17	50	$374,237	$181,159	$7,418	$3,591
TRANSPORTATI ON SERVICES	6	6	$209,825	$143,510	$30,837	$21,091
PARKING	3	7	$73,114	$38,936	$9,310	$4,958
2035 – 2050 Vehicle Replacements						
FACILITY MANAGEMENT	59	88	$3,082,62 3	$2,813,569	$35,143	$32,076
HOUSING	34	72	$1,999,74 9	$1,754,416	$27,674	$24,279
SAFETY	33	94	$670,410	$320,443	$7,107	$3,397
TRANSPORTATI ON SERVICES	3	3	$28,025	$6,436	$9,285	$2,132
PARKING	12	14	$167,202	$109,764	$12,059	$7,916

TABLE 7: INCREMENTAL COST OF CARBON REDUCTION – POTENTIAL ELECTRIFICATION SCENARIO

Department	# of Vehicles	Carbon Reductions ($mtCO_2$)	Marginal Capital Costs ($)	Marginal Total Cost of Ownership ($)	Cost of Abatement – Capital cost ($/$mTCO_2$)	Cost of Abatement – TCO ($/$mTCO_2$)
2025 – 2035 Vehicle Replacements						
FACILITY MANAGEMENT	72	114	$4,042,163	$3,641,988	$35,372	$31,870
HOUSING	29	40	$1,259,036	$1,055,176	$30,932	$25,924

SAFETY	18	52	$497,337	$299,182	$9,519	$5,726
TRANSPORTATION SERVICES	17	205	$8,158,665	$7,410,364	$39,713	$36,071
PARKING	3	7	$73,114	$38,936	$9,310	$4,958
2035 – 2050 Vehicle Replacements						
FACILITY MANAGEMENT	70	150	$4,089,851	$3,663,451	$27,204	$24,368
HOUSING	37	77	$2,464,320	$2,185,348	$31,846	$28,241
SAFETY	35	96	$898,014	$507,812	$9,345	$5,284
TRANSPORTATION SERVICES	16	356	$9,565,345	$8,108,617	$26,866	$22,774
PARKING	12	14	$167,202	$109,764	$12,059	$7,916

PART II

EV CHARGING NEEDS

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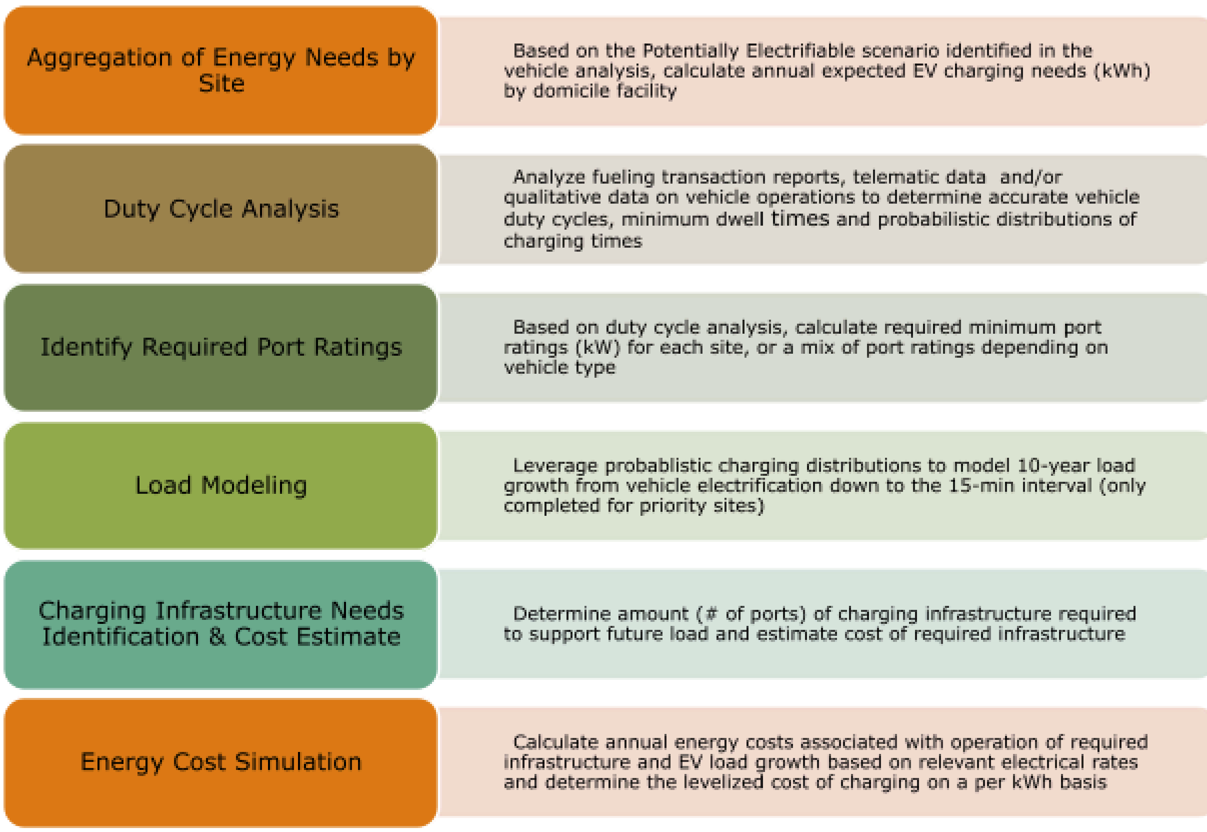
Methodology

Figure 3, below, outlines the general approach used in the detailed EVI analysis. Each step in this approach is further discussed in the following sections.

Figure 3: EVI Analysis Approach



When determining required charging infrastructure to support fleet electrification, there are two primary constraints that must be solved for. First, charging ports must have power high enough to charge vehicles during their dwell time. Appropriate port ratings (kW) may vary by vehicle type or use case. Second, there must be enough charging ports to provide sufficient energy to every vehicle parked at each domicile facility. Solving for both constraints enables site-specific recommendations of charging infrastructure needs to be made for every domicile facility based on the energy needs and operating patterns of the vehicles at a given site, enabling a fleet to cost-effectively plan for implementation.

Since the purpose of long-term charging infrastructure planning is to enable CU Boulder to cost-effectively phase implementation of charging infrastructure with future needs in mind, this analysis relies on the **Complete Electrification** scenario for vehicle electrification identified in during the vehicle analysis. While it is likely that, due to expected expansion of medium- and heavy-duty electric vehicle options, CU Boulder will not purchase the *exact* electric models identified during the vehicle analysis, the required energy needs calculated will remain reflective of future needs. Thus, leveraging an aggressive vehicle electrification scenario ensures that charging infrastructure recommendations are sufficient to support all possible vehicle electrification and avoid the need for expensive retrofits.

Data Sources

Two primary data sources were used to assess the dwell times, identify required port ratings and calculate charging probabilities for CU Boulder's fleet.

- **Fueling Transactions:** A record of fueling transaction completed by existing ICE vehicles in 2022 was analyzed to inform required port ratings and provide insight into when vehicles currently fuel. Based on the Best Fit model for each existing vehicle, existing fueling events were converted to charging events to assess minimum, maximum and average charging times that could be expected if each existing vehicle were converted to electric and continued to fuel as it does today. Additionally, the time distribution and length of these synthetic charging events were used to create charging probabilities (discussed further below).
- **Staff Interviews:** Interviews with Facilities and Transportation staff were used to supplemental qualitative information on how vehicles operate.

Duty Cycle Analysis & Port Power Ratings

Fueling transaction data and staff interviews were leveraged in different ways to analyze vehicle duty cycles in order to identify dwell times and combined with expected per vehicle energy needs to identify required port ratings for each facility. In some cases, multiple port ratings were identified for a single domicile facility due to differences in the operations of subsets of vehicles located at a particular facility. Dwell times were compared with vehicle energy needs to identify a common port power rating needed to provide the required daily energy during an average dwell time. Fueling transactions converted to charging events were analyzed to filter out vehicles, usually those with large battery capacities, that may require charge times longer than the average dwell time in certain instances when the battery is depleted.

Managed Charging Potential

For many fleets, employing managed charging strategies that use the charging station software to limit the hours in the day when vehicles can charge are effective for reducing the cost of charging. For the purposes of this analysis, it was assumed that vehicles are charged on the same utility rate as the University buildings without variation in time of day (Time-of-Use or TOU). As a result, a managed charging scenario may result in more fueling savings than reported here.

Load Modeling & Overall Infrastructure Needs

After determining port ratings, the number of ports required must be calculated. For the suggested centralized domicile sites at CU Boulder, a sophisticated probabilistic load modeling technique was used, as described below.

Charging Probabilities

To enable accurate modeling of load growth over time and identification of total charging infrastructure needs in 2030, 2040, and 2050 at sites with many vehicles, a site-specific, annual, probabilistic method was used. Probabilities are calculated based on estimated vehicle usage windows, load, and charging behavior. Vehicles assigned to light- and medium-powered chargers are assumed to charge at any point during the workday; vehicles assigned to very high powered chargers are mostly buses, and were assumed to have shorter windows to charge between shifts. Annual load was calculated based on the vehicles' annual mileage and the recommended EV replacement. Most vehicles were assumed to seek a charge at 40% remaining battery life; high-powered vehicles were assumed to seek a charge at 20% remaining battery life.

Load Profile Builder

In order to simulate the electric load profiles from charging of a future electric vehicle fleet, time-dependent load profiles were modeled. The Load Profile Builder leverages the probability profiles discussed above to take an index of 672 numbers (the number of 15-minute intervals in a week), where each number represents the likelihood that a random charging interval will occur on that day and time. Once the charging probability indices are determined, the user provides additional inputs to the load profile builder. The load profile builder was given these fixed inputs for each department site in each year studied:

- Number of EVs at each facility[7]
- The total annual amount of electrical energy needed to fuel all EVs domiciled at each facility from 2025 to 2050
- Maximum number of ports available
- The power rating of each port, as determined for each site, with different port ratings for different sub-classes of fleet vehicles, as appropriate
- The site's time-of-use structure, if applicable[8]
- Variable charging windows during the day, as described previously
- The time at which overnight and weekend charging treatment should be assumed for vehicles which are exclusively used during normal business hours, and parked during nights and weekends

These choices are given to the load profile builder as inputs in a control panel of a Visual Basic-based spreadsheet simulator. Over the course of a non-leap year, there are 35,040 charging intervals.[9] For each vehicle, the load profile builder calculates the number of times during the year that vehicle will seek a charge. It then casts these events randomly amongst available charging windows in order to reconstruct the vehicle's load. The program throws away events that occur when the ports are already all used up, to simulate vehicle conflicts and allow easy detection of insufficient charging. The load profile builder then takes the sum of all charging in all intervals across all ports. The user is given this annual total along with an error signal which compares the total delivered energy to the required annual energy as determined in the fixed inputs. If the total amount of energy delivered is below the amount needed, more ports may be added, or charge windows may be lengthened. Due to the design of the algorithm, the load profile builder

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[7] This determines the maximum number of vehicles charging at any given time, since the number of ports active is assumed to be less than or equal to the number of vehicles

[8] This was not applied for CU Boulder

[9] 365 days per year x 24 hours per day x 4 intervals per hour (with each interval at 15 minutes)

will generally not exceed required load by more than a few percentage points, meaning it is up to the user to adjust inputs until a near-minimum number of chargers required is reached.

Total Port Needs

From the simulations of annual charging completed for each site, the total port needs for each power rating can be identified by analyzing the maximum number of coincident ports in use. To account for variations in vehicle charging needs, a safety factor of 20% is applied to the maximum coincident port number to determine the final recommended port counts.

Infrastructure Cost Assumptions

Given the rapid expansion and evolving nature of the electric vehicle industry, charging infrastructure costs are widely variable and come with a significant amount of uncertainty. Recent research has indicated that the industry is following a pattern similar to the solar industry, where the cost of materials falls according to a standard "experience curve" but soft costs (site assessment, utility interconnection and permitting) remain high, unpredictable and site-specific.[10]

The cost assumptions for charging hardware and installation costs in this study are specifically for California and are primarily drawn from a 2019 study by the International Council on Clean Transportation.[11] This study aggregated data from past studies, as well as costs reported to public utility commissions via utility programs. Data on charger component costs aggregated through industry interviews by the Rocky Mountain Institute confirmed that the costs in the ICCT study were in an accurate range. Representative of the limited data available, both the ICCT and RMI studies built significantly on data from a 2013 Electric Power Research Institute study.[12] Given the age of the EPRI data, costs figures may have fallen in the intervening years. However, the cost range remains sufficiently broad to warrant a conservative approach.[13]

Table 3 includes a summary of the cost figures used to calculate total cost.

Table 3: Summary of EVI Cost Assumptions

CHARGER HARDWARE COSTS (PER PORT)		INSTALLATION COSTS				
CHARGER TYPE	COST ($)	# OF PORTS INSTALLED	L2 COST PER PORT (6.6 KW)	L2 COST PER PORT (11.5 KW)	DCFC COST PER PORT (25 KW)	FREEWIRE COST PER PORT
LEVEL 2 (6.6 KW)	$1,925	1	$39,600	$39,600	$52,600	$46,400
LEVEL 2 (11.5 KW)	$2,500	2	$19,800	$19,800	$49,600	$43,400

[10] Chris Nelder and Emily Rogers, Reducing EV Charging Infrastructure Costs, Rocky Mountain Institute, 2019, https://rmi.org/ev-charging-costs

[11] Michael Nicholas, Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas, International Council on Clean Transportation, August 2019, https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

[12] Electric Power Research Institute, Electric Vehicle Supply Equipment Installed Cost Analysis, 2013, https://www.epri.com/research/products/000000003002000577

[13] Initial data reported to the California Energy Commission via the CALeVIP project shows even higher installation costs than assumed in this report. However, these costs result from a small sample size that CEC indicates may have been skewed by a few high-cost sites. As a result, these costs have not been included in this study. The data is available here: https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/california-electric-vehicle/calevip-level.

DC FAST (25 KW)	$15,746	3-5	$24,400	$24,400	$48,600	$42,400
FREEWIRE	$267,000	>6	$17,800	$17,800	$47,600	$41,400

The hardware costs used are per port and assume networked capability. Installation costs include labor, permits, taxes and the cost of make-ready electric infrastructure on the customer side of the meter. Make-ready electric infrastructure on the customer side of the meter generally includes wiring, conduits, trenching, service panels and switchgear upgrades (if needed) and can vary significantly from site to site.[14] The cost figures above include only wiring, conduit and service panel costs. Trenching costs for installation are *not* considered in the cost estimates calculated for this study because site layouts have not been determined.

Cost assumptions are used to provide a starting point in estimating infrastructure costs. University staff can adjust cost assumptions for key sites in the Fleet Electrification Pro-Forma accompanying this report.

Infrastructure Needs & Capital Cost Estimates

Unlike vehicle electrification, which has the potential for total cost of ownership savings, the infrastructure required to charge electric vehicles is a cost that the University of Colorado Boulder is required to bear in support of their fleet electrification goals. A primary challenge when identifying charging infrastructure needs is identifying the minimum number of charging ports at each location required to satisfy the fleet's daily energy needs while balancing operational considerations such as dwell time. One way to minimize the total cost of EVI is to minimize installation costs through futureproofing. Instead of installing a handful of charging stations to meet immediate need and then having to remove those, expand power capacity and re-install more chargers as fleet electrification continues, total costs can be minimized by installing make-ready electrical infrastructure to support future charging needs at the time of initial installation. Long-term planning of charging infrastructure allows fleets to futureproof effectively.

Operational Considerations of Vehicle to Port Ratios

For every domicile facility considered, the recommendations indicate a vehicle to port ratio greater than 1:1. Implementing vehicle to charger ratios higher than 1:1 minimizes EVI hardware and installation costs but has operational considerations, as not every vehicle can be plugged in at the same time. This challenge can be managed in a variety of ways ranging from staff training to software solutions. A first solution is to recognize that during standard operations vehicles do not need to be charged every night. It is important to recognize that, especially as electric vehicle range increases, the common perception that EVs need to charge every night is a misconception. Across the sites analyzed in this report, the average daily energy needs per vehicle ranges from 2.5-58.6 kWh per day, with a maximum of 58.6 kWh per day at the SEEC Lot, where Transportation buses are domiciled. In contrast, the vehicle types modeled have between 16-525 kWh battery capacities. This is a clear indication that the majority of vehicles in the University's fleet will not be required to charge every night.

Finally, the recommendations provided below are for "fully powered" ports, meaning charging ports that have sufficient circuit capacity to provide a power output at their nameplate capacity. In some cases, it may be advantageous for the

[14] Reducing EV Charging Infrastructure Costs, Rocky Mountain Institute, 2019

University to add additional charging ports, without taking the capital-intensive step of expanding the recommended power capacity, to enable more vehicle to be plugged in at once and leverage software to balance charging across ports.

OVERALL INFRASTRUCTURE NEEDS

CENTRALIZED PARKING FOR FLEET VEHICLES

Currently, the University's fleet of vehicles are managed, operated, and parked individually by departments throughout campus. The Transportation Department maintains a master list of vehicles and oversees maintenance, but day-to-day vehicle use is decentralized. At the recommendation of the University's Transportation Master Plan, the EV charging infrastructure analysis started with the identification of nine (9) centralized domicile locations for fleet vehicles. The following locations were identified with assistance from University staff:

TABLE 10: RECOMMENDED DOMICILES & CHARGING NEEDS

SITE	APPROXIMATE TOTAL VEHICLE COUNT (2050)	# OF PORTS (FULLY POWERED)	VEHICLE TO PORT RATIO
HFOC / HSSC (3500 MARINE ST.)	77	2 x 6.6 kW 6 x 11.5 kW 2 x 25 kW	7.7
REGENT GARAGE (LOT 436) / PDPS	72	4 x 6.6 kW 8 x 11.5 kW 2 x 25 kW	5.1
FOLSOM GARAGE (LOT 391)	23	2 x 6.6 kW 4 x 11.5 kW 1 x 25 kW	3.3
STADIUM LOT	142	4 x 6.6 kW 8 x 11.5 kW 4 x 25 kW 2 x 200 kW	7.9
SEEC LOT	49	2 x 6.6 kW 4 x 11.5 kW 3 x 25 kW 12 x 200 kW	2.3
MACKY LOT	4	1 x 6.6 kW 2 x 25 kW	1.3
VARIOUS LOTS	24		
LOT 306 / LOT 319	25	2 x 6.6 kW 4 x 11.5 kW	4.2
UMC DOCK / SERVICE LOT N (1045 18TH ST)	16	4 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	2.3

Projected Infrastructure Needs by Site

This section summarizes infrastructure needs for 2030, 2040, and 2050 across all domicile facilities. The infrastructure needs in 2040 are cumulative and include 2030, and infrastructure needs in 2050 include 2040.

Table 11: Summary of Infrastructure Needs by Site (2035)

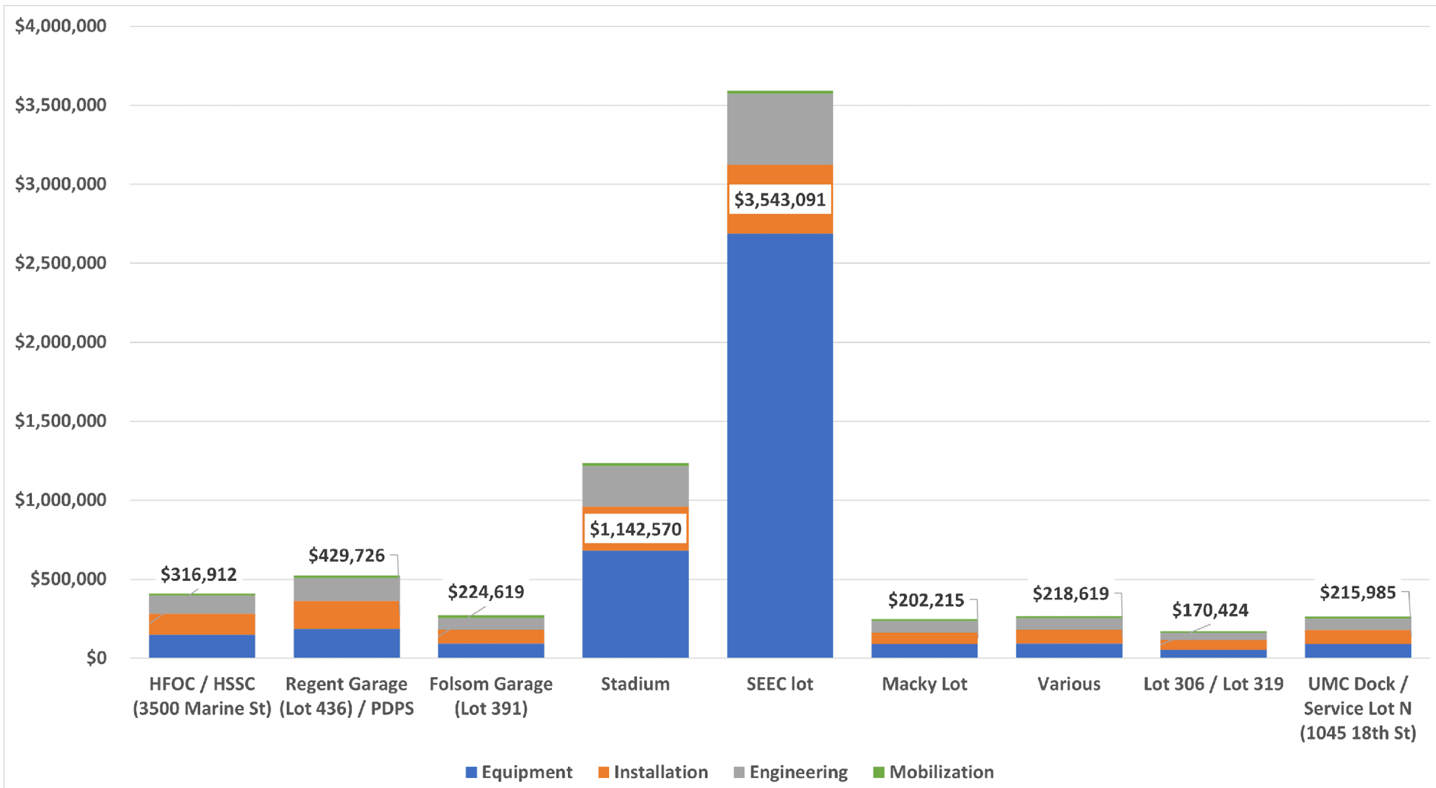
SITE	2030			2040			2050		
	# OF EVs (% OF TOTAL)	# OF PORTS	VEHICLE TO PORT RATIO	# OF EVs (% OF TOTAL)	# OF PORTS	VEHICLE TO PORT RATIO	# OF EVs (% OF TOTAL)	# OF PORTS	VEHICLE TO PORT RATIO
HFOC / HSSC (3500 MARINE ST.)	28 (36%)	2 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	3.1	47 (61%)	2 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	5.2	77 (100%)	2 x 6.6 kW 6 x 11.5 kW 2 x 25 kW	7.7
REGENT GARAGE (LOT 436) / PDPS	13 (18%)	2 x 6.6 kW 4 x 11.5 kW	2.2	44 (61%)	4 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	4.9	72 (100%))	4 x 6.6 kW 8 x 11.5 kW 2 x 25 kW	5.1
FOLSOM GARAGE (LOT 391)	4 (17%)	2 x 6.6 kW 2 x 11.5 kW	1	10 (43%)	2 x 6.6 kW 4 x 11.5 kW	1.7	23 (100%))	2 x 6.6 kW 4 x 11.5 kW 1 x 25 kW	3.3
STADIUM LOT	53 (37%)	4 x 6.6 kW 6 x 11.5 kW 2 x 25 kW	4.4	94 (66%)	4 x 6.6 kW 6 x 11.5 kW 2 x 25 kW 1 x 200 kW	7.2	142 (100%))	4 x 6.6 kW 8 x 11.5 kW 4 x 25 kW 2 x 200 kW	7.9
SEEC LOT	22 (45%)	2 x 6.6 kW 2 x 11.5 kW 3 x 25 kW 6 x 200 kW	1.7	34 (65%)	2 x 6.6 kW 4 x 11.5 kW 3 x 25 kW 6 x 200 kW	2.1	49 (100%))	2 x 6.6 kW 4 x 11.5 kW 3 x 25 kW 12 x 200 kW	2.3
MACKY LOT	1 (25%)	1 x 6.6 kW	1	2 (50%)	1 x 6.6 kW	2	4 (100%))	1 x 6.6 kW 2 x 25 kW	1.3
LOT 306 / LOT 319	5 (20%)	2 x 6.6 kW 2 x 11.5 kW	1.3	16 (64%)	2 x 6.6 kW 4 x 11.5 kW	2.7	25 (100%))	2 x 6.6 kW 4 x 11.5 kW	4.2
UMC DOCK / SERVICE LOT N (1045 18TH ST)	4 (25%)	2 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	0.8	12 (75%)	4 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	1.7	16 (100%))	4 x 6.6 kW 2 x 11.5 kW 1 x 25 kW	2.3

Projected Infrastructure Needs: Costs

The section presents projected electric vehicle infrastructure costs for each site based on build out to meet 2050 needs. The costs listed are total costs for a given site and are not reflective of project-specific costs if the University pursues phased implementation of the required charging infrastructure.

Figure 8 summarizes the estimated costs by component across all sites for base infrastructure needs in 2050. Costs include all charging station hardware and installation costs, as well as costs for procurement management (as applicable) and estimated overhead for Engineering from Facilities Management staff.

Figure 8: Estimated EV Charging Infrastructure Costs (2025 – Base Needs)



Beyond costs for charging hardware, conduit, wiring and trenching, additional electrical infrastructure upgrades to building equipment can add cost above the estimates in Figure 8 if charging infrastructure is connected to the building meter, or a new service is needed. Adaptive load management is a solution that leverages software to balance the power a set of charging stations is drawing to ensure that the total draw never exceeds the building capacity. This can be a less capital-intensive solution but requires the ability to curtail charging ports.

Incremental Cost of Carbon Reduction

Table 11 summarizes the incremental cost of carbon, inclusive of estimated charging infrastructure upgrade costs, based on 2030, 2040, and 2050 infrastructure buildout. In this case, costs reported for 2040 are incremental to those reported for 2030, and 2050 are incremental to those reported in preceding phases.

Table 11: Incremental Cost of Carbon Reduction from Fleet Electrification

TIME PERIOD	CARBON EMISSIONS REDUCED ($MTCO_2$)	MARGINAL CAPITAL COST ($)	MARGINAL TCO ($)	CHARGING INFRASTRUCTURE COSTS ($)	ESTIMATED COST OF CARBON REDUCTION ($/$MTCO_2$)
2025-2029	90	$14,314,393	$12,770,056	$3,330,307	$178,078
2030-2039	215	$6,271,403	$5,168,754	$620,304	$26,886
2040-2050	248	$15,842,533	$13,337,904	$2,513,550	$63,913

NEXT STEPS

IMMEDIATE TERM ELECTRIFICATION & TCO

A summary of the identified EV alternatives and associated TCOs for immediate vehicle replacements (2025-2027) is included to guide immediate action by the University. **Table 10** summarizes the total upfront investment and TCO for the ICE and the best fit EV alternative for all vehicles to be replaced for each year. This table also identifies the total number of vehicles to be electrified, which is consistent with the numbers presented in the Electrification Timeline. **This table only includes vehicles that were identified as a Best Fit.** The number of vehicles to be electrified could be increased if the University confirms feasible models for vehicles in the Potential Electrification category.

TABLE 10: UPFRONT COST & TCO SUMMARY FOR IMMEDIATE VEHICLE ELECTRIFICATION

Replacement Year	# of Vehicles to be Electrified	ice vehicle		Recommended EV		
		MSRP	TCO	MSRP	TCO	PROJECTED TCO SAVINGS FROM ELECTRIFICATION
2025	20	$583,479	$835,327	$1,428,359	$1,528,092	($692,765)
2026	14	$437,780	$619,257	$1,091,365	$1,172,584	($553,327)
2027	32	$1,120,675	$1,455,877	$3,452,262	$3,584,906	($2,129,029)
Total	**66**	**$2,141,934**	**$2,910,462**	**$5,971,986**	**$6,285,582**	**($3,375,121)**

Appendix A: COMPREHENSIVE FLEET DATABASE & TOTAL COST OF OWNERSHIP

Appendix A

The detailed Comprehensive Fleet Database and results of the Total Cost of Ownership calculations have been provided to the University separately from this document in an Excel spreadsheet. This database allows the University to sort results by any category necessary including Department, Division and Replacement Year.

Appendix B: FLEET ELECTRIFICATION PRO FORMA

Appendix B

The Fleet Electrification Pro Forma has been provided to the University separately from this document in an Excel spreadsheet.

TO: Kristin Cushman, Blue Strike Environmental
FROM: Optony
DATE: March 30, 2023
RE: CU Boulder Climate Action Plan – Renewable Energy Methodology & Assumptions

SOLAR BASELINING

As part of the renewable energy baselining project, Optony developed a solar baseline in Helioscope for all three of CUB's campuses. The following variables were used in the baseline:

- For arrays at all campuses, Canadian Solar CS6U – 350P modules were used for analysis.
- For sloped roof solar, a tilt of 30 degrees was used. North-facing surfaces were not covered, and modules were mounted flush with one another. Modules were kept at least 4 feet away from edges.
- For flat roof solar, modules were tilted slightly at 10 degrees and spaced out from one another to avoid coverage. Keep outs and shading were used to avoid roof obstructions, and modules were kept away from roof edges.
- For carport solar, modules were mounted on fixed-tilt racking in portrait or landscape arrangements. Driving lanes were maintained and array depth was limited. All parking lots on CUB's campus were covered.
- For ground mount arrays, modules were arranged in 4 by 8 landscape arrays with a 5-degree tilt and 2 foot frame spacing. Array locations were selected to try and minimize campus disruption.

PRICING FOR SOLAR

Rates for PPA pricing were drawn from a list of City of Boulder PPAs approved in 2019.

- An escalation rate of 3% is used, drawn from that data
- For a direct-purchase option, a price of $3,000/kW is used for installation, while $300/kW is used for inverter replacements
- 30% installation incentive is assumed, and O&M costs are modeled at $17/kW
- Panels are assumed to degrade at 0.5%/year
- kWh/kW production ratios are drawn from Helioscope models of the modelled microgrid arrays

SOLAR PV-THERMAL (PVT) MODELING

For solar PV-thermal (PVT), the model assumes a PVT array flowing mass into a thermal storage tank, which itself is linked to a heat pump or pumps connected to the CUB water loop. These pumps heat water to 85 degrees Celsius to match their hot water; however, this can be reconfigured in the model for lower-temperature heat pumps (in order to match the energy output, the pumps would need to process more of the loop's water to compensate for their lower temperature output, assuming the output temperature is greater than the temperature at the back end of the loop). The model returns an amount of PV solar electricity generated, an electricity draw from the heat pumps, and some number of natural gas therms saved by using heat pumps. The campus's thermal load is approximated from weather data by distributing the known natural gas heating energy usage according to temperature data. The mass flow through the water loop is approximated by assuming a minimum loop return temperature of 55 degrees Celsius.

PVT PRICING

PPA rates for PVT are assumed to be similar to PV, but slightly higher. PVT direct purchase prices were also modelled. Here, a $5,000/kW price was used for the array. A $3/kg thermal tank pricing, $6,699/battery pricing, and around $280/kW heat pump pricing was used. Inverter and incentive pricing was the same as for PV.

Technical Annex for CU Boulder's CAP

Introduction

The Technical Annex provides a detailed discussion of the technical analysis that was undertaken to produce the greenhouse gas inventory, forecasts, and scenario analyses within this climate action plan. As such, it details the processes of quantifying greenhouse gas (GHG) emissions, forecasting emissions under various benchmarking scenarios, establishing reduction targets, and evaluating strategic scenarios for reducing GHG against a baseline. First, an inventory of GHG emissions will be discussed; the discussion will highlight both activities that drive emissions, and the emission factors (EFs) that are associated with those activities. Second, the process for forecasting activity levels and EFs will be detailed. Third, the establishment of reduction targets will be considered. Fourth, the process of strategy creation, scenario selection, and evaluation will be examined. The quantitative analysis of these steps took place in a calculator and scenario analysis tool called the Climate and Energy Scenario Analysis (CESA). CESA is a proprietary, Excel-based software tool specifically designed to reflect the energy use and system design of CU's unique operations.

Emission Drivers

Greenhouse gas "drivers"—sources of emissions—can be divided into three categories, called "scopes." The three Scopes are defined by the GHG Protocol, a globally recognized standard for measuring and managing greenhouse gas emissions, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The Protocol provides businesses, governments, and other organizations with a comprehensive, standardized framework for accounting and reporting on greenhouse gas emissions. This CAP is developed from the perspective of "operations", meaning that emissions are reported from areas over which the Boulder campus has operational control.

Scope 1 emission sources include those that are directly controlled or owned by the University. These are natural gas purchases (for use in boilers and furnaces), gasoline, diesel, and biodiesel use from fleet vehicles owned by the university, etc. Scope 2 emissions come from purchased electricity, which is used for campus cooling, electricity-based heating, lighting, etc. These emissions are included in the University's inventory because they are purchased by CU Boulder. Scope 3 emissions are emissions that are not under the university's direct control, and are discussed in much further detail in Appendix D. The submitted use data for Scopes 1 and 2 are summarized below.

Table 1: Use data collected from CU

SCOPE 1 ITEMS	UNITS	2019	2020	2021
Natural gas consumption	*Therms*	*8,442,790*	*9,072,090*	*9,818,000*
Fleet gasoline (unleaded, ethanol) purchases	*Gallons*	*96,102*	*72,505*	*92,171*
Fleet diesel purchases	*Gallons*	*21,156*	*21,178*	*21,049*

Fleet Biodiesel purchases	*Gallons*	*68,068*	*52,378*	*68,311*
Other diesel use (Grounds, Generators, MRS)	*Gallons*	*10,368*	*6,367*	*14,935*
Other unleaded use (Grounds, Generators, MRS)	*Gallons*	*3,638*	*2,574*	*3,251*
SCOPE 2 ITEMS		**2019**	**2020**	**2021**
Electricity consumption (total)	*kWh*	*162,091,211*	*143,400,748*	*150,591,300*
Electricity consumption (minus solar and co-gen)	*kWh*	*156,081*		
Electricity provider		*XCEL*	*XCEL*	*XCEL*

Emission Factors

Scope 1 emission factors are taken from the EPA's emission factors for Greenhouse Gas Inventories[1] which was last updated April 18, 2023, as part of an annual revision process. The emission factors for Scopes 1 and 2 are summarized in Tables 2. Those for Scope 3 are found in the Scope 3 Annex.

Table 2: Emission factors for Scopes 1 and 2

Energy Fuel	Factor	Kg CO2e/	EPA Table Reference
Natural gas[2]	*5.3414*	therm	EPA EFs, Table 1
Gasoline[3]	*8.78*	gal	EPA EFs, Table 2 (CO2 only)
Diesel[4]	*10.21*	gal	EPA EFs, Table 2 (CO2 only)
Biodiesel[5,6]	*9.45*	gal	EPA EFs, Table 2 (CO2 only)
Propane[7]	*5.7417*	gal	EPA EFs, Table 2

Calculating emissions

To calculate emissions, usage data are multiplied by the emissions factors, and further multiplied by a global warming potential (GWP) factor to calculate Carbon Dioxide equivalent emissions (CO2e). Global warming potentials (GWP) are sourced using the Intergovernmental

[1] https://www.epa.gov/climateleadership/ghg-emission-factors-hub
[2] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf
[3] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf
[4] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf
[5] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf
[6] While biodiesel comes from renewable sources such as vegetable oils and animal fats, and typically produces fewer greenhouse gasses when burned compared to petroleum diesel, it still emits carbon dioxide and other pollutants during combustion. In terms of immediate emissions upon combustion, biodiesel and diesel fuel have relatively similar profiles.
[7] https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf

Panel on Climate Change (IPCC), in the Fourth Assessment Report (AR4), in 2007. Methane emissions in the 100-year GWP have a value of 25.[8] Nitrous Oxide emissions have a global warming potential of 298. Many other greenhouse gasses can be found in the IPCC report.

Scope 2 emissions were calculated using existing information from the utility provider (Xcel Energy) about its energy mix. Xcel's emission factors were then forecasted to incorporate the State legislated goals to reach an 80% emission reduction from 2005 levels, by 2030, and 100% reduction (net zero emissions) by 2050 (see Colorado SB 19-236).[9] As a result, CU's emissions from electricity use are expected to fall as Xcel enacts its pledge to reduce carbon from its generation sources. Table 3 shows the corresponding emission factors by year, assuming the utility is able to keep its commitment.

Table 3: Xcel Energy Emission Factor (kg CO2e/kWh) by Year

year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Emission Factor	0.5581	0.5287	0.4994	0.4700	0.4334	0.3969	0.3603	0.3238	0.2872	0.2507	0.2141
year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Emission Factor	0.1776	0.1410	0.1340	0.1269	0.1199	0.1128	0.1058	0.0987	0.0917	0.0846	0.0776
year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Emission Factor	0.0705	0.0635	0.0564	0.0494	0.0423	0.0353	0.0282	0.0212	0.0141	0.0070	0.0000

Baselines and forecasts

Baselines are established to use for comparison with future emission levels. Since one objective of this CAP was to adhere as closely as possible to science-based targets, the selection of a baseline year was done according to the Science Based Target Initiative (SBTi) guidance. SBTi recommends a baseline that falls within the past five years to reflect recent emissions levels. The year 2019 was chosen to avoid outlier data from the impact of the novel coronavirus in 2020. Many emissions were impacted by the pandemic, which led to abnormal use patterns for energy, especially during the years 2020-2021. Though 2019 was used as a baseline, data were collected for years 2019, 2020, and 2021; data requests were provided through the appropriate channels and were tracked through a data request tracker. Emissions for 2019 were calculated through an inventory calculator within the CESA Tool. Figure 1 shows the emission breakdown for Scopes 1, 2 and 3.[10]

[8] We have used the 100-year GWP of Methane; this choice was not unanimous among the Steering Team members. Using a 100-year GWP (Global Warming Potential) for Methane provides a longer-term perspective, reflecting the cumulative impact of the gas over a century, which can be more consistent with long-term climate goals. However, this approach may underrepresent the short-term potency of Methane, as its GWP is much higher over a 25-year period. Opting for a 25-year GWP underscores Methane's immediate and intense warming effect but might not capture its decreasing influence over longer periods.

[9] See Colorado SB 19-236: https://leg.colorado.gov/sites/default/files/documents/2019A/bills/2019a_236_enr.pdf..

[10] According to SBTi, the first step in creating a Scope 3 accounting is to take a high-level assessment of Scope 3 categories, to determine if Scope 3 emissions might contribute more than 40% of total emissions. During the process of developing emission totals for this CAP, it was determined that Campus Scope 3 emissions were likely contributing

Figure 1: Emissions by Scope[11]

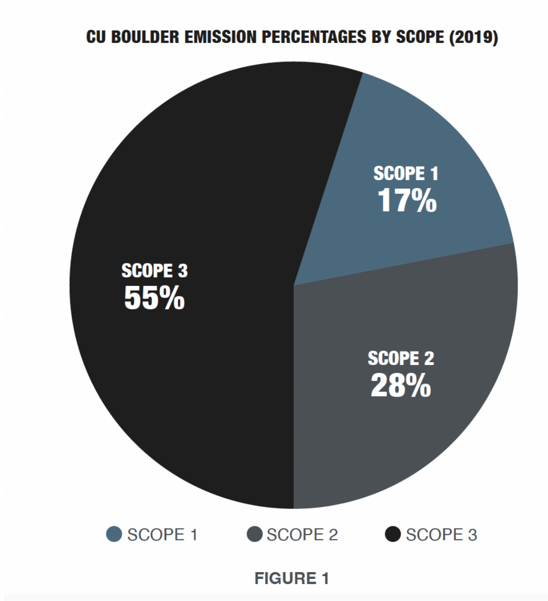
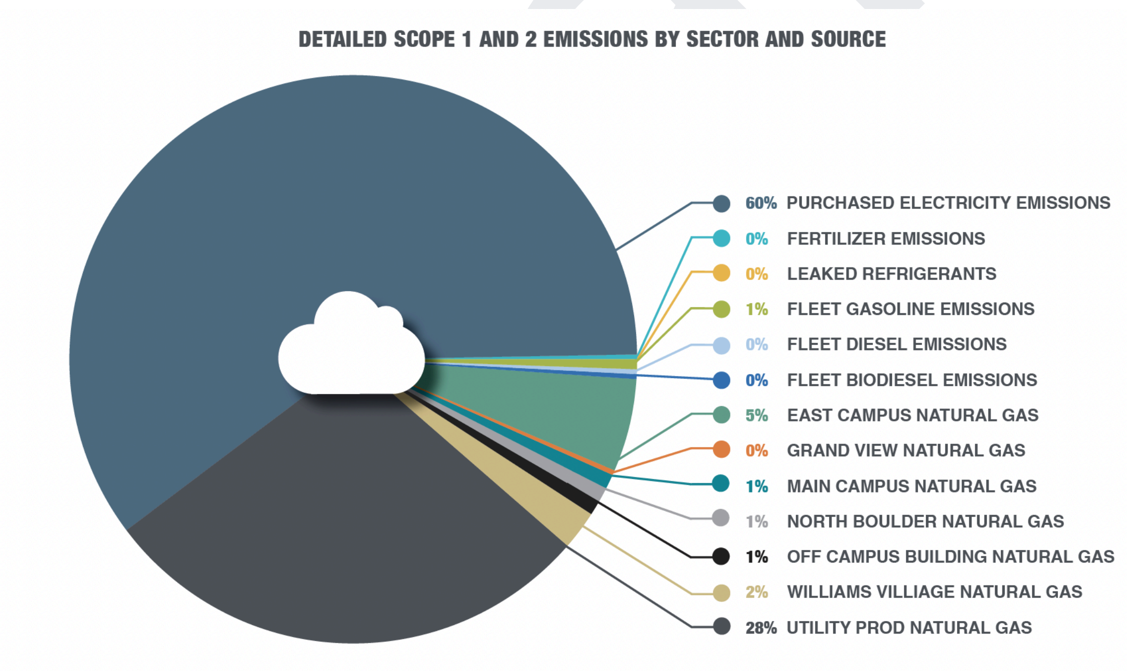


Figure 2: Scope 1 and 2 emissions by source[12]



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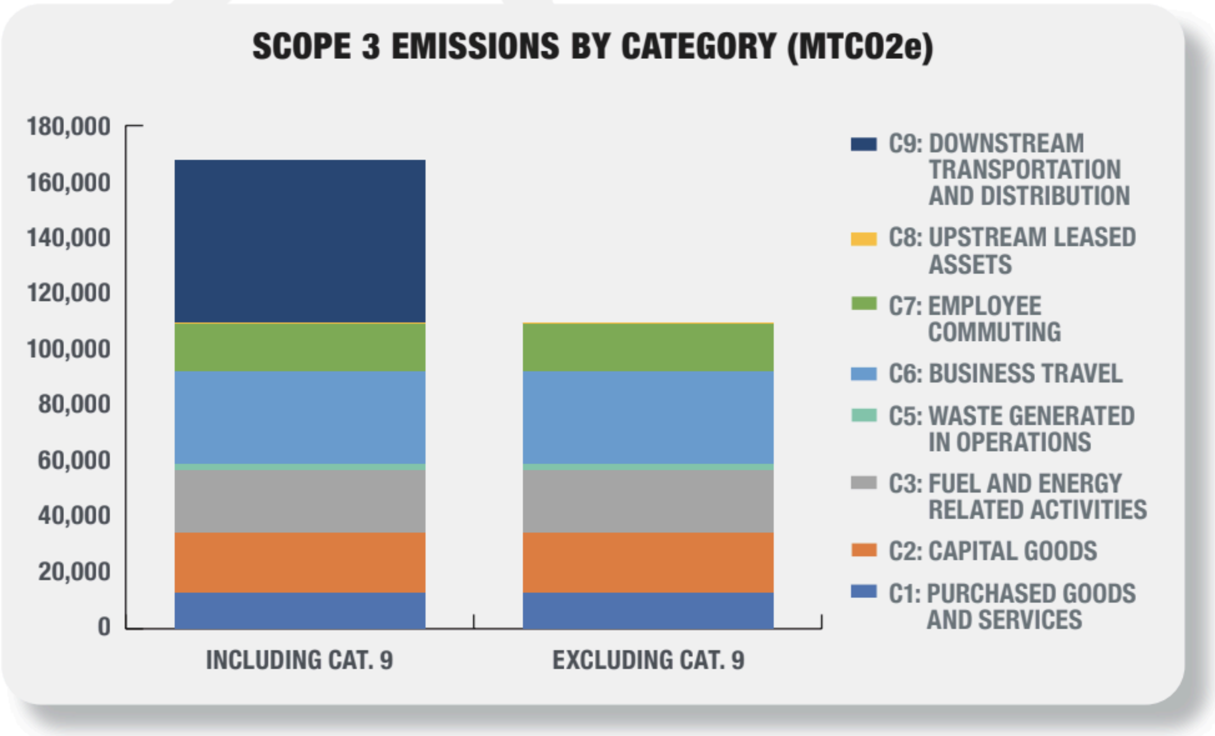
more than 40% to the overall total, and that a deeper accounting would be necessary. When a company's or institution's Scope 3 emissions account for more than 40% of their total emissions, the SBTi recommends that the company or institution should set a Scope 3 target. Please see the Scope 3 Annex for additional information.

[11] The Scope 3 percentage includes eight of fifteen categories, graphically displayed below. Please see the Scope 3 Annex for a full explanation of the Scope 3 approach, inventory and target setting.

[12] Natural gas emissions are from the year 2021 in this graphic, as detailed emissions are available in 2021 only.

Figure 3: Scope 3 Emissions by category[13]



Many local, state, and national entities have also used 2005 as a baseline for emission reduction targets. As a result, an additional 2005 baseline has been included in the analysis for comparison, in order to align CU with those entities. The 2005 baseline was not recalculated specifically for this study; rather the SIMAP reported emissions from 2005 were used.[14] The two baseline emission figures are found in Table 4.[15]

CUB's 50% reduction target (by 2030) leads to a lower emission total in 2030 if an SBTi-recommended "recent year" of 2019 is used as a target-setting baseline, due to moderately higher 2005 emissions. In fact, a 50% reduction from the 2005 baseline is only 5%, and roughly 3,000 MTCO2e, higher than a 50% reduction from the 2019 baseline, as also shown in Table 4.

Table 4: Impact of using 2019 baseline over 2005.

[13] The University acknowledges that this is an incomplete measurement of Scope 3 emissions. Since this is the first attempt at a Scope 3 inventory, data from some categories were not readily available in time for inclusion. The Scope 3 Annex fully describes these limitations, and the steps the Campus is taking to improve record keeping for a more robust inventory in subsequent CAPs.
[14] SIMAP (Sustainability Indicator Management & Analysis Platform) is a carbon and nitrogen-accounting platform commonly used by universities to track, analyze, and improve campus-wide sustainability.
[15] The 2019 emissions total differs slightly from what CU reported through the campus Second Nature report, which is 126,442 MTCO2e. It was difficult to precisely match the Second Nature reporting figures due to the possible use of different emission factors, etc.

Year	Emissions (MTCO2e)	2030 Scopes 1 & 2 Resulting Emissions - 50% Reduction (MTCO2e)
2005	135,609	67,805
2019	129,328	64,664

The goal of the CAP is to determine strategies (described below) that will drive emissions toward selected targets. The ability of the strategies to reduce emissions is evaluated by comparing forecasted emissions after strategy implementation to forecasts without the strategies. The baseline benchmarks (2005 & 2016) are two of these comparison forecasts, which simply project a consistent emission value until 2050 (27 years).

Additional Benchmarks

The next benchmark was a Business-As-Usual forecast (BAU), which projected the University's emissions if it were to make no investments in decarbonization. The BAU includes a growth rate of 1% in campus footprint, beginning in 2035; prior to this date, it includes planned capital building projects.[16] Importantly, it also includes Xcel Energy's projection to reduce their emissions by 80% by the year 2030 (from 2005), and achieve net zero emissions by 2050. The result is a steady reduction of the University's scope two emissions, which eventually reach zero by 2050. No other emissions are being reduced in this benchmark.

Two targets were also included as benchmarks. One was the campus "Science-Based Target," a target which refers to the emission pathway for the organization, such that it performs its role in reducing global temperature rise to less than 1.5℃. The science-based target for CU Boulder was calculated using the downloadable calculator available from the Science Based Target Initiative (SBTi).[17] There are long term goals and short-term goals aligned with SBTi. The short-term goal for CU would be a target of 67.2% reduction by 2035[18], from 2019 Scope 1 and 2 levels, and the long-term goal would be to achieve net zero by 2050. These reduction targets average approximately 7% year on year reduction in emissions from Scopes 1 and 2 until 2035. From 2035 to 2050, emissions are expected to move to net zero.

The second target, and final benchmark, was CU Boulder's own emission reduction goal[19]. The University has committed to a reduction of 50% in emissions from Scopes 1 and 2 activities by 2030[20], and to full decarbonization by 2050, to go along with a similar reduction of 50% emissions in certain scope three categories. The target line also presents incremental

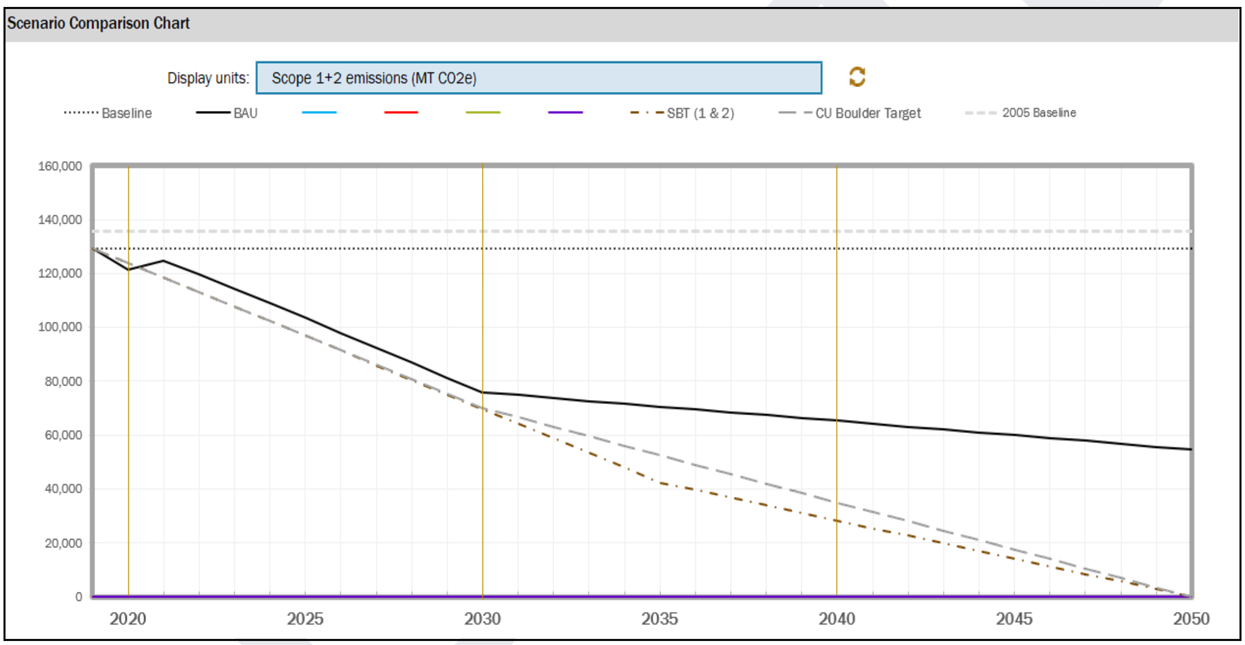
[16] CU Boulder Campus Master Plan 2021.
[17] SBTi is an organization that defines and promotes best practice in emissions reductions and net-zero targets in line with climate science. It provides technical assistance and expert resources to companies who set science-based targets in line with the latest climate science.
[18] As reported by the Science-Based Target Setting Tool Version 2.2 with the Absolute Contraction Approach.
[19] https://www.colorado.edu/sustainability/programs/climate-action-plan
[20] 2009 Conceptual Plan for Carbon Neutrality

annual targets on the way to zero emissions. All five benchmarks are summarized in Table 5 and shown in Figure 3.

Table 5: Benchmark descriptions

Benchmark	Description
2005 Baseline	Previous CUB climate planning and other State Plans have referenced 2005 as a baseline.
2019 Baseline	The SBTi recommends a recent year for a baseline in order to develop strategies that account for up to date emissions
BAU Forecast	If CUB were to take no action, emissions are expected to follow this curve; reductions come from the utility's efforts in reducing emissions from its generation

Figure 4: Figure showing baseline and BAU benchmarks



Strategies

CESA utilized a suite of strategies to project emissions after decarbonizing projects are completed. These strategies include: renewable energy (RE) projects that increase solar energy generation on campus; vehicle fleet; (VF) projects which replace internal combustion vehicles with electric vehicles; Energy Efficiency (EE) projects, which have a substantial impact on emissions through reducing building energy use on campus; and heating system upgrades (HSU), which provide wholesale upgrades to the heating and cooling systems of the campus.

Energy Efficiency Projects

Energy efficiency projects are building upgrades that save energy through more efficiently managing building needs. The building efficiency projects fall into the following categories: envelope projects, lighting projects, commissioning, HVAC, and HVAC in labs (which present special challenges). The specific projects that compose each category type are shown in Table 6, where Envelope Upgrades, for example, comprises Building Envelope Upgrades, Weatherization, and Window Upgrades. The table also shows the relative financial impact of installing each project, shown in years of simple payback. The simple payback and data sources for the quantitative analysis came from the CUB Energy Master Plan report.

Table 6: Project types and simple payback periods

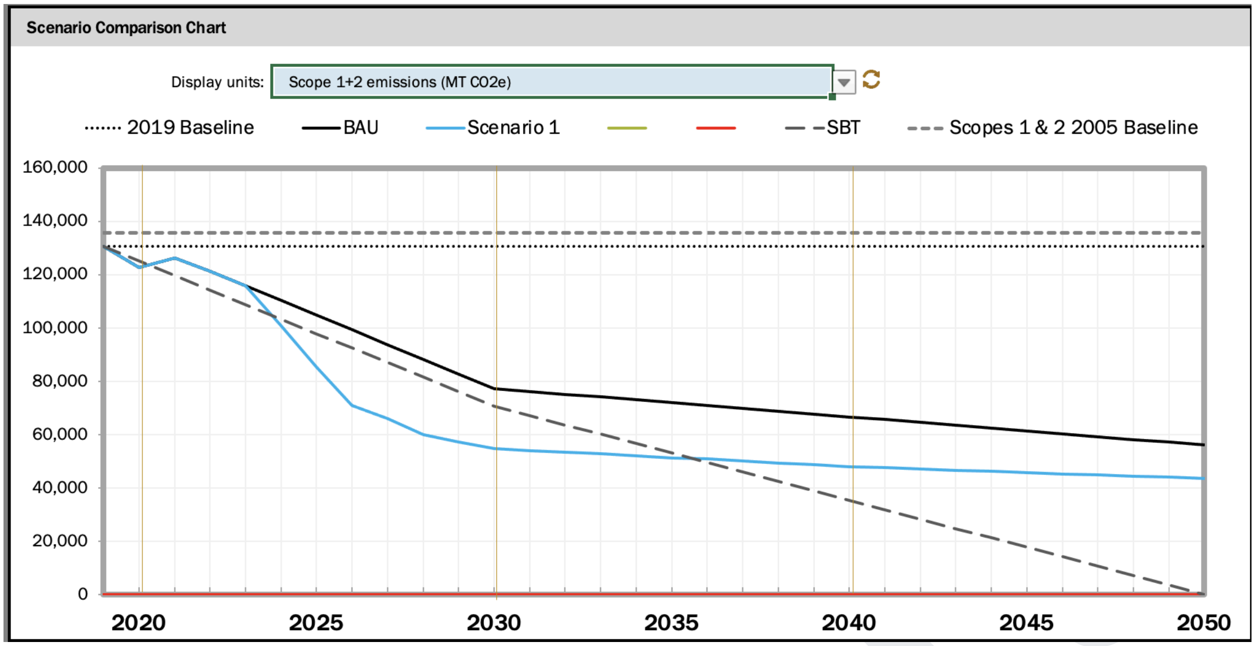
Project Category	Project Types	Simple Payback (years)
Envelope Upgrades	Building Envelope Upgrades	26.5
	Weatherization	14
	Window Upgrades	197
Commissioning	Commissioning	6
Lighting Upgrades	Lighting Daylight Controls	30
	Lighting Occupancy Sensors	27
	Lighting Upgrades	10
HVAC Upgrades	Energy Recovery	94
	Ventilation Upgrades	161
	HVAC Control Upgrades	69
	Piping and Equipment Insulation	32
	Temperature Setbacks	7
HVAC Upgrades (Research)	Fume Hood Controls	34

Information in the table was adapted from the 2022 Energy Master Plan developed by AECOM. Further detail on capital costs and energy savings figures can be found in that report.[21]

The building efficiency projects are projected to achieve the Campus' 2030 Scopes 1 and 2 emission targets goals, on their own. However, without further reductions in campus natural gas consumption, the gains from building efficiency eventually level out, and by 2035 the campus falls behind these targets. These results are illustrated in Figure 4.

Figure 5: GHG Reductions resulting from energy efficiency projects

[21] The 2022 Energy Master Plan for University of Colorado, Boulder.



Heating System Upgrades

The Campus's centralized heating and cooling system consists of two separate District Energy Plants, each with several large natural gas boilers and chillers used for heating and cooling, and delivers roughly half of all energy consumed by campus buildings. The Western and Eastern District Energy Plants (located on the western and eastern sides of the Main Campus) utilize over 15 miles of chilled water and steam distribution piping to provide heating and cooling capabilities to the Main Campus buildings. Currently, there is a study underway evaluating how to replace the heating system at these two plants over the next 25 years. This significant undertaking would involve replacing the boilers at the central plant itself and retrofitting the extensive piping and building level systems to be suitable for delivering hot water rather than steam.[22]

Results of the heating system study, including specific costs of equipment and timing of investment, were not available for this CAP. The upgrade will be very expensive and impact major portions of building operations across the campus. While electric boiler replacements are relatively expensive, the primary drivers of cost will be upgrades to the distribution system and the building-level modifications that need to be made, in order to use lower temperature water. A rough estimate of the timing (and cost) of boiler replacement has been integrated into the analysis, but significant uncertainty will remain until the aforementioned study is complete next year.[23]

[22] There are two additional aspects of campus: i) East Campus does not have a centralized District Energy Plant, and ii) Williams Village, which has its own separate, dedicated district energy that already utilizes hot water rather than steam for heating. These portions of campus are not a part of the study.

[23] Because little is known about the upcoming HSU plan, including the sequencing of investments, it was difficult to model the timing of emission reductions, or occurrences of costs. For example, if initial investments are made in distribution piping rather than in boilers, these investments would have little impact on existing emissions. The authors therefore made a simplifying assumption to divide the emissions that will be saved by the upgrades, into five

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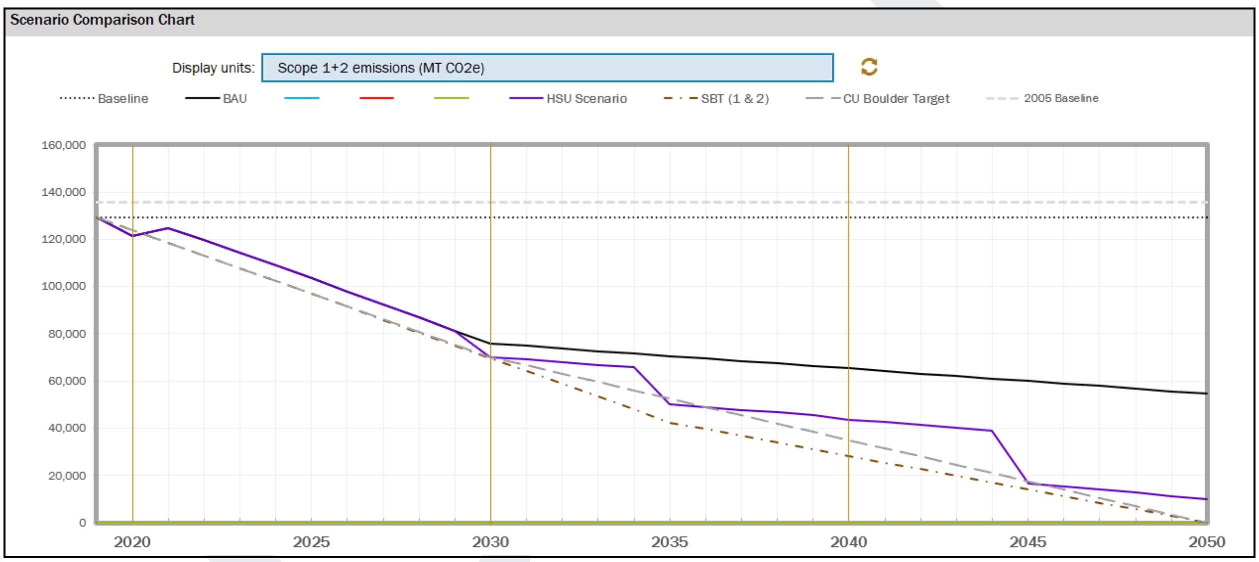
The first of the heating upgrade projects may enable CUB to reach its targets for Scopes 1 and 2, by 2030. However, as Figure 5 shows, it may not achieve the SBT, slightly more stringent target. The series of projects falls behind emission targets in future years, without the additional implementation of the building efficiency projects.

Figure 6: GHG savings from Central Plant projects compared to BAU and other benchmarks



Renewable energy: on-campus solar PV installation

The first strategy evaluated was renewable energy.[24] An assumption was made that 7 MW worth of capacity could be quickly installed in 2025. The GHG reduction impact is not significantly different from the business-as-usual scenario and does not drive the campus to

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equal amounts. The cost of the investment was also divided, and modeled in five equal amounts. In reality, both the emission reductions and the costs would be much more uneven.

[24] CU Boulder's recent Energy Master Plan found the campus has up to 10 MW of PV generation capacity across Main and East Campus roofs, carports, and open areas. The installation of PV on these areas will be required for the campus to achieve its 2030 target of 10 percent renewable energy on-site. (Energy Master Plan 2022).

achieve its intended reduction goals. Even the most accelerated investment pathways do not substantially change emission outcomes.

Table 7: Modeled solar PV projects

Project	Project Cost	First year energy production (kWH/year)	Start Year for Solar PV installation
1	$3,227,455	1,047,875	2025
2	$2,514,435	816,375	2025
3	$1,243,935	403,875	2025
4	$2,465,925	640,500	2025
5	$241,395	62,700	2025
6	$1,486,485	386,100	2025
7	$5,467,000	1,420,000	2025
8	$687,225	178,500	2025
9	$5,505,500	1,430,000	2025
10	$3,578,960	929,600	2025
11	$1,889,799	280,000	2030

This is not to say that renewable energy installations should not be pursued. The CU Boulder Energy Master Plan highlights the importance of resilience for the campus, which it defines as, "the ability of energy systems to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions". Energy resilience is critical for CUB to meet its service requirements to research and other essential campus functions. Transitioning energy sources from fossil fuels to renewables, means decreased GHG emissions, reduced operational costs, and when constructed on-site, an invaluable source of power for resilience. As a result, projects such as rooftop and carport solar PV installations, are in the early stages of deployment across the campus, and other areas on campus have been identified for possible solar PV installations, some of which were assessed in this report. CU Boulder has established an on-site target of 10% clean energy by 2030.[25]

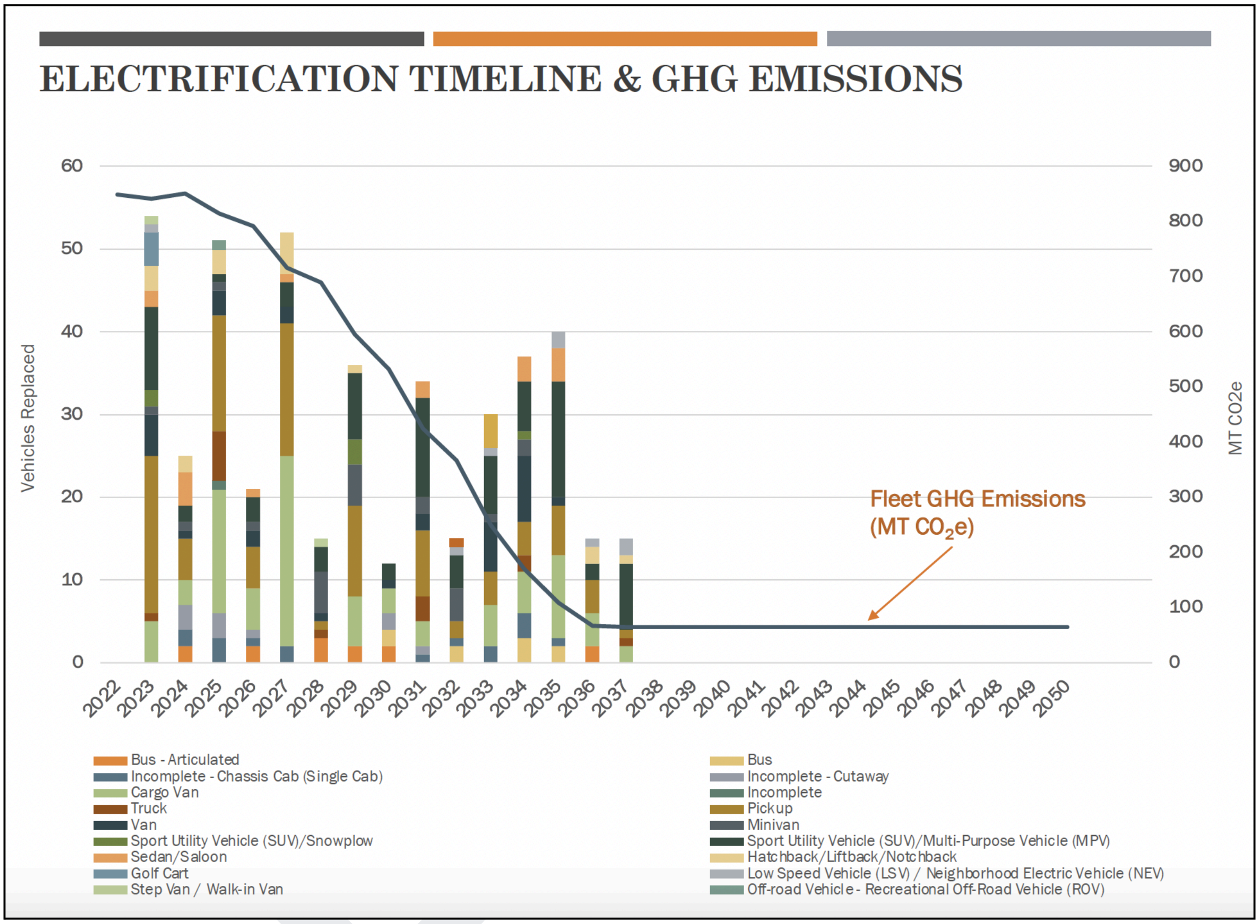
Fleet electrification:

The second strategy evaluated was that of fleet electrification. After accounting for non-street legal assets (trailers, generators, etc.) and vehicles that are already electric, 452 out of 454 total vehicles owned by the University were studied for electrification. Of this subset, 81% can be replaced with equivalent electric vehicles that are currently commercially available, predominantly sedans, SUVs, pickup trucks, and campus buses. Most of the remaining vehicles

[25] CU Boulder Energy Master Plan. 2022.

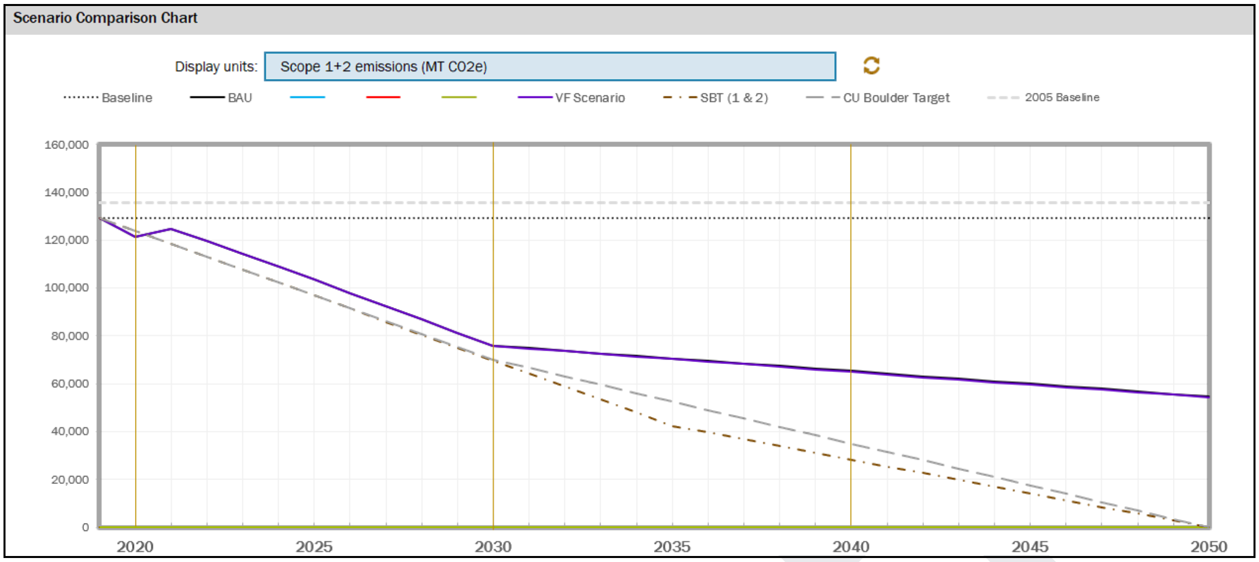
(14% of 452) have potential electric candidates for replacement but challenges related to cost-effectiveness or operational requirements remain. About 4% of the vehicles provided do not have a potential candidate for electrification currently available or announced in the market. The analysis was accomplished by assuming an electric vehicle would replace an internal combustion vehicle at the end of its useful life. In total, the replacement schedule saves about 7,400 MTCO2e between now and 2050. The replacement schedule and resulting emission reduction curve are presented in Figure 6 below.

Figure 7: Electrification timeline and GHG emission reductions



While an EV replacement strategy may not contribute significantly to overall emissions, the strategy is being prioritized based on its significant co-benefits. Compared to overall emissions and the impact of other strategies, vehicle replacement has only a small effect on campus emissions and does not promise significant departure from the business-as-usual case.

Figure 8: GHG savings from fleet electrification compared to BAU and other benchmarks



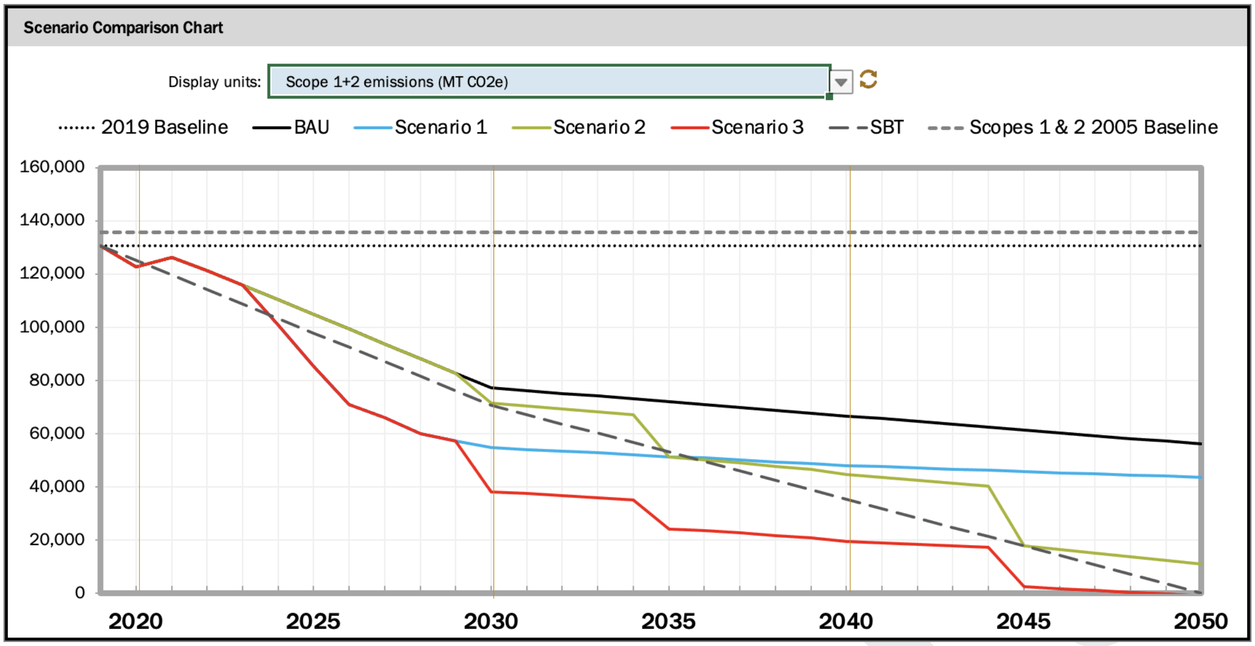
Scenario analysis using the Climate-Energy Scenario Analysis Tool

The CESA Tool was used as a planning and visualization software to help decision-makers understand the financial, environmental, and energy impacts of several suites – or "scenarios" - of climate and energy mitigation measures. Through selecting bundles of energy efficiency, heating system upgrades, renewable energy, and vehicle fleet projects, the tool can create a number of scenarios for achieving climate and energy goals for the university. The "Scenario Comparison Chart" compares these scenarios over time along various climate and energy metrics, such as GHG reduced, implementation costs, energy savings or cash flows. Four scenarios were prepared by combining the strategies above; these scenarios can be compared to the benchmarks.

Scenario Analysis

Following the analysis of the four strategic categories (EE, RE, VF, and HSU) combinations of the strategies were grouped into three scenarios to evaluate pathways to reduce Scopes 1 and 2 emissions, toward carbon neutrality for the CU Boulder campus. The emission reductions represented by these scenarios are presented in Figure 8.

Figure 9: Full scenario comparison chart showing each scenario against the benchmarks.



Scenario 1 (blue line): Energy efficiency (EE), renewable energy (RE), and Fleet replacement. This Scenario considers over 300 energy efficiency projects (lighting, controls, envelope & HVAC), 7 MW of renewable energy installations, and the replacement of approximately 365 internal combustion campus fleet vehicles with electric vehicles (blue line). This combination of projects allows CU Boulder to achieve its short term goals, but not its long term goals.

Scenario 2 (green line): Heating system upgrade (HSU); this is the phased conversion of Central Campus heating to an electrified, lower temperature hot water (green line). This complex series of projects is currently being studied; results, including project schedule and costs, are expected in 2024. Decarbonizing the campus heating system is expected to contribute significant emission savings, but will not achieve zero emissions on its own.

Scenario 3: Combines Scenarios 1 and 2 (red line). This combination of projects will achieve CU Boulder's short and long term goals, of 50% reduction by 2030 and 100% by 2050. This is the most aggressive of the researched pathways, and includes very near term investment in renewable energy, an accelerated implementation of recommended EE projects, and the decarbonization of the central campus heating system.

Key Performance Indicators

The following Tables show key metrics from each of the scenarios. First, the cost per MTCO2e reduced is given for each of the strategies. A positive number means that the campus experiences a net gain per ton of emission reduced, whereas negative numbers mean there is a cost per ton of GHG reduction. The differences in cost in the EE and HSU strategies between scenarios are due to the efficiency interplay between those two strategies.

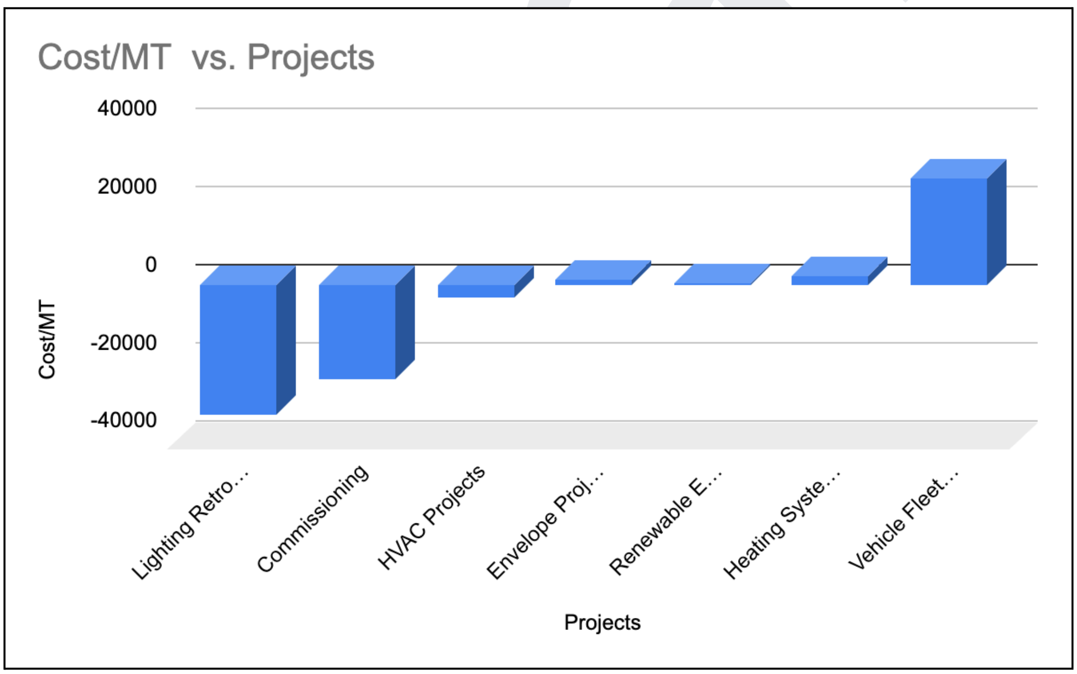
Table 8: Estimated $/MT CO2 reduced for original Scenarios 1-3, and strategies

Scenario name	Total Scenario $/MT CO2e	Energy Efficiency (EE)	Renewable Energy (RE)	Vehicle Fleet (VF)	Heating System Upgrade (HSU)

	reduced[26]	Measures $/MT CO2e reduced	Measures $/MT CO2e reduced	Replacement Measures $/MT CO2e reduced	Measures $/MT CO2e reduced
BAU	--	--	--	--	--
1: All projects (EE, RE, Fleet) except HSU	$26.07	$101.48	($149.93)	($2,538.84)	--
2: Only HSU	($1,219.51)	-	-	-	($1,220)
3: Scenario 1 plus HSU	($545.63)	$101.48	($149.93)	($2,538.84)	($973)

A cost abatement curve for seven strategies is helpful as a comparison and is presented in Figure 9 below. Importantly, the Energy Efficiency (EE) strategy in Table 6 above has been divided into four categories in the Cost Abatement curve; those four categories within the EE strategy are: lighting retrofits, commissioning projects, HVAC projects, and envelope projects. Due to the large cost of abatement for fleet replacement, a natural log scale is used to show the relative differences.

Figure 10: Cost abatement curve for four strategies, as envisioned in Scenario 3.



Next, scenario and strategy NPVs are presented, along with the investment required (first costs). While the overall NPVs are negative, owing especially to the cost of the HSU projects and vehicle fleet replacement, the building efficiency projects show positive NPV, which indicates that positive cash flow from these projects can help to offset significant overall costs.

[26] The numbers in this column are not the sum of numbers in the other columns because each strategy

Table 9: Scenario and strategy NPV

Scenario name	Scenario NPV ($)	EE NPV ($)	HSU NPV ($)	RE NPV ($)	VF NPV ($)	Total investment ($)
BAU	$0	$0	$0	$0	$0	$0
Scenario I	$12,490,174	$49,852,726	$0	($3,008,412)	($34,354,140)	$197,000,000
Scenario II	($630,559,186)	$0	($630,559,186)	$0	$0	$1,250,000,000
Scenario III	($611,318,140)	$49,852,726	($623,808,314)	($3,008,412)	($34,354,140)	$1,460,000,000

EE is energy efficiency, HSU is heating system upgrades, RE is renewable energy on campus and VF is vehicle fleet replacement.

To determine NPVs several assumptions about price, escalations and discount rate were made. For natural gas, the starting value was $0.50/therm[27], and a 3% annual escalation rate has been included.[28] For electricity, the starting value was $0.078/kWh[29], and a 3% annual escalation.

Additional analysis

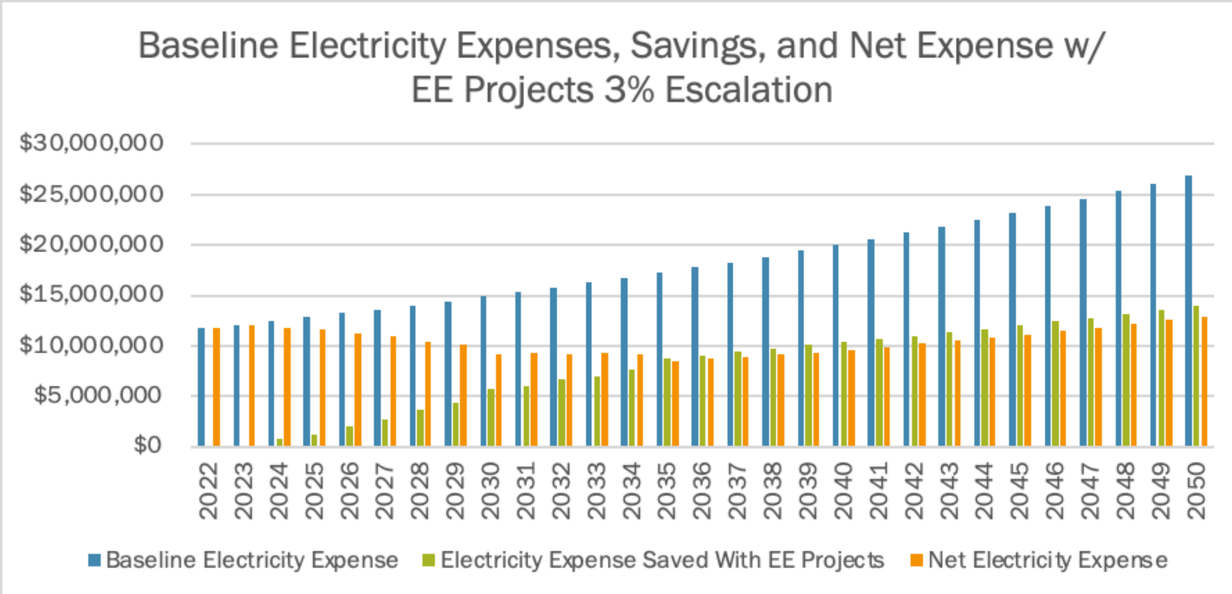
Some energy efficiency projects are expected to net energy savings against a baseline. The following figure shows baseline energy expenses, savings from implementation of EE projects, and net annual electricity expenses for the analysis period. An annual escalation rate of 3% has been added to electricity prices. For this analysis, no escalation for electricity consumption, and no capital costs have been included; the point of the analysis is to show gains against a baseline. The analysis shows that electricity expenses would be cut in half once all projects have been fully implemented, under the aforementioned assumptions.

Figure 11: Comparison of with- and without- EE Projects against baseline.

[27] From CU Boulder campus

[28] World Bank Commodity Price Data (The Pink Sheet). Sept. 2023. The escalation was calculated by averaging annual price increases from 1960 to 2022.

[29] From CU Boulder campus



Implementation Timetables

An implementation pathway is implicit within each of the scenarios. For further analysis and illustration, the group of projects associated with Scenario 3 is assessed as a possible decarbonization pathway. The Tables below showcase several key performance indicators for the project categories and the overall Scenario 3. For each group of projects, a first cost estimate is provided, along with costs per square foot, net present value, net present value including the social cost of carbon ($185/MT)[30], the average cost to reduce each MT of CO_2e, and the total GHG reduced by that particular category. Each table shows a decade's worth of project implementation.

The investment estimates are very high level, and this CAP did not provide a detailed design costing analysis of any of the projects listed. Estimated costs for lighting, envelope, commissioning, and HVAC projects have come from AECOM's Energy Master Plan for the University of Colorado, Boulder, published in 2022. Heating system upgrade projects are being studied currently, so only very rough estimates were available. To account for the ambiguity with these HSU costs, we have included a high and low estimate of HSU projects that ranges from $600 million to $1 billion. Further, since there is no definitive schedule for construction, the total has been divided into five equal portions, each portion being "implemented" in 5-year increments.[31] Finally, due to the inter-connection of heating with other building systems (esp. HVAC) there may be double counting in the costs of the projects in this CAP.

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[30] https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf. This document represents the most progressive social cost of carbon SCC. This SCC had not been officially codified as of September 2023, but has been studied and recommended by the EPA.

[31] For example, in the Table representing 2031 – 2040, HSU projects show a low cost of $300 million and a high cost of $500 million. Two projects are modeled as implemented during this ten-year period, one in 2035 and the next in 2040. The low and high costs show the per-project estimate as $150 million and $300 million respectively.

The rough cost estimates outlined herein do not include any university associated construction fees, which can often reach 35% of initial investment costs. Finally, this is not an investment pathway as none of the investments has been approved by the Board of Regents, nor vetted by any investment committee. Several steps of engineering analysis and financial due diligence, followed by approvals, would be required before implementing the following projects.

Table 10: Estimated Implementation of Projects recommended for 2024-2030

Project	First Costs ($m) low	First Costs ($m) high	Cost per Sq Ft ($)	NPV ($m)	NPV in $m (incl SCC)	Ave. NPV (SCC)/MT Reduced	Total GHG Reduced (MTCO2e)
Energy Efficiency	125.1	125.1	16.2	64.8	103.5	60412.0	466269.0
Lighting Retrofits	55.6	55.6	6.4	22.6	30.9	33,470	75,720
Envelope Projects	7.2	7.2	0.8	3.1	-1.5	-1,075	18,465
Commissioning	3.6	3.6	2.3	20.1	32.3	24,858	132,551
HVAC Projects	58.7	58.7	6.7	19.0	41.8	3,159	239,533
Vehicle Fleet Replacement	18.3	18.3	NA	-16.3	-15.7	-27,150	5,273
Renewable Energy	NA (PPA)	NA (PPA)	NA	-3.0	0.7	-298	20,066
Heating System Upgrades	150	250	17-34	-177.3	-168.2	-2,008	83,726
Decade Total Cost ($m)	419	519	32	-67	24	91,368	1,041,603
Average cost per year ($m)	70	86	5	-11	4	15,228	173,601

Table 11: Estimated Implementation of Projects recommended for 2031-2040

Project	First Costs ($m) low	First Costs ($m) high	Cost per Sq Ft ($)	NPV ($m)	NPV in $m (incl SCC)	Ave. NPV (SCC)/MT Reduced	Total GHG Reduced (MTCO2e)
Energy Efficiency							
Lighting Retrofits	NA	NA	NA	NA	NA	NA	NA
Envelope Projects	16.5	16.5	2.3	-8.7	-6.9	-9,151	25,001
Commissioning	NA	NA	NA	NA	NA	NA	NA
HVAC Projects	NA	NA	NA	NA	NA	NA	NA
Vehicle Fleet Replacement	8.5	8.5	NA	-6.2	-5.8	-25,534	5,434
Renewable Energy	NA	NA	NA	NA	NA	NA	NA
Heating System Upgrades	300	500.0	34-57	-264.6	-241.9	-1,720	281,334
Decade Total Cost ($m)	325.0	525.0	2.3	-279.5	-254.6	-36,405	311,769
Average cost per year ($m)	32.5	52.5	0.2	-28.0	-25.5	-3,641	31,177

Table 12: Estimated Implementation of Projects recommended for 2041-2050

Project	First Costs ($m) low	First Costs ($m) high	Cost per Sq Ft ($m)	NPV ($m)	NPV in $m (incl SCC)	Ave. NPV (SCC)/MT Reduced	Total GHG Reduced (MTCO2e)
Energy Efficiency							
Lighting Retrofits	NA	NA	NA	NA	NA	NA	NA
Envelope Projects	NA	NA	NA	NA	NA	NA	NA
Commissioning	NA	NA	NA	NA	NA	NA	NA
HVAC Projects	NA	NA	NA	NA	NA	NA	NA
Vehicle Fleet Replacement	15.8	15.8	NA	-11.9	-11.7	-245,216	2,825
Renewable Energy	NA	NA	NA	NA	NA	NA	NA
Heating System Upgrades	300	500	34-57	-182.1	-166.3	-2,203	263,629
Decade Total Cost ($m)	315.8	515.8	0	-194	-178	-247,419	266,454
Average cost per year ($m)	31.6	51.6	0	-19	-18	-24,742	26,645

Total implementation investment has been estimated as follows:

Table 13: Total cost estimate to implement Scenario 3

Total Program Cost ($m)	1,059	1,559
Average Program Cost per year ($m)	40.7	60.0

Finally, an approximation of investment required to operationalize the entire Scenario 3 plan during the first ten years alone, is presented in Table 13.

Table 14: CAPEX estimates to operationalize the Scenario 3 plan during the first ten years, in $ millions

Year	Total Estimate	Lighting	Envelope	Commission	HVAC	Fleet/ Charging	Solar	HSU
10-year Totals	$352	$31	$5.5	$3.6	$ 42	$ 19	$ -	$250

Scope 3 Measurements, Targets and Future Plans

Scope 3 emissions are those that result indirectly from CU operations, either from upstream or downstream activities. The University does not have direct control over these emissions, though it can exert influence over these emissions through its operations, procurement and other activities. This Annex contains a summary of Scope 3 emissions, followed by a detailed account of CUB's inventory approach for each scope 3 category. It also describes the intent of the University relative to Scope 3 inventory and targets, and a series of concrete steps the University can take to achieve its goals and improve the inventory and target setting in future years.[1]

Importantly, the University is not seeking to establish a science-based target at this time, nor is it seeking conformance with the GHG Protocol Scope 3 Standard. Neither are we seeking validation from SBTi on our inventory or target setting process. We have, however, sought guidance from the GHG Protocols[2] and the Science Based Targets initiative (SBTi)[3] to instruct our inventory and target setting process. This CAP is a "living document" in the sense that it will be updated on an annual basis with more refined data, accurate forecasts, and mitigation steps. This is the first time CUB has attempted a Scope 3 inventory, time will allow future iterations to be more comprehensive.

Universities nation-wide are beginning to pay attention to Scope 3 emissions including CU Boulder. For this CAP, CU seeks to initiate the process, by incorporating SBTi criteria and recommendations where data are available and the campus has influence over category emissions. Where the Campus is not able to fully measure certain categories, due to difficulty obtaining either internal or external data, a strategy has been set in place for future measurement and target setting.

The first step in Scope 3 measurement and target setting is to take a high-level assessment of Scope 3 categories, to determine if they might contribute more than 40% of total emissions. During the process of developing emission totals for this CAP, it was determined that Campus Scope 3 emissions were contributing more than 40% to the overall total, and that a deeper accounting would be necessary.

When a company's or institution's Scope 3 emissions account for more than 40% of their total emissions, the SBTi recommends that the organization should set a Scope 3 target. However, SBTi does not provide a specific percentage reduction target for Scope 3 emissions. Instead, it advocates for setting targets that are "ambitious and measurable."

For a university, the achievement of a science-based target could include a variety of measures such as encouraging more remote participation in faculty business events, promoting use of public transportation, biking, or walking over private cars for commuting, implementing sustainable procurement policies, reducing waste, and making campus construction projects less carbon intensive.

Scope 3 consists of 15 distinct categories of emissions. Seven categories are considered "upstream" and eight are considered "downstream." Upstream emissions are those that result from activities involved in

[1] This inventory does not include CU Athletics, which is a separate organization from CU Boulder Campus.
[2] GHG Protocol. 2011. Corporate Value Chain (Scope 3) Accounting and Reporting Standard. P 6.
[3] SBTi has been leading the way in developing guidance for institutions in setting reduction targets for Scope 3 emissions. SBTi is a partnership between the Carbon Disclosure Project (CDP), the United Nations Global Compact, the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF). SBTi encourages companies and institutions to set targets for reducing greenhouse gas emissions in line with the latest climate science.

what the campus purchases, while downstream activities are those that result from what the university delivers. Table 1 offers a definition of each category from Scope 3. If any categories are not included, the reason for their omission is also indicated. Some categories have been included in the inventory, but no targets have been set. The reason comes from SBTi guidance:

"The nature of a scope 3 target will vary depending on the emissions source category concerned, the influence a company has over its value chain partners and the quality of data available from those partners."[4]

These two conditions were used as criteria for whether to include the category in: a) the inventory, and b) the target. Categories for which data were available, or could be heuristically estimated, were included in the inventory; even high-level data can offer a start to more accurate measurements in the future. Inclusion in the target required that a) accurate data were available (not simply a best-guess estimate) *and* b) that the campus has relatively strong influence over that category's emissions. Categories in which emissions were calculated using high-level estimates (no direct data) were not included in the target. The reason is that no accurate benchmark could be established at this time, against which to measure targets. In these cases, recommendations have been made for how CUB can augment its tracking and data collection in these areas for future iterations of the CAP. Also not included in the targets were categories in which CUB has limited influence to affect emissions.

Table 1 provides a summary of Scope 3 results and the decision making process for inclusion in the inventory and target. Each of the Scope 3 categories are numbered and listed on the left; the categories reflect those found in the GHG Protocols.[5] The third column provides the estimated emissions from each category tracked for this CAP. The fourth column provides a definition of the category according to the GHG Protocol, which is then contextualized for the university. Column five provides a note on data availability and quality for that category. The final column indicates the level of influence by CUB to affect category emissions, with a value of 3 meaning significant influence, 2 meaning moderate influence, and 1 meaning limited influence. All "influence-values" of 2 or 3 have been included in the target.

While Table 1 provides a high-level summary, the remainder of the Annex provides detailed information about each category, including estimation and calculation methods, emission factors used, possible strategies for reduction of scope 3 emissions, and suggestions for improvement in data collection for future target setting.

[4] Science Based Targets. 2020. Science-Based Target Setting Manual.
[5] GHG Protocols

Table 1: Scope 3 categories, emissions (in MTCO2e), definitions, data availability/quality and CUB's influence over each.

#	Category	Emissions	Definition	Data Availability / Source	Influence
1	Purchased goods and services	12,216	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company not otherwise included	Direct[6] spend data were obtained in 5 primary procurement categories	3
2	Capital goods	20,944	Extraction, production, and transportation of capital goods purchased or acquired	High-level estimates[7] of embodied carbon in buildings and fleet	3
3	Fuel and energy related activities (not included in 1,2)	21,553	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company, not already accounted for: ・Upstream emissions of purchased fuels ・Upstream emissions of purchased electricity ・Transmission and distribution (T&D) losses ・Generation of purchased electricity that is sold to customers	High-level estimates of upstream emissions from electricity and gas T&D loss assumptions for both electricity and gas delivery; CUB occasionally sells a small amount of electricity to the grid, these emissions are counted in scope 1	2
4	Upstream transportation and distribution	Not Calculated	Of products purchased between a company's tier 1 suppliers and its own operations (in vehicles not owned by company)	These emissions are included in Category 1[8]	2
5	Waste generated in operations	2,595	Disposal and treatment of waste generated	Direct data obtained	3
6	Business travel	28,481	Transportation for business-related activities	High level data were available through CU travel booking partner; no survey for outside booking	3
7	Commuting	16,407	Transportation between home and work (includes daily faculty, staff and student commuting)	Survey data available, but small sample size	2
8	Upstream leased assets	538	Operation of assets leased by company (not in S1/S2)	Estimated using average energy use intensity for office space	NA

[6] Direct data are data that were obtained directly from an on or off campus source, or from a University publication.
[7] High-level estimates means that industry averages, or other heuristic methods were used in place of direct data.
[8] Data not available does not mean the data don't exist, rather that processes have not been established to collect data within an adequate time to complete this CAP.

9	Downstream transportation and distribution	50,226	Use of "products" sold by the company between operations and the end consumer. For CUB, this is out of state student and parent travel to and from campus	High-level estimate of out-of-state student and parent travel to/from campus	1[9]
10	Processing of sold products	N/A	Processing of intermediate products by downstream companies	No raw or intermediate goods are sold by CUB that enter processing	NA
11	Use of goods and services sold	N/A	End use of goods and services sold by the reporting company	This category was deemed not relevant to CUB operations	NA
12	End-of-life treatment of sold products	N/A	Waste disposal and treatment of products sold at the end of their life	Data not available[10]	NA
13	Downstream leased assets	N/A	Operation of assets owned by company, and leased to other entities, but not included in scopes 1 and 2 of lessor (the reporting company); examples include retail entities leasing space from CUB	These emissions are included in Scopes 1 and 2, or other Scope 3 categories	NA
14	Franchises	N/A	The operation of franchises, not included in S1/S2 of the lessor (applicable to operations that franchise)	CUB is not a franchising entity	NA
15	Investments	372,000	Operation of investments, including debt & equity, not included in S1/S2	High-level estimate; Data are not transparent at a University system level (University of Colorado)	1[11]

[9] The academic calendar is decided at the University system level (University of Colorado), CUB does not directly control the calendar
[10] Category 1 includes lifecycle emissions of sold products, which includes end-of-life treatment
[11] Estimated as of December 2022.

Of the fifteen categories, the University has included eight in its inventory (plus investments), and is setting goals in the following:

1. Category 1: Purchased goods and services
2. Category 2: Capital goods
3. Category 3: Fuel and energy related activities (not included in scopes 1,and 2)
4. Category 5: Waste generated in operations
5. Category 6: Business travel
6. Category 7: Employee & student commuting
7. Category 8: Upstream leases

Several downstream categories are largely irrelevant to the University, since category 1, purchases of goods and services, has taken a life-cycle carbon approach. Finally, the Steering Committee has made a non-unanimous decision to exclude category 15 - Investments - as not measurable at the Campus level, since these are not managed by the Boulder campus, but rather at the University System level.[12] Figure 1 shows the breakdown of measured Scope 3 emissions for CU Boulder in 2019.

Figure 1: Reported Emissions by Scope

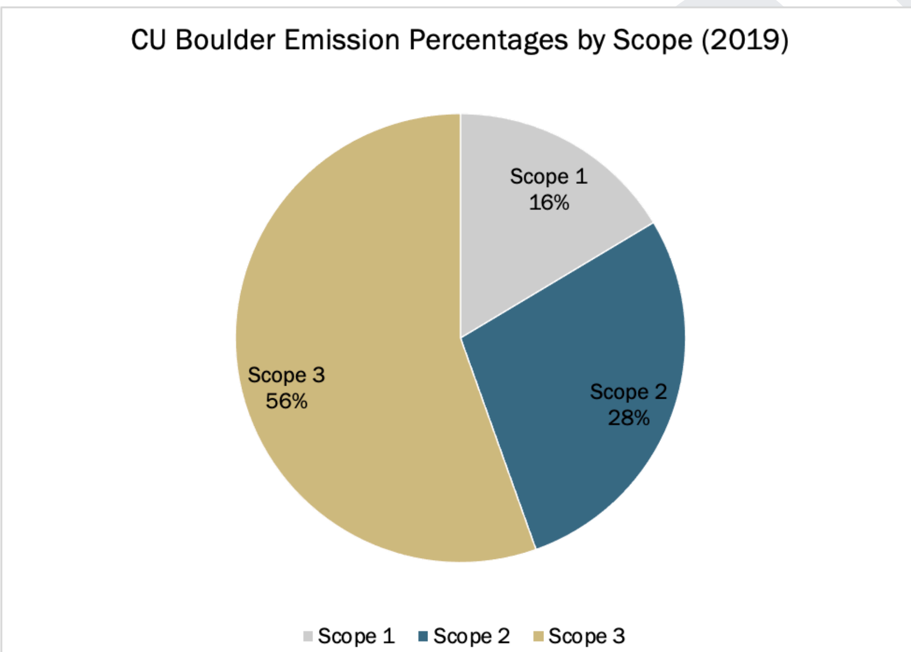
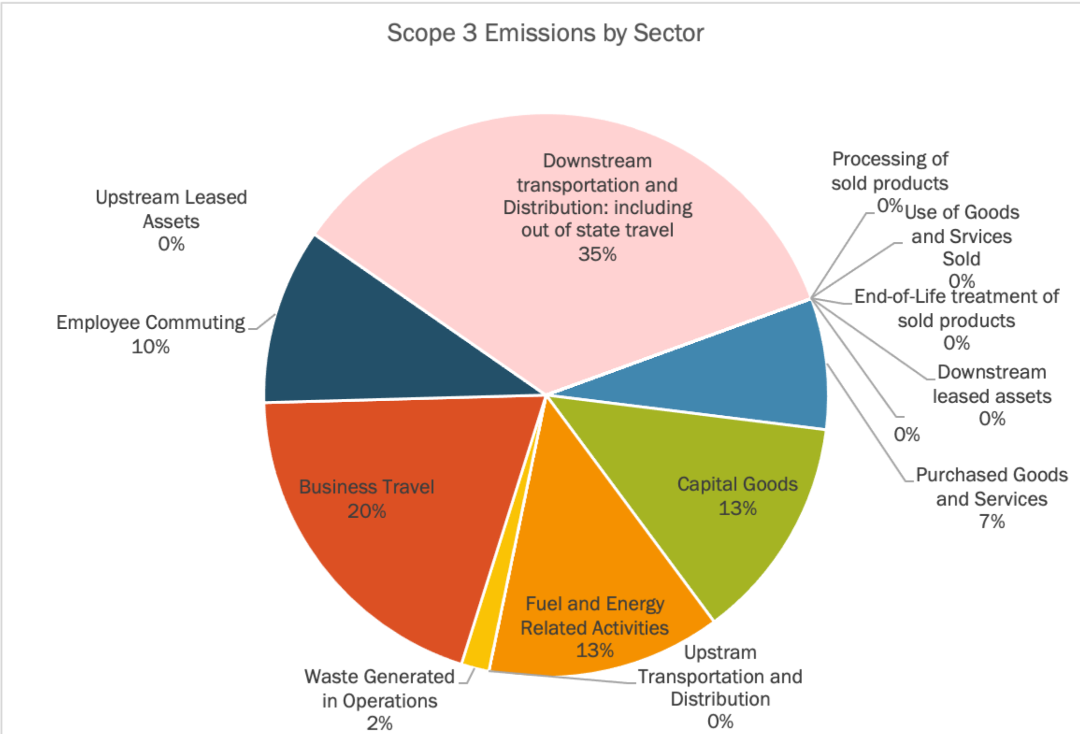


Figure 1 shows the 2019 breakdown by category. The primary contributors, by a significant margin, are out of state travel, paid air travel, embodied carbon from buildings and commuting.

[12] CU Boulder students and faculty# wrote to the Steering Committee and suggested that category 15 could be included by reporting a proportional share, which could be calculated by prorating CU Boulder's share (# of students at CU Boulder divided by total system students). This method was adopted as a means for estimating category 15 emissions.

Figure 2: Scope 3 emissions by sector (does not include Investments)



Target setting

SBTi does not mandate specific targets for Scope 3 emissions. Instead, it recommends setting targets that are "ambitious, measurable, and aligned with the latest climate science." Further, according to SBTi, a 7% reduction year over year, for all entities, would cut global emissions 50% by 2050. The following points summarize SBTi guidance for Scope 3 target setting[13]:

- If a company has significant scope 3 emissions (over 40% of total scope 1, 2 and 3 emissions), it should set a scope 3 target.
- Scope 3 targets generally need not be science-based, but should be ambitious, measurable and clearly demonstrate how a company is addressing the main sources of value chain GHG emissions in line with current best practice.
- The scope 3 target boundary should include the majority of value chain emissions, for example, the top three emissions source categories or two-thirds of total scope 3 emissions.2
- The nature of a scope 3 target will vary depending on the emissions source category concerned, the influence a company has over its value chain partners and the quality of data available from those partners.
- SBTs should be periodically updated to reflect significant changes that would otherwise compromise their relevance and consistency.

For the analysis below, an absolute 7% reduction goal for selected categories of Scope 3 emissions has been adopted, which will allow the Campus to reach its 50% Scope 3 reduction targets by 2050. At the end of the discussion, a hypothetical scenario has been outlined, showing the effect of a combination of

[13] SBTi Guidance.

improvements in operational changes in six primary categories (which cover approximately two-thirds of scope 3 emissions, not including investments) on overall Scope 3 emissions.

Categories, Measurements and Strategies

The remainder of this Annex defines each category from Scope 3, and sets them in the context of the CU Boulder campus. It also describes the methodologies for calculating emissions from each category. Finally, for each category, directional strategies are suggested for reducing emissions, or for strengthening the data collection process so emissions can be better calculated and tracked for the next iteration of this CAP.

Category 1: Purchased goods and services. The calculation of emissions from purchased goods and services should include the quantification of emissions from all upstream suppliers to CU Boulder. This CAP was able to initiate a process with the campus procurement team that is expected to grow over time. Currently, neither the procurement department nor department purchasing agents are tracking data in a manner that is conducive to a full carbon accounting. As a result, only five categories (out of many) were assessed, which may result in significant under-measurement.[14]

There are several ways to calculate emissions from purchased goods and services. The first two options are called site specific and hybrid, and require reporting entities to obtain data from supplying companies. The other two options are called average-data and spend-based, and use industry average data to calculate emissions. For this CAP, spend data were available for 5 primary categories, while other data were not. To calculate emissions, dollars spent on major categories of goods and services were multiplied by appropriate emissions factors.[15] The following primary categories of goods and services purchased by the campus were, 1) Computers and IT equipment, 2) Food and beverage service, 3) Paper and books, 4) Advertising and marketing, and 5) Clothing and apparel. Emission factors for these categories are provided in the Table below, with footnoted sources.

Table 2: Spend categories and emission factors for rough estimate of Category 1, Scope 3 emissions

Purchased item or service	**Dollars spent** ($)	**Emission factor** (kg CO2e/$ spent)	**Resulting emissions** (MTCO2e)
Advertising, Marketing & Print Services[16]	5,400,486	0.187	1,010
Athletics, Apparel and Linen[17]	9,472,393	0.188	1,781
Books, subscriptions and library services[18]	17,640,772	0.737	3,299
Food related products and service[19]	20,783,109	0.155	3,221

[14] As an example, Stanford University has counted 1,065 Stanfrod-defined categories, and measured Category 1 emissions at 402,153 MTCO2e.
[15] https://ghgprotocol.org/sites/default/files/2022-12/Chapter1.pdf
[16] Emission factor from: https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-models
[17] Emission factor from: https://www.climatiq.io/data/explorer?search=clothing&data_version=4.4
[18] Emission factor from: https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-models
[19] Emission factor from: https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-models

IT hardware and maintenance[20]	5,400,486	0.183	2,905

Reducing emissions in this category will mean making strategic decisions in the selection of suppliers, and engagement with existing partners. The process will need to begin by developing an emissions total based on supplier's actual emissions, rather than on spend data. CU Boulder will be gradually pivoting to this approach in the coming years. A supplier engagement plan is to be developed that will focus on collecting the full array of procurement data and identifying mitigation opportunities in partnership with the university's top suppliers. Here are several strategies to help reduce emissions in this category:

- Supplier Engagement and Collaboration. Work closely with suppliers to understand their own emissions and sustainability goals, encouraging them to measure their own GHG emissions, adopt cleaner energy sources and manufacturing processes, and improve energy efficiency.
- Begin tracking emissions by supplier-based GHG inventories, rather than spend data. Spend data is adequate to initiate the emissions measurement process for CU Boulder, but not sufficient to design strategies, since the only action that would decrease emissions would be to spend less. Spending less in each category may be a partial strategy, but will not be available across all categories and in the long run.
- Add procurement categories. The five categories that have been identified represent the five largest in terms of dollars spent. However, ongoing partnership with the procurement department to identify all categories, vendors and their product emissions will eventually be required. The use of Sievo, or similar procurement tracking software is recommended.
- Sustainable Procurement. Develop and implement sustainable procurement policies and guidelines, and prioritize suppliers that have lower carbon footprints and demonstrate commitment to sustainability.
- Product Design and Selection. Opt for products and services that have lower emissions during their production, use, and disposal phases. Consider product durability, energy efficiency, and recyclability when making purchasing decisions.
- Supply Chain Optimization. Streamline campus supply chain to reduce transportation-related emissions. Use technology and data analytics to optimize logistics and transportation routes. Encourage the use of lower-emission transportation methods.
- Leverage Eco-Labeling and Certification by favoring products and services that carry recognized eco-labels or certifications indicating lower environmental impacts.
- Measurement and Reporting. Implement robust data collection and reporting systems to track emissions associated with purchased goods and services. Use these data to set reduction targets and monitor progress over time.
- Education and Awareness. Raise awareness within campus organization and among suppliers about the importance of reducing emissions in the supply chain.
- Adopt Circular Economy Practices, such as product reuse, remanufacturing, and recycling, to reduce waste and emissions.

Reducing emissions from purchased goods and services in Scope 3 Category 1 requires a collaborative and holistic approach for making long-term investments in sustainable practices and technologies.

[20] Emission factor from:
https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-models

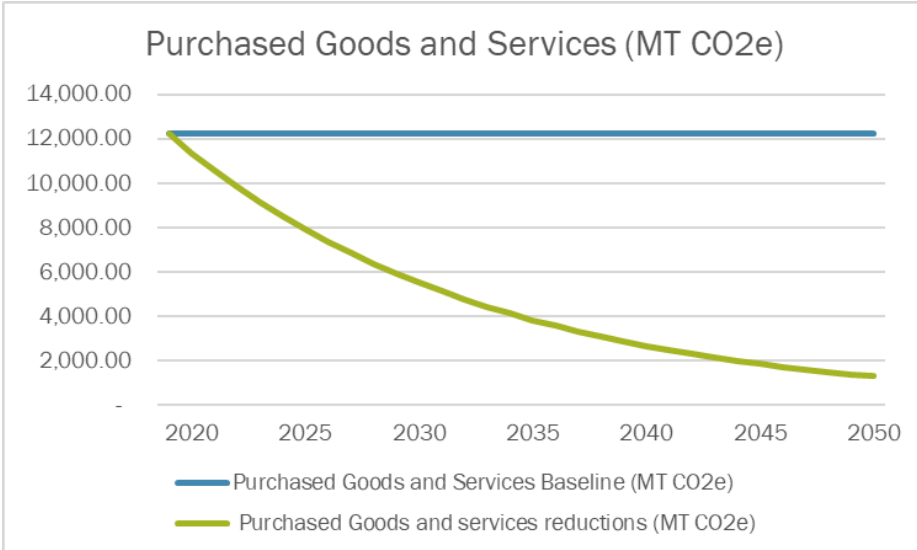


Figure 3: Purchased goods and services baseline and reductions

Food

Food-specific emissions often garner special attention due to the connections with other sustainability categories, including equity and health. As a result, the health and social impact of food should be considered when making emissions-based purchasing choices. For example, Menus of Change is a current initiative that incorporates health and sustainability into menu and recipe development, thereby creating business strategies that integrate both environmental and nutrition science into their framework. Every menu item features ingredients that are locally sourced, which is defined as within 250 miles from Boulder. Beyond this, culinary decisions can further potentiate positive social impacts through methods such as supporting local farmers and establishing food recovery networks to ensure that excess food is not wasted.

Co-Benefits

University operations pose many complex challenges associated with food access, food waste, and food procurement. Many students and staff on campus experience food insecurity despite high amounts of food waste that are generated from catered events and dining halls. In addition, emissions generated from production and transportation of food (and food waste) to and from campus contribute to the University's emissions, making these potent areas for improvement. Options for reducing waste and emissions while increasing equity around food include broadening eligibility requirements and availability of Basic Needs food distribution on campus, decreasing emissions associated with food procurement by sourcing from local and, where possible, women and BIPOC agricultural producers, and expanding plant-based food options across campus.

Food-specific Strategies

- Establish a food recovery program on campus for all catering and culinary events, with program information available in multiple languages and formats.
- Research and explore the possibility of an app to streamline food recovery on campus, Work with the food safety team and culinary team to determine the app's logistics, potential costs associated with providing containers, and overall feasibility
- Increase percentage of locally-grown foods purchased and plant-based meals served

- Estimate and track carbon footprint of foods purchased
- Consider a pilot carbon labeling project–with food items labeled as having high carbon, medium carbon, or low carbon emissions–that will be conducted in the UMC Alferd Packer Grill to track potential impacts on purchasing habits

Category 2: Capital goods. These emissions include those produced in the extraction, production, and transportation of capital goods purchased or acquired. In the absence of a thorough record of all capital goods, the analysis included construction of CU building stock and campus fleet purchases. To calculate the embodied carbon in buildings and set an emission target for future construction, the first step was to calculate an average amount of embodied carbon found in building projects over the past 17 years (this was the period with the most reliable data). First, a baseline of campus growth was established, measured by the increase in outside gross square feet (OGSF) during the time horizon. In 2005 OGSF was 10,076,039 gsf, and by 2022 the figure had grown to 12,926,079 gsf, for an increase of 2,589,354 gsf (174,000 gsf/year) and growth rate of about 1.5%. An emission factor (EF) of 120 kgCO2e/GSF[21] was used to calculate carbon from the new construction, for a total emissions baseline of about 21,000 MT/CO2e per year. This figure became the baseline amount of embodied carbon emissions for buildings, under a BAU scenario.

Similarly, vehicles in the campus fleet also contain embodied carbon. The campus purchases an average of 8 vehicles per year, and currently owns about 450 internal combustion engine vehicles. Each annual vehicle purchase was assessed an emission factor of 6 MTCO2e for a total embodied carbon baseline of approximately 50 MTCO2e.

Summing embodied carbon from buildings and from vehicles yields a total baseline of 21,050 MTCO2e in embodied carbon from capital goods. In order to reach its goal of 50% reduction for Scope 3 emissions in this category, a 7% reduction year over year, is required. The Figure below shows the baseline and the target reduction adopted by the Campus.

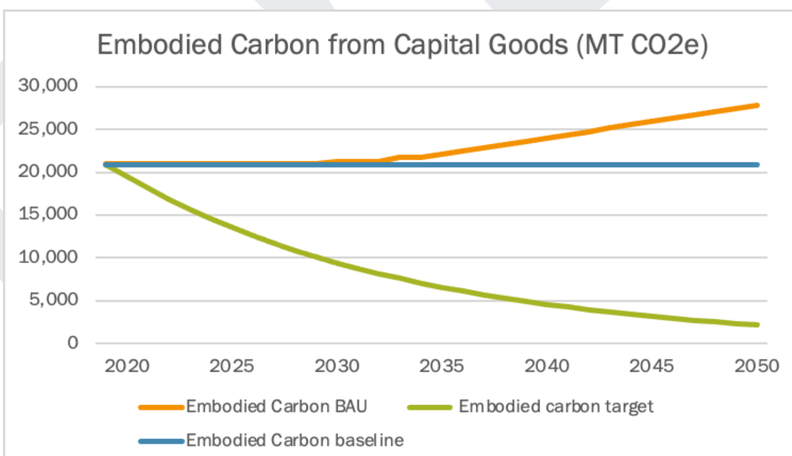


Figure 4: Capital Goods and potential reductions

Specific ways to reduce embodied carbon include the use of low carbon building materials, switching to renewable energy, and utilizing electric heat pumps. SBTi also recommends incorporating “circularity principles” in the construction and design of buildings which can reduce emissions by 38% by reducing

[21] Rocky Mountain Institute. 2011. “Green Footstep; Calculations and data sources.” P 13.

demand of steel, aluminum, cement, and plastic[22]. According to SBTi, 25% of building materials can often be reused in future construction, and 70% can be recycled in some form to reduce the emissions from embodied carbon in buildings.

Strategies to reduce Embodied Carbon emissions include:

- Update the campus building design standards for new construction and major renovations
- Perform a whole-building Life Cycle analysis
- Reduce embodied carbon by a minimum of 10% and targeting 20% against a baseline (using either NRMCA[23] or ILFI ZC[24] methodologies)
- Prioritize low carbon construction techniques
- Align with Buy Clean Colorado
- Update targets annually

Category 3: Fuel and energy related activities. Emissions counted under this category are those related to upstream processes from purchased electricity and purchased fuels. This includes upstream emissions in the processing and delivery of mobile fuels, and transmission and distribution losses from electricity and gas. Emissions for generation of purchased electricity that is sold to end users isn't applicable in this case as CU operations don't include sales of electricity. Upstream emissions from purchased electricity in 2019 rounded up to 9,078 MTCO2e, which was calculated by multiplying annual electricity consumption by 11%[25]. Upstream emissions from purchased fuels include gasoline, diesel, and natural gas with emission factors of 2.4 kg of CO2e per gallon of gasoline, 2.3 kg of CO2e per gallon of diesel, and 0.97 kg of CO2e per therm respectively[26]. Total upstream emissions from fuel and energy related activities yield 21,553 MTCO2e in 2019. No specific target has been set for this category; however, the decarbonization of the campus heating system will eventually eliminate this source of emissions.

Strategies to reduce emissions from fuel and energy related activities have been mentioned previously, but include the following:

- Energy efficiency improvement such as those discussed in this CAP
- Renewable energy sourcing, such as has been evaluated in this CAP and the Energy Masterplan
- Transition to zero-carbon alternatives, including fleet electrification.
- Supply chain engagement, as mentioned under Category 1.

Category 4: Upstream transportation and distribution. Data on upstream transportation and distribution were not available for this CAP. Recommendations are that a robust engagement strategy be developed for all procurement that begins to gather data on categories 1, 2 and 4, as these may contain overlapping emissions. An engagement strategy will clearly communicate the Campus's priorities, establish protocols for data collection, policies for purchasing in various categories, and set clear

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[22] https://sciencebasedtargets.org/resources/files/DRAFT_SBTI_Buildings_Guidance.pdf pg 25

[23] The National Ready Mixed Concrete Association (NRMCA) has been actively involved in promoting sustainability in the concrete industry, including efforts to reduce embodied carbon in concrete construction. NRMCA has developed various methodologies and resources to help reduce the carbon footprint associated with concrete.

[24] The International Living Future Institute (ILFI) has developed the Zero Carbon (ZC) certification program, which aims to encourage and recognize buildings and projects that achieve net-zero carbon emissions over their operational lifetime.

[25] Disclosure by VitalMetrics https://sustainable.stanford.edu/sites/g/files/sbiybj26701/files/media/file/scope-3-emissions-from-fuel-and-energy-activities-march-2023.pdf

[26] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022

expectations for suppliers. It may also include supplier education and training, collaborative goal setting, and perhaps an audit practice. Within the strategy, the campus can clearly delineate the boundaries of all procurement categories, and collect and organize data accordingly.

Category 5: Waste generated in operations. Landfills emit significant amounts of methane, and therefore any diversion activities that reduce landfill waste will result in few emissions. To estimate waste emissions data on two types of waste have been gathered: mixed solid waste (5,841 tons in 2019) and composted solid waste (1,265 in 2019). The emission factors for these types of waste are 520 kg/ton and 170 kg/ton respectively, leading to a total emissions of about 2,600 MTCO2e. This category includes a goal of 7% reduction year on year.

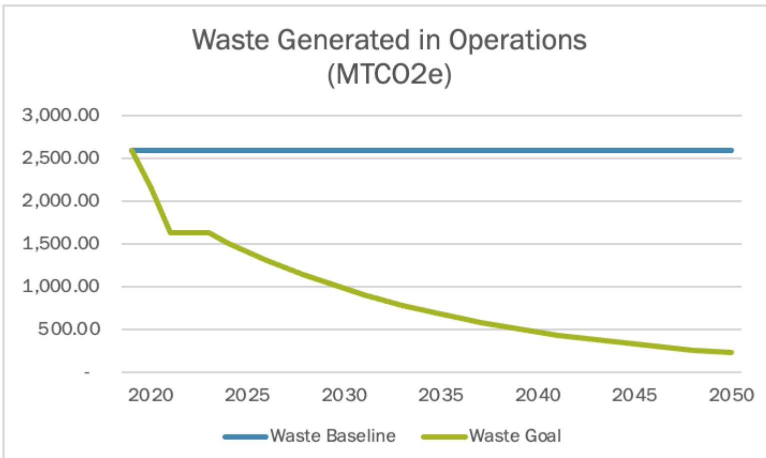

Figure 5: Waste generated in operations and potential reductions

The University has long prided itself on a dedication to zero waste initiatives. One public facing arm of the zero waste program is a group of students, known as Ralphie's Green Stampede, who divert up to 90% of all waste generated at CU's athletic stadium. Students are also employed at the campus Material Recovery Facility (MRF) which was constructed, in part, as an intentional educational opportunity for students about the materials economy. While trash and recycling can parity, together with education and outreach, resulted in over 50% waste diversion prior to COVID, the current goal of zero waste by 2025 may not be able to be reached. Regional compost parameters have recently changed and only food and grounds waste is now accepted with all "compostable" packaging, containers and utensils, now going into the landfill. For many reasons, the campus is faced with a need to transition away from compostable single-use items and define programs around reuse solutions.

Co-Benefits

Waste management can disproportionately expose low-income communities, communities of color, and other marginalized communities to environmental hazards from landfills and pollution. Accordingly, the University is collaborating with waste management authorities and community organizations to ensure responsible waste disposal practices and reduce the environmental burden shouldered by marginalized communities. The University has made significant progress in waste management and waste reduction. As more meaningful equity and justice elements are being considered, the campus is focused on waste diversion and re-use with an emphasis on impacts and benefits to low-income and marginalized communities in and around Boulder. Potential equity-focused strategies for waste diversion include distribution of used or restored CU computers to CU Boulder students and high school students as well as donations of surplus research instruments to elementary, middle, and high schools to help stock science classrooms. In all efforts, we aim to rely on existing relationships with communities to solicit input and feedback while ensuring appropriateness and equity in any distribution/donation processes.

Strategies to reduce waste generated in operations include:

- Reduce package-related plastic waste by sourcing products with sustainable packaging, setting incremental improvement targets
- Create a baseline assessment for leftover edible food and food waste ending in the landfill
- By 2030, reduce paper usage by 25% from 2019 baseline as per Governor’s Executive Order B 2021 01
- Use student research to assist campus procurement officials in revising contracts to complement Zero Waste programs
- Increase the number of clothing, furniture and equipment reuse events, grow the online reuse listings platform, and expand education around the CU Distribution Center
- Clarify the goals and responsibilities of Ralphie's Green Stamped and explore how it could be expanded to a more centered program
- Write a Zero Waste plan to address construction and demolition, and strategies around compostables and food recovery efforts
- Create behavior change through education around single-use plastic bags and polystyrene, University recycling guidelines, and zero waste targets

Category 6: Paid business travel. These are emissions associated with any business travel that is paid for by the university and includes student study-abroad programs. The University travel department reports that over 56.7 million miles were flown under this category in 2019. This figure is up from 36.5 million miles in 2009, which indicates an average 4% growth rate year over year. While this fell off considerably during COVID-19, a return to similar numbers is expected. Furthermore, a growth rate comparable to recent averages would create a BAU case if significant emissions (see figure XX below for baseline, BAU and reductions in emissions). Air miles are considered to have an emission factor of 0.209 kg/mile traveled (EPA, short-haul miles). However, an additional coefficient is applied due to the fact that these emissions occur higher in the atmosphere, and therefore have a greater impact on the climate. This coefficient is called the radiative forcing index, and the Intergovernmental Panel on Climate Change (IPCC) recommends a value of 2.7.[27] Under this methodology total emissions for the 2019 baseline was about 28,400 MTCO2e. The target is to reduce this amount by 7% year over year.

[27] Stanford University has adopted a value of 2.7 and published this comparison of values: https://sustainable.stanford.edu/sites/g/files/sbiybj26701/files/media/file/s3-radiative-forcing-rfi-memo_public.pdf.

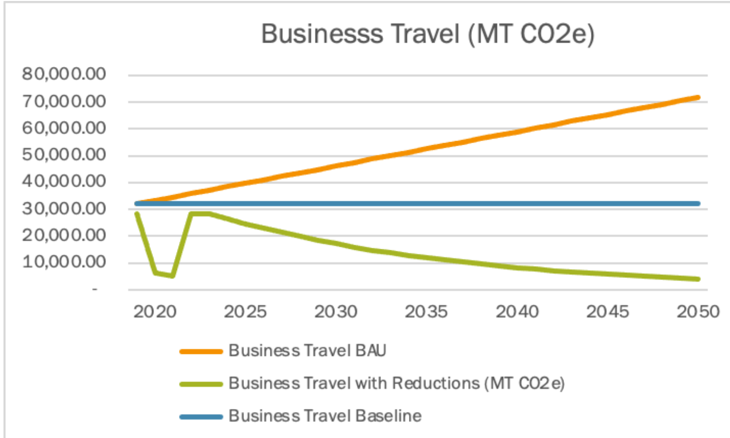

Figure 6: Paid Business travel and potential reductions

Strategies to reduce emissions from paid business travel include:

- Develop a comprehensive travel policy that encourages sustainable travel choices.
- Set guidelines for when travel is necessary and consider alternatives to in-person meetings.
- Encourage staff and faculty to prioritize sustainable travel options when planning trips.
- Prioritize airlines that offer renewable fueling options.
- Reduce conference and travel budget by 50% of 2019 baseline by 2030
- Encourage staff and faculty to attend conferences virtually

Category 7: Employee & student commuting. Emissions from regular trips to and from campus are a significant part of Scope 3 emissions. To calculate emissions within this category, estimates of vehicle miles traveled (VMT) are made for faculty, staff and students. The Transportation department at CU makes regular estimates of these totals from survey data and occasionally from a more thorough approach through the use of professional consultancies. In 2019, total VMT from all three categories was nearly 50 million miles (VMT has remained lower than this even after the pandemic due to work from home policies and preferences). The emission factor used for VMT is 0.33 kgCO2e/mile, leading to a total of over 16,000 MTCO2e. The campus has set a target to reduce this amount by 7% year over year.

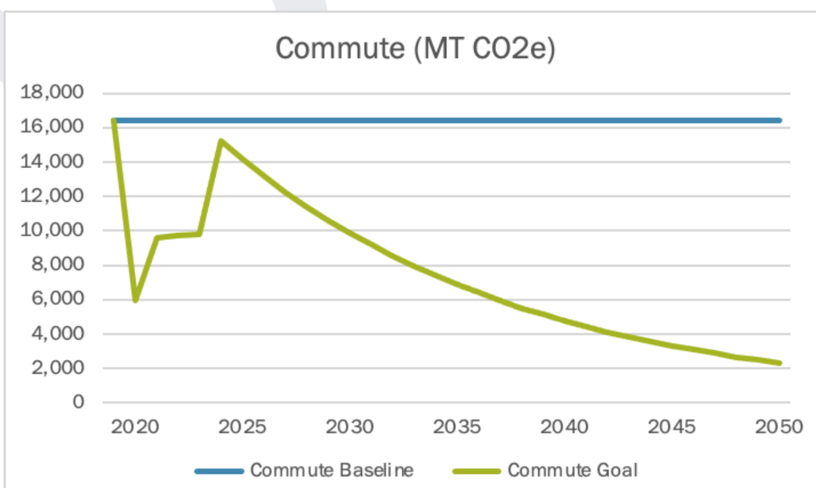

Figure 7: Commuting emission and potential reductions

Reducing VMT will have a significant impact on GHG emissions; however, to do so requires both the enhancement of available TDM programs and strategies, as well as building out behavioral change programs in order to realize these reductions. Response to the COVID pandemic demonstrated that a downward trend in campus emissions is possible thanks to the increases in remote work and improvements in video conferencing. Furthermore, transportation options such as electric bikes, rideshare companies and app based ride matching have recently expanded to make the car-free lifestyle more viable, prompting a focus on VMT reductions as a viable option for achieving transportation and sustainability goals.

Possible strategies to reduce emissions from employee and student commuting include:

- Improve the VMT estimation process to ensure accuracy and replicability of the VMT number annually for sustainability reporting and program analysis. Include GIS based analysis of average daily commute distance, and establish a plan for regular and ongoing survey of both students and employees to ensure timely and accurate mode split data, to accurately measure the rate at which CU affiliates commute to campus each day/week.
- Institute a formal Transportation Demand Management Plan that includes strategies aimed at increasing the use of transit, biking, vanpool, carpool, carshare, and micro mobility
- Expand EcoPass program to offer non-benefit eligible employees an annual subsidy
- Expand and electrify the vanpool program and explore options and innovations that will support employees working irregular schedules.
- Expand the Lime scooters and B-cycle bike sharing programs on campus
- Develop a plan for expanding the Zip and Colorado Car Share program
- Develop a more systematic way in which to regularly measure commuting VMT.

Co-Benefits

Housing and transportation disparities within Boulder County influence access to sustainable transportation options, which has driven the University to work with local transportation authorities to improve infrastructure, accessibility, and connectivity for all residents. Sustainable approaches to transportation are linked to declines in pollution, which is more likely to benefit communities with poor air, water, and soil quality. Often these communities have a long history of environmental injustice which increases their exposure to pollution. At CU Boulder, due in part to the high cost of living in Boulder County, many students and staff commute from nearby cities to campus each day. This highlights the need for sustainable and accessible transportation infrastructure to support emissions reductions while minimizing pollution in local communities and decreasing costs and challenges associated with public transportation. When considering equity and justice in the transportation sector, in addition to fleet electrification plans, CU Boulder is focused on increasing ridership by reducing or eliminating price and accessibility barriers to vanpools, carpools, and last mile transport to and from campus. Beyond this, more inclusive approaches to transportation can provide additional opportunities to support the needs of the campus community by, for instance, including basic needs distribution for those participating in vanpools.

Category 8: Upstream leased assets. This category includes emissions from the operation of assets that are leased by the campus in the reporting year and not already included in the reporting company's scope 1 or scope 2 inventories. Examples for the campus are leased buildings or space in buildings where energy consumed has not been counted in scopes 1 or 2, and car rentals.[28]

[28] Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard.

The Real Estate Services office within the Finance & Business Strategy Department of the CU campus maintains information about building and space leases for campus business. However, the office has not been in a position to collect energy use data from those leases. At the time of CAP completion it was not clear whether energy bills from these leases were paid centrally (and therefore included in scopes 1 and 2) or separately. Similarly, the Procurement office has not tracked mileage for car rentals.

Strategies to include this category in subsequent CAPs:

- Tracking real estate leases: equip the Real Estate Services office to identify electricity and natural gas consumption for leased space.
- Work with property owners to develop clean energy use programs. Since leased office space is served by Xcel Energy, the expectation is that emissions will reduce as the utility reaches state renewable energy goals. Emissions from natural gas may prove more difficult depending on the property. However, low-cost energy efficiency initiatives, with the permission of the owner, can achieve some results, as can exploring incentives for longer-term electrification of building systems.
- Tracking car rental mileage:
    - Create rental agreements with preferred vendors, by negotiating terms that require these agencies to provide monthly or periodic detailed reports of faculty car rentals, including mileage. Ensure the rental agreements stipulate full-fuel returns, which can help in estimating distances traveled.
    - Establish a university-wide policy requiring faculty to report mileage for any car rental used for official purposes. Clearly communicate the importance and reasons for this policy, whether for budgeting, environmental reasons, or otherwise.
    - Include mileage reporting with the expense management software where faculty can submit rental receipts and mileage details.

Category 9: Downstream transportation and distribution. Normally, this category reflects the use of products sold by the company between operations and the end consumer. For the university campus, the use of products sold can be considered the travel back and forth from campus to attend classes and other campus events. In this way students are “using” the “product” of education, while other campus visitors attend campus events such as graduation and parents’ weekend. The CU campus has not monitored student and parent travel to and from the university; as a result, only very high-level estimations are available. To calculate emissions several rough estimates were made.

The following table shows the assumptions and resulting figures that were made. The Table shows total student population and the percentage of students who are from out of state according to the University webpage. From these figures the out of state population is 14,296. Assuming an average distance of 1000 miles from campus, and an average of six trips a year, and 2 parent trips a year (per student), gives a total airmiles figure of 100 million miles, and an emission figure of over 50,000 MTCO2e (the EF and RFI are applied in the same way as above).

Table 3: Assumptions for calculating category 9 emissions.

Total student Population	33,246
Percentage out of state student	43%
Total out of state student population	14,296
Average distance traveled	1000
Number of trips per year	6

Student Trips	85,775
Parent Trips	14,296
Total miles	100,070,460
Total Emissions (MTCO2e)	50,226

This category is under consideration at other universities as well, though the difference in measurement methodologies and definitions can be significant. For example, Stanford includes a figure for Student Travel, but includes air miles related to study abroad programs; in the CU Boulder case, study abroad is counted in Business Travel. Another consideration is the availability of adequate tools to influence these emissions. While a few have been listed below, additional disincentives to travel may be difficult for the Campus to sustain.

Strategies to reduce emissions from out of state travel include:

- Consistently funding a survey that gathers reliable data on actual trips taken by out of state students, parents and other visitors.
- Intensify education about the GHG footprint of Spring Break travel
- Create a plan around the Limelight conference center, which currently may increase the air travel footprint by several 10k of MTCO2e
- Educate families on the emissions impact of family visits
- Create remote participation options in commencement for extended family and friends
- CU Boulder could explore remote learning opportunities between Thanksgiving and Christmas as well as spring break to reduce transportation and housing issues

Discussions on additional practical strategies to address this category are currently underway.

For this iteration of the CAP, it is not setting a reduction target for these emissions due to the absence of data available to establish a meaningful baseline. The category has been measured and described below, along with a full description of considerations relating to out of state travel.[29]

Category 10: Processing of sold products. This category includes emissions from processing of sold intermediate products especially by manufacturers, subsequent to sale by the reporting company. Intermediate products are products that require further processing.[30] The CUB campus does not sell this type of intermediate product. Therefore, this category is not included in the inventory.

Category 11: Use of goods and services sold. This category includes emissions from the use of goods and services sold by the reporting company in the reporting year. A reporting company's scope 3 emissions from use of sold products include the scope 1 and scope 2 emissions of end users. End users include both consumers and business customers that use final products.[31] This category is relevant to producers

[29] The University of Colorado has chosen Stanford University as a benchmark and example to follow in the area of measuring, tracking and target setting for Scope 3 emissions. In 2020 the Stanford Board of Trustees passed resolution to eliminate its Scope 3 emissions by 2050; the Faculty Senate later urged a revision to target 2040. In Stanford's 2019 Climate Action Plan Scope 3 section, it states the campus is measuring 8 Scope 3 categories. The additional categories Stanford has included are: Purchased goods and services, Campus leases, and an additional category called Student Travel, which is measured as study abroad and travel to and from campus, and is based on a survey. No survey was available for CU students, though plans are now underway to track this important category.
[30] Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard.
[31] Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard.

of goods and services that directly cause emissions from their use. As an educational institution, CUB does not fit this profile, and this category has not been included.

Category 12: End-of-life treatment of sold products. This category includes emissions from the waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life.[32] CUB sells apparel, IT equipment, books and other merchandise. However, these can all be considered resale items, which have first been purchased by the Campus. Those purchases have been included in Category 1. The emission factors used to estimate Category 1 emissions include end of life treatment. As a result, no additional emissions have been counted for this category.

Category 13: Downstream leased assets. This category includes emissions from the operation of assets that are owned by the reporting company (acting as lessor) and leased to other entities in the reporting year that are not already included in scope 1 or scope 2.[33] CUB leases space on its campus to retail vendors. However, energy consumption for those leases have been counted in Scopes 1 and 2.

Category 14: Franchises. This category includes emissions from the operation of franchises not included in scope 1 or scope 2. The category is applicable to franchisors, which are companies that grant licenses to other entities to sell or distribute its goods or services in return for payments, such as royalties for the use of trademarks and other services.[34] CUB does not grant such licenses, and therefore this category has not been included.

Category 15: Operation of Investments. The University of Colorado Foundation, a distinct entity to both the University System and the CU Boulder campus, manages the University's endowment investment. Further, the University System[35] is the owner of University investments and is responsible for the specific portfolio of the endowment investment and all other University investment decisions. Though the Boulder Campus does not own or manage endowment investments, the University is the ultimate beneficiary of a significant portion of endowment funds held by the CU Foundation.[36] This places the Boulder campus in a position by which it benefits from, but does not hold decision making power for, its investment portfolio. Instead the CU System (owner) directs the CU Foundation (manager) on portfolio decisions. For this reason, category 15 is included in the analysis, though no target is being set for this CAP.

One methodology to calculate an entity's financed emissions is to calculate the reporting entity's share in a company and multiply that share by the company's emissions (see PCAF Global GHG Standard[37]). This has been the approach to approximate CUB's share of oil and gas sector emissions.

According to recent reports, the CU System maintains $270 million of its endowment in fossil fuel investments.[38] Due to the lack of a breakdown in individual investments, we have made two important assumptions about the nature of these investments. One, we assume they are in the oil and gas sector (O&G) rather than coal (which would likely push the emissions for this category higher). Two, we assume

[32] Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard

[33] Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard.

[34] Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard.

[35] The University of Colorado System is made up of four distinct campuses (CU Boulder, CU Colorado Springs, CU Denver, and CU Anschutz Medical Center. The CU System is governed by an elected Board of Regents, which consists of nine members serving staggered six-year terms. The board is responsible for setting policies and making decisions about the system's overall direction.

[36] https://www.cu.edu/doc/cu-afr-finalpdf.

[37] https://carbonaccountingfinancials.com/standard.

[38] https://www.cu.edu/doc/cu-afr-finalpdf

that the portfolio is weighted evenly across O&G sector companies. Further, we have allocated the CU Boulder share of the CU System endowment as proportional to its share of student enrollment, which is about 54% (36,000 students at CUB vs. 66,000 students system-wide). Under this assumption, CUB's share of the fossil fuel investments would be $146 million (=0.54*$270 million).

To finish the calculations, as of September 2022, the total market capitalization of 341 O&G companies is $7.055 trillion or $7,055 billion,[39] meaning CUB's "share" is 0.002% of the total industry ($146 million / $7,055,000 million). GHG emissions from the O&G sector was about 18.6 GtCO2e in 2022[40], meaning CUB's share in those emissions is 0.002% * 18.6 GtCO2e, or 372,000 MTCO2e. These emissions are significantly higher than all other categories. By comparison, total Scope 1-2 emissions from this report are calculated at 138,000 MTCO2e.

Target Reductions

CUB has set a target to reduce selected Scope 3 categories by 50% by 2030 and 100% by 2050. SBTi offers several possible courses of action within its target setting guidance. One approach is to seek an overall Scope 3 emissions target. Under this approach, one category might remain at present emission levels while others make up the difference. Another is to try to reduce all category emissions by a fixed percentage per year. Using this approach to achieve the CU target would require a 7% year-on-year reduction in all current target categories. This level of annual reductions would also achieve SBTi targets[41], putting the Campus on track for formally aligning itself with SBTi outcomes when the time comes for closer alignment. As an example, a plausible scenario has been created, in which approximately two-thirds of CU's Scope 3 emissions[42] are reduced by 7% annually.

Beginning with the procurement strategies for goods and services mentioned above, the campus would engage with suppliers, and seek those who are able to supply with reduced emissions, to the extent that a 7% annual reduction would be met. To reduce embodied carbon, moderate expectations are that emissions could be reduced by 15% per year, by using either NRMCA or ILFI ZC methodologies. Regarding commuter mileage and associated emissions, JD Power and Associates finds that current EV adoption rates are 8.6% nationwide, and ranks Colorado in the top ten. We have included a decrease in emissions of 7% per year in this category, based on these adoption rates. To reduce paid air travel, some universities have adopted programs for faculty to voluntarily reduce their air miles. Leveraging this type of strategy, we have projected these emissions to fall by 7% per year as well. Finally, waste makes up 4% in the baseline year and by applying the above mentioned strategies, it may be realistic to reduce these emissions also by 7% per year. Finally, fuel and energy related activities are also projected to fall 7% per year within the scenario, through compliance by the utility with renewable energy supply rules and the campus's own decarbonization program.

If these reduction assumptions are applied, emissions from the targeted categories would fall by approximately from 102,425 MT CO2e to 55,734 MT CO2e by 2030, a reduction of 45.5%. Further, they would fall to 11,744 MT CO2e by 2050.

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[39] https://companiesmarketcap.com/oil-gas/largest-oil-and-gas-companies-by-market-cap/.

[40] https://iea.blob.core.windows.net/assets/3c8fa115-35c4-4474-b237-1b00424c8844/CO2Emissionsin2022.pdf
The publication offers total emissions from oil of 11.2 GTCO2e, and mentions that natural gas emissions fell by 1.6% or 118 MT; this would make global totals equal to 7.4 GTCO2e for a total O&G emissions of 18.6 GTCO2e.

[41]The Absolute Contraction Approach for keeping global temperature rise below 1.5 degrees Celsius was visualized in Figure XX for the Universities tracked scope 3 emissions.

[42] The two-thirds figure includes all categories in the inventory, except Category 15 Investments.

Figure 8: Selected Scope 3 Categories and Targets

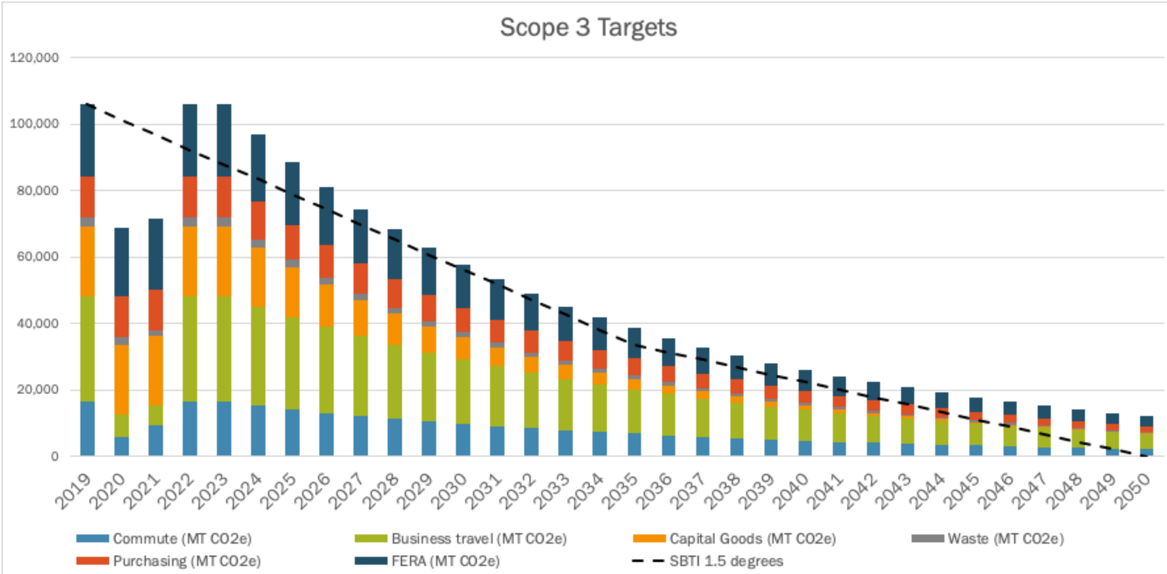

Table 4: Emission factors for Scope 3

Source	Quantity	Factor	Kg CO2e/	Emissions	EPA Table / Notes
VMT[43]	49,083,638	0.334261	mile	16,407	EPA EFs, Table 10
Air miles[44]	56,746,533	0.209126	mile	32,041	EPA EFs, Table 10 (short haul)
Solid waste[45]	5,841	520	short ton	2,379	EPA EFs, Table 9
Composted waste[46]	1,265	170	short ton	215	EPA EFs, Table 9
Embodied carbon[47]	174,536	120	square foot	20,944	Rocky Mountain Institute Page 13
Upstream Gasoline[48]	96,102	0.00654	gallon	238	Converted to gallons
Effective Building life		50	years		Assumption
EV Embodied	367	9.4	vehicle	3,449	IEA Data

[43] https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
[44] https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
[45] https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
[46] https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf
[47] https://rmi.org/insight/green-footstep-calculations-and-data-sources/
[48] https://www.gmsustainability.com/priorities/reducing-carbon-emissions/vehicle-emission-reduction.html

Carbon[49]					
ICE Embodied Carbon[50]	367	6	vehicle	2,502	IEA Data
RFI[51]		2.4	NA	i.e	UNFCCC Guidance

Conclusion

The comprehensive analysis and strategic planning outlined in the annex on Scope 3 Measurements, Targets, and Future Plans are pivotal steps for CU in managing and reducing its indirect emissions. Despite the complexity and challenges associated with Scope 3 emissions, CU has demonstrated a proactive approach in understanding, inventorying, and setting realistic targets for these emissions. Drawing on guidance from the GHG Protocols and the SBTi, offers a transparent and practical approach. Importantly, the CAP's status as a "living document" ensures ongoing refinement and adaptation of strategies based on emerging data and evolving best practices. We hope that the focus on influencing emissions through its procurement policies, operational changes, and community engagement, especially in categories where it has significant control, starts the campus in a strong, strategic direction toward its Scope 3 reduction goals. This initial foray into Scope 3 inventory and targeted emission reductions marks an essential step in CU's broader commitment to sustainability and environmental stewardship.

49 https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-of-a-mid-size-bev-and-ice-vehicle

50 https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-of-a-mid-size-bev-and-ice-vehicle

51 https://archive.ipcc.ch/ipccreports/sres/aviation/index.php?idp=71#:~:text=RFI%20is%20a%20measure%20of,here%20(see%20Section%206.6).

Financing Possibilities

Universities can finance investment in climate-related measures in several ways. Here are some of the most common methods:

Traditional Methods

1. Internal Campus Funds: Universities can use their own funds to finance projects, including the use of ongoing funds from their operating budget and/or capital budget, one-time funds from reserves, and other one-time funds that may become available.

2. Revolving Funds: Universities can establish revolving funds, which are dedicated pools of money that are used to finance energy efficiency projects. The funds are initially financed through a cash infusion, loan or grant, and then any savings generated by the projects can be reinvested into the fund for future projects. Ideally the savings replenish the fund to allow for more projects to be financed.

3. Campus Debt: Universities can issue their own debt instruments, usually in the form of 30-year bonds, to investors. Debt issuances allow the university to generate a sizeable amount of up-front cash that is used for large and expensive construction and sustainability projects. The university then uses internal campus funds to make annual debt payments over the term of the bonds. Bonds are typically only used for large projects as they have considerable issuance fees related to underwriting and the significant disclosures that must be developed and described in the legal documentation of the security by bond counsel. Additionally, as the bond issuer, the university will have to make, keep, and have readily available up to date information on the use of proceeds which adds administrative cost and burden.

a. Green Bonds: Universities can issue green bonds to finance climate-related projects. Green bonds are specifically designed to attract environmental, social and governance (ESG) minded investors to finance environmentally sustainable projects.

4. Endowment: A special endowment fund could be raised through Advancement. This would involve campus fundraisers engaging donor networks and asking for contributions to establish a fund dedicated to climate projects.

5. Appropriations: Universities can request funds from state legislatures, who are responsible for appropriating funds for public institutions. Legislatures may provide funding for specific initiatives or general operating expenses. Universities typically work with their government affairs offices or lobbyists to advocate for their funding priorities, testify at committee hearings, and provide data and research to support their requests.

Government Programs

State grants and loans: Universities can apply for grants from government agencies, foundations, or other organizations that support climate-related projects. These grants can occasionally provide a significant portion of required funding. Here are several examples:

1. Colorado C-PACE (Commercial Property Assessed Clean Energy) is a financing program that provides low-cost, long-term financing for energy efficiency upgrades and renewable energy installations for commercial, industrial, and agricultural properties in the State of Colorado. The program allows property owners to finance these upgrades through a special assessment on their property tax bill. The interest rate for C-PACE financing in

Colorado can vary depending on the size and term of the loan, as well as the creditworthiness of the borrower. However, as of April 2023, the interest rates for C-PACE financing in Colorado typically range from 4% to 7%, with loan terms of up to 25 years. The loan limit for C-PACE financing in Colorado is based on the property value and can vary depending on the size of the project and the expected energy savings.

a. According to the Colorado Revised Statutes § 32-20-104, tax-exempt properties, including those owned by public universities, are eligible to participate in the C-PACE program. However, they are required to obtain a waiver of their tax-exempt status from the county where the property is located. The university would also need to work with an approved C-PACE lender and contractor to develop and implement the project.

2. High Efficiency Electric Heating & Appliances (HEEHA) Program: Supports community efforts to switch to high efficiency electric heat & appliances. Grantees may use money received through the high efficiency electric heat and appliances program for the following purposes: 1) the purchase and installation of high-efficiency electric equipment for space heating, water heating, or cooking; 2) the purchase of electrical installations and upgrades necessary to support the installation of high-efficiency electric equipment; 3) the purchase and installation of other innovative building heating technologies that will likely achieve equal or lower levels of greenhouse gas emissions. Award amounts TBD. Total fund amount is $10.85 million. Program Length: July 1, 2022 - June 30, 2027. Further program details will be made available with program launch expected in early 2023.

3. Public Building Electrification Program: Provides public buildings with funding to explore and implement building system electrification measures and infrastructure upgrades. Eligible project types include 1) the purchase and installation of high-efficiency electric equipment for space heating, water heating, or cooking, 2) the purchase of electrical installations and upgrades necessary to support the installation of high-efficiency electric equipment, and 3) the purchase and installation of other innovative building heating technologies that the Colorado Energy Office (CEO) determines will likely achieve equal or lower levels of greenhouse gas emissions than high efficiency heat pumps. Further program details will be made available by May 2023. Total grant funding amount is $10 million. Each funding round will outline a specific amount of funding available to applicants during that Request for Applications cycle. Funding cycle dates and frequency are to be determined. Program Length: July 1, 2022 - June 30, 2027

4. Clean Fleet Vehicle Technology Grant Program: Offered by Clean Fleet Enterprise (CFE), the program is a competitive statewide application process designed for eligible light-, medium-, and heavy-duty fleet vehicles. Fleet operators will need to provide information about their current fleet composition, demonstrate their level of planning for fleet transition, and offer financial details regarding the vehicles or technologies they intend to acquire. Successful applicants will typically exhibit a clear understanding of the grant program criteria, demonstrate readiness to manage a complex and long-term fleet transition project, and express a commitment to integrating battery and fuel cell electric vehicles or vehicles powered by recovered methane into their everyday fleet operations. The program offers a total grant funding of $12.6 million for fiscal year 2023-2024, with an allocation of $8,000 per vehicle for light-duty vehicles, while funding for other vehicle categories is determined based on a percentage of the vehicle's value. Additionally, fleets opting to scrap pre-2010 vehicles wherever possible may be eligible for additional funding, such as $4,000 per light duty vehicle.

5. Charge Ahead Colorado: Provides grant funding for community-based Level 2 (L2) and DC Fast-Charging (DCFC) electric vehicle (EV) charging stations. The program operates on a three-round application cycle per year, with funding amounts varying based on the power level of the charging station.

6. Fleet Zero-Emission Resource Opportunity (Fleet-ZERO): Operated by Community Access Enterprise (CEO), this grant program aimed at supporting the transition of light-, medium-, and heavy-duty fleets to zero-emission vehicles through the funding of EV charging infrastructure. The maximum award per applicant, per

round for Standard applications is likely $250,000-500,000 (depending on the power capacity of the charging infrastructure). The maximum award for Rolling applications is $50,000. Eligible applicants include light-, medium-, and heavy-duty fleets (private, public, and non-profit). A minimum 20% match is required, which is reduced to 10% for Qualifying Entities. The first round of funding is anticipated to open in May 2023. Qualifying entities, including non-profits, are eligible for enhanced incentives and can submit applications on a rolling basis. The funds can be used for the purchase and installation of EV charging equipment and infrastructure for fleets, as well as for the 5-year networking and warranty requirements.

7. Geothermal Energy Grant Program: Set to launch in midyear 2023, the program aims to promote the adoption of zero-emission geothermal energy for electricity generation, as well as heating and cooling purposes in residential, commercial, and community settings. Grantees will have the opportunity to utilize the funds for various purposes, including the installation of geothermal primary heating or cooling systems in new or existing buildings, implementation of community geothermal systems, geothermal electricity generation projects, and design studies. The grant award amount is capped at $3,000 per ton of capacity, with a tonnage limit of 100 tons.

8. Colorado's Green Business Loan Fund: A program offered by the CEO that provides low-cost loans to Colorado businesses and organizations for energy efficiency and renewable energy projects. The Green Business Loan Fund offers loans ranging from $10,000 to $500,000 with interest rates typically below market rates. The program is designed to help organizations reduce their energy consumption and costs, improve their environmental performance, and contribute to a cleaner energy future in Colorado.

Federal grants: Financial awards provided by the federal government to support specific climate projects or initiatives.

1. Department of Energy (DOE) Grants: The DOE offers a variety of grant programs that support clean energy projects, including those related to renewable energy, energy storage, and energy efficiency.

• Renew America's Nonprofits: Provides grants for energy efficiency projects in nonprofit buildings. Eligible nonprofits can apply to be Prime Recipients and propose a plan to create a portfolio of building efficiency projects across many nonprofit buildings. In this portfolio, Primes will sub-award grants of up to $200,000 to nonprofit 501(c)(3) subrecipients that own and operate their buildings, for building energy efficiency improvements. Partners may complement the services of Primes by providing technical, financial, or other assistance to portfolio entities. DOE anticipates awarding $45 million in grants to 5-15 Prime Recipients. Individual awards are expected to be between $3-$9 million.

2. Environmental Protection Agency (EPA) Grants: The EPA offers a variety of grant programs that support environmental projects, including those related to climate change mitigation and adaptation. Examples include the Climate Showcase Communities Program and the Environmental Justice Small Grants Program.

• Clean Heavy Duty Vehicles: Grants and rebates are available for up to 100% of the costs associated with clean heavy-duty vehicles, such as school buses and garbage trucks. Eligible recipients include states, municipalities, Tribes, and nonprofit school transportation associations. The funds can be used to replace existing heavy-duty vehicles with clean, zero-emission vehicles and also cover expenses related to infrastructure, workforce training, planning, and technical activities.

3. Department of Transportation (DOT) Grants: The DOT offers grant programs that support projects related to transportation and infrastructure that can help reduce greenhouse gas emissions. Examples include the Transportation Alternatives Program and the Congestion Mitigation and Air Quality Improvement Program

• Neighborhood Access and Equity Grant Program: Provides grants to state and local governments to improve community walkability and connectivity through the removal, retrofitting, or replacement of roads and highways. Funding level: $1.893 Billion. Nonprofits and Higher Ed are eligible if they partner with States and Territories, Tribes, Units of Local Government, Political Subdivisions of a State, MPOs, Special Purpose Districts and Public Authorities with a Transportation Function.

Federal tax credits and deductions.

Normally, the University would need to find a private "tax equity" partner to take advantage of tax credits, since it is a non-taxed entity. However, for investment tax credits under the IRA, the University can receive a cash payment rather than a tax credit eliminating the need for a partner. The payment would come after project completion, so short term financing or cash would need to be secured up front to complete a project. If that financing proved difficult, a private partner may be found, who could contribute up-front capital and take advantage of the tax credit.

Under a tax equity partnership, the University would collaborate with a private partner who has a significant tax burden and could take full advantage of the credit. The diagram in Figure 1 shows a generalized arrangement of how cash flows may move under the partnership. Both partners may contribute capital to the project, though the amounts and timing may be uneven. For example, the private partner may contribute a greater portion of initial capital, while the university contributes to operations and maintenance. Cash flows generated by the project may also be distributed unevenly. Since the private partner is receiving the tax credit benefit from the government, a greater portion of project revenues may flow to the University. Contractual arrangements between the parties would specify these amounts, and any changes in timing once the tax credits have been exhausted.

1. Inflation Reduction Act for renewable energy projects:

a. Clean Energy Investment Tax Credit (ITC): Investment tax credits for clean energy deployment, including onshore and offshore wind, solar, geothermal, battery storage, and pumped-storage hydro. Funding level: $13.9 Billion / Base Credit: 6% of Project Cost; Bonus Credit: 30% of Project Cost if prevailing wage and registered apprenticeship requirements are met.

b. Clean Energy ITC Technology Neutral: Investment tax credit for energy deployment for projects with net zero carbon emissions. This credit will go into effect for new projects placed in 2025 through sometime in the 2030s. This credit is not limited to a particular clean energy technology, but rather any technology that does not contribute carbon emissions. Funding level: $50.8 Billion Base Credit: 6% of Project Cost; Bonus Credit: 30% of Project Cost if prevailing wage and registered apprenticeship requirements are met.

c. Clean Energy Production Tax Credit (PTC): Production tax credits for clean energy deployment, including solar, offshore and onshore wind, and geothermal to receive a tax credit for the production of electricity based on kilowatt-hour of power produced. Funding level: $51 Billion Base Credit: 0.05 cents per kWh, increased for inflation since 1992 Bonus Credit: .25 cents per kWh if prevailing wage and registered apprenticeship requirements are met, increased for inflation since 1992.

d. Clean Energy Production Tax Credit (PTC) Technology Neutral: PTC for energy projects with net zero carbon emissions. This credit will go into effect for new projects placed in service in 2025 through sometime in the 2030s. This credit is not limited to a particular clean energy technology, but rather any technology that does not contribute carbon emissions. Funding level: $11.2 Billion Base Credit: 0.05 cents per kWh, increased for inflation since 1992 Bonus Credit: 0.25 cents per kWh if prevailing wage and registered apprenticeship requirements are met, increased for inflation since 1992.

e. Clean Hydrogen Production Tax Credit: Credit for producing hydrogen where the lifecycle ("well-to-gate") greenhouse gas emissions to make the hydrogen are no more than 4 kg per kg of hydrogen. The full credit can be claimed only if lifecycle greenhouse gas emissions are less than 0.45 kg per kg of hydrogen. Option to claim an ITC on the hydrogen production facility instead.

f. Commercial Clean Vehicle Tax Credit: Accelerates the deployment of clean vehicles for commercial and other fleets. Funding level: $3.6 Billion Tax credit of 15% of the vehicle cost (30% for a pure EV), but not more than the incremental cost of above what a comparable powered solely by gasoline or diesel would cost.

g. Alternative Fueling Property Credit: Provides a tax credit of up to $100,000 per property for the installation of EV charging or alternative fueling infrastructure for ethanol, natural gas, compressed natural gas, liquefied natural gas, liquefied petroleum gas or hydrogen. Funding level: $1.7 Billion. The base tax credit is 6%, but it increases to 30% if the wage and apprentice requirements are satisfied.

2. 179D for energy efficiency initiatives. Section 179D of the U.S. tax code provides a tax deduction for building owners or designers who implement energy-efficient improvements in commercial buildings. Under Section 179D, eligible non-profit universities can claim a deduction of up to $1.88 per square foot for energy-efficient improvements made to their buildings. This includes upgrades to lighting, heating, cooling, and ventilation systems, as well as improvements to the building envelope, such as insulation and windows.

Other Federal climate related grants and loans:

1. National Science Foundation (NSF) Grants: The NSF offers grant programs that support research related to climate change and its impacts on the environment, society, and the economy. This includes funding for projects related to climate modeling, adaptation, and mitigation.

2. Department of Agriculture (USDA) Grants: The USDA offers grant programs that support sustainable agriculture practices and reduce greenhouse gas emissions associated with agricultural practices. This includes funding for projects related to renewable energy, soil health, and more.

3. Title 17 Innovative Clean Energy Loan Guarantee Program: Provides an additional $40 billions of loan authority for clean energy projects eligible for loan guarantees under section 1703 of the Energy Policy Act of 2005. Funding level: $40 Billion

Table 1: Summary of 179D Tax Deductions

Compliance Path		Savings Requirement*	Tax Deduction**		
			taxable years before 2021	taxable year beginning 2021	taxable year beginning 2022
Fully Qualifying Property		50%	$1.80/ft²	$1.82/ft²	$1.88/ft²
Partially Qualifying Property	Envelope	10%	$0.60/ft²	$0.61/ft²	$0.63/ft²
	HVAC and HW	15%			
	Lighting	25%			
Interim Lighting Rule		25%–40% lower lighting power density (50% for warehouses)	$0.60/ft²***	$0.61/ft²***	$0.63/ft²***

Third party solutions

6. Energy Performance Contracts (EPC): EPC are agreements between a university and an energy service company (ESCO) that provide energy efficiency upgrades and maintenance in exchange for a portion of the savings generated. ESCOs typically provide a guaranteed level of energy savings, which can help to mitigate some of the risk associated with the investment.

7. Public-Private Partnerships (PPP): Universities can partner with private sector companies to finance energy efficiency projects. This can include energy service companies, equipment manufacturers, or other companies that can provide financing or expertise to support the projects. Due to their complexities, PPPs are often reserved for projects that require large capital outlays, and may involve long concessions, and the surrender of ownership, labor and other elements typically held by the university to produce sufficient efficiency to make the arrangement "bankable".

8. Infrastructure as a Service (IAAS): Similar to PPPs, some private capital groups that are dedicated to climate mitigation have emerged as a funding source. These may provide more flexibility in the terms of the arrangement than a traditional PPP due to the fact that investments may be mandated toward positive climate outcomes.