CLIMATE
ACTION
PLAN

ANNEXES

University of Colorado **Boulder**

ANNEXES

APPENDIX A: EQUITY ANNEX

This annex provides additional background on equity in climate action and describes the efforts taken by the equity subcommittee to incorporate equity and justice throughout the CAP. Due to space and a desire to narrow the scope of the plan, some of the resources, analysis, and synthesis were excluded from the full document. Here we provide information on:

- Additional background on climate justice, the Boulder context, and the need for equity in climate action
- An overview of the outreach and community engagement efforts to achieve broad perspectives on equity in climate action
- Brief descriptions of some of the ways equity intersects with sectors of climate action
- A brief discussion of future actions and strategies to advance equity, largely in response to public comments received on the CAP during the public comment period.
- An equity prioritization matrix used to evaluate the strategies first proposed in the CAP
- Equity suggestions and implications

EQUITY IN CLIMATE ACTION

Equity refers to fairness and justice in the distribution of resources, opportunities, and benefits. In the context of climate action and climate justice planning, equity is an important consideration as the impacts of climate change disproportionately affect marginalized and vulnerable communities, including frontline communities who are affected first and worst by changing climate conditions. “Frontline communities include those that have a historically been marginalized, have faced histories that include redlining, racism and discrimination, are older adults, children, and those who are economically disadvantaged, live in poverty, and do not have the resources to adequately prepare for and/or respond to extreme weather events and other disasters”.[1]

Equity is often further characterized into different forms:[2]

- **Recognition Equity:** identifying and acknowledging injustices affecting specific populations as well as respecting differences and avoidance of domination.
- **Procedural Equity:** addressing how decisions are made and by whom as well as power structures and access to participation in decision-making. A key to this is ensuring equitable, inclusive, and meaningful engagement and asking how our engagement shifts power, builds trust, and ensures accountability, both structurally and intergenerationally.

[1] https://www.cincinnati-oh.gov/sites/oes/assets/File/Climate%20Equity%20Indicators%20Report_2021.pdf

[2] https://www.cincinnati-oh.gov/sites/oes/assets/File/Climate%20Equity%20Indicators%20Report_2021.pdf

- **Distributional Equity:** addressing the distribution of burdens and benefits across different populations.
- **Structural Equity:** recognizes the ways in which historical, systemic, and pre-existing inequities shape or exacerbate other equity or justice issues and that some groups may be structurally vulnerable and intergenerationally disadvantaged in terms of their cultural, political, and socioeconomic rights.[3]

All of these types of equity are important considerations in climate action planning to ensure a fair and just transition to a sustainable future for all. By centering equity in our approach to climate action, the University can begin to address systemic injustices and ensure that our efforts are transformative and inclusive. This means not only addressing the immediate impacts of climate change but also working towards building more equitable and resilient communities. Our shared vision is to create a just and equitable future for the university and its surrounding communities through our efforts to mitigate and adapt to the impacts of climate change.

EQUITY AND JUSTICE IN THE CU BOULDER CONTEXT

The city and county of Boulder, like many cities and counties in the US, have a history of violence, racism, and exclusionary policies impacting people of color and many other historically marginalized groups that influences the current landscape and equity considerations today.[4] By understanding the demographics of the campus and surrounding community, CU Boulder can better address the specific challenges faced by communities affected by its operations. For example, food insecurity is a concern with links to actions proposed in the CAP, with a rate of 9.2% in Boulder County. The university is implementing initiatives to promote access to affordable and nutritious food options and considering shifts to more plant based food as part of climate action. In Boulder city and on CU Boulder's campus, there are disparities in poverty rates across racial and ethnic groups, groups with different educational statuses, and across those with and without disabilities, providing opportunities to promote economic equity through targeted programs and partnerships that have links to strategies proposed in the CAP, such as shifts in procurement. Additionally, Boulder's high cost of living heightens the need for affordable and sustainable housing options, particularly for marginalized groups, and the city, county and University are exploring initiatives to increase availability. Housing affordability is linked to vehicle miles traveled, a key contributor to CU's scope 3 emissions. Considering equity in the local community and context will help mitigate inequitable outcomes associated with climate action and campus operations.

[3] McDermott et al, 2013

[4] https://bouldercolorado.gov/media/4167/download?inline

In addition to disparities across demographics in the region, CU Boulder understands that hazards and climate change do not affect all people equally. Colorado is in the 95-100 percentile for wildfire risks[5] and has experienced several years of drought since the turn of the century.[6] Wildfire, water scarcity, and related climate hazards impact communities, households, and individuals differently due to variation in access to resources, knowledge of hazards, and systemic inequities.[7] By incorporating such social considerations into hazard mitigation strategies, the University aims to address disparities and promote environmental justice.

An environmental justice lens demands that CU Boulder not only consider how external hazards differentially impact certain groups, but also how campus operations may differentially impact marginalized groups. An important example is waste management, which 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 impact on marginalized communities. Similarly, transportation disparities within Boulder County influence access to sustainable transportation options and push the University to work with local transportation authorities to improve infrastructure, accessibility, and connectivity for all residents. A final 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 building design and construction.[8] These histories and inequities require CU Boulder to commit to monitoring and improving air quality, implementing emission reduction strategies, and collaborating with stakeholders to address disparities.

By acknowledging these disparities within the CAP and involving stakeholders in decision-making, CU Boulder aims to create a more equitable and inclusive environment for all community members and to implement climate action strategies that begin to address these inequities. To enhance community collaboration, CU Boulder actively seeks stakeholder feedback and involvement in decision-making processes. The university values the expertise and perspectives of faculty, students, local organizations, and residents in shaping its climate action plan.

[5] https://ejscreen.epa.gov/mapper/

[6] https://libguides.colostate.edu/waterhistory/drought

[7] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6214520/

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

OUTREACH OVERVIEW

Summer and Fall 2022, the Climate Action Plan Equity Team has conducted engagement opportunities with stakeholders off campus on the Climate Action Plan. Community engagement events with Boulder Housing Partners, Boulder County Latino Coalition, Latino Chamber of Commerce and Climate Justice Collaborative of Boulder County were done. Since Summer 2022, the Climate Action Plan Equity Team has conducted 10+ engagement opportunities with stakeholders on and off campus on the Climate Action Plan including 3 greater Boulder and Boulder County community engagement events.

In 2023, the CAP Equity team conducted 8 workshops and feedback gathering sessions for faculty, staff, and student (including Feb 15 CAP luncheon, April 20 CAP town hall, October 25 CAP focus group, and CAP implementers outreach through november and december) and also partnered with MENV6100-019 Stakeholder Engagement class to create a survey and gain feedback (151 responses gathered) on the CAP from the CU community on campus.

MOVING BEYOND THE SCOPE: ADVANCING EQUITY IN THE IMPLEMENTATION OF THE CAP

Climate justice and equity goes well beyond campus infrastructure and operations. Accordingly, the CAP steering committee, the equity subcommittee, and the many stakeholders engaged throughout the development of the CAP recognize the limitations of the plan in achieving equity outcomes that are critical for climate justice. Many constraints arise from the plan's limited scope and the expectation that the specific equity outcomes associated with strategies proposed in the CAP are still unclear. As the plan is implemented, we suggest the following to strengthen the ability of CU to support equity when taking climate action:

- Increase equity expertise and capacity in infrastructure and operations on campus, enabling ongoing evaluation of equity implications as CAP strategies are implemented. This may include additional hires, formation of a body on campus to advise implementers on equity outcomes, or related activities.
- Establish specific strategies to measure equity impacts of climate actions, in partnership with curriculum development, student research opportunities, and faculty research efforts on campus.
- Explore opportunities to identify and address the links between fair wages, campus culture, university equity and justice goals, and climate justice

- Identify opportunities to collaborate with organizations and offices on and off campus engaged in equity efforts that are linked with CU's climate action strategies and broader equity goals. Specific equity related concerns that have been widely raised that might lend themselves to ongoing partnerships include:
  - Working with the city and county of Boulder to explore options for affordable housing and improved transportation to and from campus
  - Strengthen partnerships with local community organizations around climate action and climate justice to build collective capacity and shared responsibility
  - Working with the Center for Native American and Indigenous Studies and the Associate Vice Chancellor for Native American affairs, build and strengthen partnerships with Tribal and Indigenous communities, and continue to fund and grow the Tribal Climate Leaders Program
  - Consider the development of an advisory committee to support plan implementation that includes members from communities affected by CU operations, local organizations involved in equity and justice and/or climate and environmental work, local businesses, etc.
  - Strengthen partnerships between community colleges and CU Boulder through climate action. Consider partnering with community colleges to train and hire workers with sustainable job training for electrification upgrades and other on campus climate action and consider improving pathways for transfer and enrollment.
  - Ensure fair compensation and recognition of any partnerships to minimize overburdening any group or individual interested in equity and climate action
  - Explore the links between high admissions of out of state students and increasing tuition on air travel, scope 3 emissions, and access to higher education for in state students.
  - Continue to refine measures of CU Boulder's contributions to system level investments that fuel emissions. Pursue strategies with other CU campuses and the system to achieve divestment.

INTEGRATING EQUITY INTO CLIMATE ACTION: SCORING AND EVALUATIONS

Initially when evaluating the Climate Action Plan (CAP) strategies, we used evaluation criteria from the University of California's "**A Framework for Incorporating Environmental and Climate Justice into Climate Action**". Through an iterative process, we redeveloped the **equity prioritization matrix** from Blue Strike Environmental Consulting to better assess the equity prioritization of particular strategies in the Climate Action Plan, based on conceptions of equity and justice found in the University of California framework. This matrix could use some further editing and iterating, but for transparency is included below.

The key equity and justice guiding questions asked, for the plan broadly, and for each proposed action are adapted from widely used definitions of equity that aim to identify:

- Who the proposed strategy benefits and the extent to which it achieves broad demographic reach
- How the proposed strategy prioritizes support and/or relief for people and communities with greatest need and/or history and ongoing marginalization. These communities include, but aren't limited to, lower-income, LGBTQIA+, disabled, unhoused, and communities of color. The University also identifies several protected classes[9] that may be considered when considering impacts and outcomes of climate actions.
- How the proposed strategy engages marginalized and underrepresented groups in outcomes, implementation, and/or decision-making.
- If a strategy potentially ignores or worsens existing disparities or produces other unintended consequences on or off campus and how to mitigate those impacts.
- If and how each strategy prioritizes improvements, programs, and/or changes that address the needs of underrepresented and marginalized communities, on or off campus.

During the development of a previous iteration of the CAP, the equity team also described their thoughts on the equity implications of each strategy as well as suggestions to make the strategy or its implementation more equitable. These implications and suggestions were partially or fully included in previous drafts of the Climate Action Plan. As the steering committee identified that some strategies didn't directly contribute to emissions reductions, they were removed from the CAP.

[9] https://www.colorado.edu/dontignoreit/what-report/discrimination-harassment/protected-class-definitions

We include the equity suggestions and implications below, as representations of the equity team's thinking about these strategies, rather than polished products. During the process of developing suggestions and implications, the equity subcommittee learned that many of the details of specific strategies remain unclear and, accordingly, so do the equity implications. This can be used as a reference and resource as the plan is implemented to further refine, measure, and address equity in the CAP. Also note that several strategies originally assessed for equity implications were ultimately removed from the plan due to limitations in scope.

Based on the below matrix, the equity subcommittee identified the top 20 climate action strategies proposed in the plan that had the greatest potential to improve equity outcomes and directly contribute to emissions reduction. Where these top priority actions showed direct connections to campus infrastructure and operations, they have been integrated into the CAP. For other actions, additional planning, partnerships, and capacity building should be explored for future implementation.

1. Increase clothing, furniture and equipment reuse events, online reuse listings platform and expand education around the CU Distribution Center (Waste)
2. Establish a food recovery program on campus for all catering and culinary events (culinary)
3. Identify a permanent funding model to address DEI on campus (equity)
4. Work with the Basic Needs Center (equity)
5. Expand EcoPass program to offer non-benefit eligible employees an annual subsidy (transportation)
6. Distribute electric bikes to low income residents which are funded by sponsors, e-bikes repaired by CU Bike Program. (transportation)
7. Stress the need to honor commitments to support Indigenous students and introduce Indigenous knowledge systems into the university's dominant framework. (equity)
8. Ensure resources go to marginalized community members who seek refuge at the Indoor Practice Facility (equity)
9. Retain 10% of vendors who are small business owned or run by people of minority identities; Increase 2% per year through 2030 (procurement)
10. Expand the Lime scooters and B-cycle bike sharing programs on campus (transportation)
11. Expand the number of water refill stations on campus (water)

12. Expand the lifecycle costs of procurement to include a social equity index (procurement)
13. Ensure all new policies and procedures are created with a lens on environmental and social considerations (Governance)
14. Incorporate an accountability process for policy implementation and review (governance)
15. Assess how each component of the plan (including goals, strategies, and overall approaches) influence equity and justice across campus and beyond (equity)
16. Conduct zero waste trainings for front line staff in preferred language to build community around environmental practices (communication)
17. Expand staff vanpools (transportation)
18. Expand “Green Office'' Certification for CU offices. (communication)
19. Design a sponsorship package specific to the climate initiates on campus (communication)
20. Track Service Learning hours by sustainability and environmental-justice focused partners and increase by 10% by 2025 (equity)

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
BUILT ENVIRON	Implement the Energy Master Plan (EMP) Implement the Energy Master Plan (EMP)	High	Low	No	Maybe	Yes	Yes	2.00	As the climate crisis impacts marginalized groups first and worst, this strategy indirectly promotes distributional justice through its emission reductions.	To align with the EMP and bolster the equity implications score, CU Boulder should consider ways to incentivize affordable renewable energy for low-income and marginalized students living on and off campus, as well as supporting programs such as FLOWS that train students and local residents to become leaders in the energy transition.
BUILT ENVIRON	Prioritize space optimization	Low	Low	No	Maybe	No		0.00	This strategy potentially enables procedural equity in prioritizing inclusive, meaningful engagement, and participation in determining how spaces are allocated, designed, and utilized.	To ensure procedural justice, those most affected by the changes made through this strategy (e.g., during renovation and construction and in future use) should be meaningfully included in the decision-making and implementation process of this strategy.
BUILT ENVIRON	Establish decarbonization Facility Maintenance programs and procedures	Low	Low	No	Maybe	No	No	0.00	Establishing decarbonization facility maintenance programs and procedures aims to mitigate the impacts of facilities operations on climate change and promote sustainable practices, indirectly supporting distributional equity.	When making facility maintenance decisions, equity can be further supported through community engagement to prioritize upgrades to buildings identified as serving diverse community needs.

[10] This preliminary equity evaluation matrix was developed by the equity subcommittee. The CAP is focused on operational GHG emission reductions and in the course of its development, it was recognized that many strategies in this matrix did not directly help achieve that overarching aim. We include them here, however, in the hope that they can provide fuel for the broader equity and climate justice discussions and efforts on campus going forward.

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
BUILT ENVIRON	Update the campus building design standards for new construction and major renovations	High	Low	No	Maybe	No	No	0.00	Updated building design standards indirectly support distributional equity by decreasing co2 emissions, but the direct impacts of the strategy do not specifically prioritize low income or marginalized groups. Consideration of any shifts in facilities management, especially janitorial staff, should engage staff as experts on waste management.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. Additionally if the building is to provide housing for people, a requirement of prioritizing dwelling spaces as affordable should be ensured. Consider if current labor on campus has skills for maintenance, if training opportunities could be developed, and/ or if additional labor should be hired.
BUILT ENVIRON	Utilize Green Building Certifications as a green building framework	High	Low	No	Maybe	No	No	0.50	This strategy indirectly supports distributional equity by broadening access to a healthy built environment for everyone, but does not specifically prioritize low income or marginalized groups.	To support procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and into the implementation process of this strategy and should be made available in multiple languages and accessible in multiple forms. Ensure all buildings on campus meet Green Building Certification status. Which prioritized, preemptively monitoring air quality.

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BUILT ENVIRON	Improve building resilience by identifying and mitigating risks to campus	High	Low	No	Maybe	No		0.50	Identifying and mitigating risks to campus buildings improves safety and security of all individuals within the CU Boulder community, but does not specifically prioritize low income or marginalized groups. This action provides everyone with access to safe and protected spaces.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. Additionally, to ensure equity, prioritize vulnerable populations such as grad and family housing on campus which host a majority of international students and low income families.
ENERGY	Develop a central plant decarbonization transition plan through 20xx-20xx	High	Low	No	No	No	No	1.00	Developing a decarbonization plan may indirectly promote distributional justice through its emission reductions, since marginalized communities are impacted first and worst by the climate crisis. However, this strategy does not have direct concrete benefits for low-income and marginalized communities.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy.
ENERGY	Improve building resilience by identifying and mitigating risks to campus	High	Medium	No	No	No	No	0.50	By addressing potential risks, the plan aims to prevent disproportionate impacts on different populations and ensure equitable access to safe and resilient buildings, supporting distributional equity	x

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ENERGY	Expand funding for energy efficiency improvement projects and programs	Medium	Low	No	Maybe	No		0.00	Expanding funding for energy efficiency projects indirectly promotes distributional justice through its emission reductions, but does not directly prioritize energy efficiency needs of low income or marginalized communities.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. Prioritize Grad and family housing for funding and energy improvement projects and programs.
ENERGY	Develop a renewable, resilient campus energy infrastructure	High	Low	No	Maybe	No	No	0.50	This strategy can indirectly improve distributional equity by providing access to renewable, resilient energy infrastructure for everyone on campus, but does not specifically prioritize low-income or marginalized communities.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy.
TRANSPORTATION	Transition campus fleet vehicles to electric by 2050	Medium	Low	No	Maybe	No	No	0.00	On one hand, the transition to electric vehicles can help in reducing air pollution, enhancing public health for everyone. However, as opposed to public transportation, electric vehicles are resource-intensive, burdening marginalized communities near resource extraction sites.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. CU should consider sharing and/or reducing its campus fleet to encourage vehicle share programs and implementing and encouraging public transportation when possible since the creation of EV's requires limited natural resources like lithium and cobalt.

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TRANSPORTATION	Install 94 additional EV charging ports campuswide by 2050	Medium	Low	No	Maybe	No	No	0.00	EV infrastructure can promote public health benefits from reduced air pollution for everyone. However, increasing infrastructure and demand for electric vehicles will primarily benefit higher-income individuals who can afford EVs, rather than low-income individuals who could benefit from more efficient public transportation.	CU should consider encouraging biking and taking public transportation over electric vehicles which are typically not affordable.
TRANSPORTATION	Improve the VMT survey for students, staff and faculty in the Fall 2023 to gather more granular transportation data.	High	Low	No	Maybe	No	No	0.50	Gathering more granular transportation data allows for a better understanding of transportation needs and preferences across different populations, but the survey itself does not directly benefit low-income or marginalized groups.	To ensure procedural equity, this survey must be accessible to the entire community by providing it in multiple languages as well as in paper format. Additionally, results from the survey could be used to meet the transportation needs of low-income or marginalized students, staff, and faculty.
TRANSPORTATION	Expand EcoPass program to offer non-benefit eligible employees an annual subsidy	High	High	Yes	No	Yes	No	4.50	Expanding the EcoPass program ensures every student, faculty, and staff has the opportunity to move about the city freely, supporting distributional equity.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. An in-depth study on structural equity should be undertaken to acknowledge structural vulnerability of certain groups such as spouses of international students who have access to a bus pass at a fee.

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TRANSPORTATION	Expand the Lime scooters and B-cycle bike sharing programs on campus	High	High	No	No	Yes	Yes	4.00	Expanding bike sharing programs ensures equal access to affordable and sustainable transportation options, reducing commuting costs for all members of the CU community, and supporting distributional equity.	CU should consider a program for Limes similar to B-cycle where the first 20 minutes are free or where students receive a discounted rate. To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy.
TRANSPORTATION	Develop a plan for expanding the Zip and Colorado Car Share program	High	Medium	Yes	No	Yes	No	3.00	Increasing access to affordable and convenient shared transportation options for all members of the CU community helps support distributional justice.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. An in-depth study on structural equity should be undertaken to acknowledge structural vulnerability of certain groups in accessing ZIP and Colorado car share programs.

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TRANSPORTATION	Distribute electric bikes to low income residents which are funded by sponsors, e-bikes repaired by CU Bike Program.	Medium	Medium	Yes	No	Yes	Yes	4.50	This action supports distributional equity by increasing accessible and affordable transportation options for all, addressing transportation barriers faced by low-income individuals, and providing equal opportunities for sustainable mobility and active transportation within the CU community.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. Bike events should be shared in multiple languages for all members of the CU community to participate.
TRANSPORTATION	Explore potential solutions to bike theft on campus	High	Medium	No	No	Yes	No	2.50	Building bike shelters to combat bike theft on campus can protect those who depend on and can only afford bikes as their primary means of transportation.	Ensure that the criminalization of bike thefts, which disproportionately impacts BIPOC and low income persons, does not increase.

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TRANSPORTATION	Reduce conference and travel budget by 50% of 2019 baseline by 2030	Medium	Low	No	Maybe	No	No	0.00	Reducing travel potentially enables distributional equity by minimizing financial and logistical barriers, ensuring equal opportunities for participation, and reducing carbon emissions associated with travel, thus promoting a more inclusive and sustainable approach to professional development within the CU community. However, marginalized students often benefit from networking opportunities at in-person conferences that are otherwise unavailable to them.	Consider providing an incentive, especially to low-income students, to attend conferences virtually.
TRANSPORTATION	Consider including student travel during breaks and family visit air travel into Scope 3 emissions	High	Medium	No	Maybe	No	No	1.00	This action may offer a reduction in transportation-related barriers and costs for those who cannot afford to travel home for multiple student breaks, and indirectly improves distributional equity through emissions reductions. However, this action does not specifically prioritize the needs of low-income and marginalized students.	To ensure procedural justice, those most affected by the changes made through this strategy should be meaningfully included in the decision-making and implementation process of this strategy. Oftentimes students travel for mental health reasons and to be with their families.

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TRANSPORTATION	Expand staff vanpools	High	Medium	Yes	Maybe	Yes	Yes	3.50	Staff vanpools provide reliable and affordable transportation options, reducing commuting costs and barriers, and ensuring equal access to employment opportunities and professional development within the CU community. This action has the potential to support distributional equity.	Early-morning staff who don't use vanpools and drive instead do so for the convenience of going to a second job. Ensure a satisfaction survey of the current vanpool users is done first to ensure strengths of the program along with ridership analysis before expansion.
WASTE	Continue to reduce package-related plastic waste by sourcing products with sustainable packaging	Medium	Low	No	Maybe	No	No	0.00	This action may indirectly promote distributional equity because a reduction in plastic waste is broadly beneficial and has potential to decrease waste pollution in marginalized communities. However, there are potential tradeoffs if costs of shifting from plastic increases costs to consumers on campus.	
WASTE	Create a baseline assessment for leftover edible food and food waste ending in the landfill	Medium	High	No	No	Yes	No	2.50	Improved data on food waste enables identification of strategies for food waste reduction and pathways to increase access to food at lower costs thus potentially enabling distributional equity.	Improve procedural equity by engaging bipoc communities and groups on campus
WASTE	Reduce paper usage 25% from 2019 baseline by 2030 per Governor's Executive Order	Low	No	No	Maybe	No	No	0.00	Reducing paper usage has the potential to make information less accessible to populations who do not have access to technology.	

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WASTE	Use student research to assist campus procurement officials in revising contracts to complement Zero Waste programs.	Medium	Low	No	No	No	No	0.50	This action supports procedural equity through involving CU students in research and the decision making process. This experience can help students gain real-life applied and marketable skills related to sustainability which they can include in their resumes.	To increase the equity score, low-income BIPOC students should be prioritized for this opportunity. (Provide incentives and reward students for engaging in this research, prioritizing marginalized students for this opportunity.)
WASTE	Increase clothing, furniture and equipment reuse events, online reuse listings platform and expand education around the CU Distribution Center	High	High	Yes	No	Yes	Yes	5.00	Provides distributional equity as reuse on campus decreases costs of furniture and clothing for low-income individuals and provides pathways for the CU and larger community to access cost-effective resources. Clothing and furniture waste is high across many university campuses. Increased reuse limits waste in communities containing landfills, and it reduces the export of waste overseas.	
WASTE	Clarify the goals and responsibilities of Ralphie's Green Stampede (RGS) and explore how it could be expanded to a more centered program.	Medium	Medium	No	No	Yes	No	2.00	RGS ensures zero waste within football and basketball games and provides left over foods to communities around the city of Boulder, thus providing distributional equity.	Continue to build partnerships with BIPOC community-based organizations and other stakeholders to ensure university policies and programs are responsive to the needs and priorities of the community.

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WASTE	Write a Zero Waste Plan to address construction and demolition, strategies around compostables and food recovery efforts.	Medium	Low	No	No	No	No	0.50	Reducing waste generation can minimize the environmental and health impacts of waste disposal, an indirect effect which often impacts marginalized communities.	Procedural equity is required to write a Zero Waste plan.
WATER	Continue to coordinate regularly with Boulder Water on stormwater quality where campus systems interact	Medium	Low	No	No	No	No	0.50	This strategy aims to increase clean water availability for everyone, but does not specifically prioritize the needs of low-income or marginalized groups.	
WATER	Continue to require all new projects to install treatment detention systems to prevent stormwater runoff	Medium	Medium	No	No	No	No	1.25	Stormwater runoff can disproportionately impact marginalized communities, so improving treatment detention systems could indirectly increase equity.	Prioritize flood-prone areas near marginalized communities.
WATER	Expand the number of water refill stations on campus	High	High	No	No	Yes	Yes	4.00	This action promotes distributional equity since it addresses potential disparities with access to filtered drinking water. Clean drinking water is a fundamental right and beneficial to the campus and wider community.	

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WATER	Consider installing rooftop gardens in all new construction where feasible	Low	Low	No	No	No	No	0.50	This action increases access to green space, environmental benefits, and health benefits such as mental health and anxiety reduction for everyone, but does not specifically prioritize marginalized groups. Rooftop gardens could decrease the urban heat island effect, which disproportionately affects marginalized groups, thereby indirectly improving distributional equity.	
WATER	Revisit gray water or rain catchment solutions	Low	Low	No	No	No	No	0.50	Minimizing strain on water supply may indirectly promote distributional equity by improving water access for all. This strategy does not specifically prioritize the needs of low-income or marginalized groups.	
WATER	Switch residence hall laundry machines to include micro-fiber filters	Medium	Low	No	No	No	No	0.50	Decreasing micro-fibers in the water holds benefits for everyone, but does not specifically prioritize the needs of marginalized or low-income groups.	

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CULINARY	Establish a food recovery program on campus for all catering and culinary events	High	High	Yes	No	Yes	Yes	5.00	Food insecurity across campus remains a problem despite ongoing efforts. Food recovery and increased availability of recovered food for low income students, faculty and staff helps minimize food waste and improve food security and helps promote distributional equity.	Broadening the eligibility for such food recovery programs increases impact and recognizes that existing criteria may exclude certain groups. Ensure marketing for this program is in multiple languages and available in multiple formats.
CULINARY	Increase percentage of locally-grown foods purchased and plant-based meals served	High	Low	No	Maybe	No	No	0.50	Increasing the availability of locally-grown and plant-based meals may increase costs for students. Additionally, a potential challenge is the logistics of working with a large organization like CU with smaller farms (e.g., delays in pay, minimum delivery amounts, in-season foods etc.).	CU should ensure that food remains affordable on campus. Additionally, CU should prioritize working with local farms owned by farmers from underrepresented backgrounds.
CULINARY	Estimate and track carbon footprint of foods purchased.	Medium	Low	No	Maybe	No	No	0.00	Improved data around the carbon footprints of food purchased increases our ability to keep better track of GHG data, and can aid in reducing emissions.	The data should be available to all on campus. This action must be done with distributional equity in mind; a potential challenge or tradeoff with behavior change around buying more carbon-friendly foods include increased costs and negative impacts on communities who grow and traditionally eat these low carbon foods.

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CULINARY	Increase percentage of products ordered that report on sustainability criteria	Medium	Low	No	Maybe	No	No	0.00	Our goal is to create a just and sustainable food system for all, where healthy and sustainable food options are accessible and affordable for all communities, and where the benefits and burdens of the food system are shared equitably across all communities promoting distributional equity. While it is important to know whether a food is sustainably sourced or not, it is important to note that many sustainability certifications cost extra money to the farmers and producers, which is inequitable.	Subsidize local BIPOC vendors CU procures from to get a sustainability criteria certification.
CULINARY	Explore options for expanding reusable to-go options and work with vendors to pilot different products.	High	Low	No	Maybe	No	No	0.50	This action could be more expensive for the campus and therefore students.	To ensure procedural equity, the campus community must be meaningfully engaged in standardizing reuse culture through working with local vendors and encouraging the CU community to bring their own reusable utensils and tupperware, mason jars, or bowls. Subsidize the price of reusable cutlery, tupperware, mason jars or bowls for the CU community and especially BIPOC communities within the university. Additionally, making your own reusable cutlery kits could be held as an activity for the CU community.

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GROUNDS	Commit to critically assess under utilized lawns with sustainable solutions that reduce water and pesticide use, increase carbon sequestration and promote a public image of climate responsive landscape solutions.	Medium	Low	No	No	No	No	0.75	Including CU community in the design and use of climate responsive landscape solutions can improve engagement in CAP implementation, or procedural equity. However, the needs of marginalized groups are not specifically prioritized.	An opportunity exists to build food resilience with increased community garden spaces, which also helps with mental health and climate resilience. Prioritize BIPOC and low-income students for this opportunity.
GROUNDS	Create a tree planting master plan that integrates solutions for specific areas and aligns with the campus designation as a Tree Campus USA.	Medium	Low	No	No	No	No	0.75	Trees help reduce urban heat island effects, and thus could improve distributional equity, however, they must be well maintained during the first three years of their lives to ensure survival.	This is a great opportunity to have community engagement from all sectors of the CU Community and the potential for groups to "adopt a tree" exists. For example, the planting master plan could include members from CNAIS and Indigenous plant knowledge to teach about native plants and trees as well as people's relationships to the environment.
GROUNDS	Commit to using electric grounds equipment as technology evolves, using safety as a top priority	Low	Medium	No	Maybe	Yes	No	1.00	By prioritizing workers' safety, health and wellness, this strategy increases distributional equity.	Commit to worker's health and safety when transitioning to electric equipment; some electronic lawn care equipment, like leaf blowers with heavy battery packs, is harder on the worker's body due to the additional weight from a battery pack. Look at body impacts of using the equipment.

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GROUNDS	Expand the area in and around the UMC as a Sustainability Commons to showcase sustainability, pilot technology, and promote innovative research on campus	Medium	Low	No	Maybe	No	No	0.25	This action increases access to knowledge around sustainability for everyone, which is a crucial part of campus life and education, but does not specifically prioritize the needs of marginalized and low-income groups.	To ensure distributional and procedural equity, look to the CU community- students, faculty, and staff- to provide innovative, cross-sectoral solutions to commonly faced problems. Reserve a space for research from marginalized and low-income students and faculty and research on environmental/climate/energy justice
PROCUREMENT	Eliminate purchasing of disposable plastics	High	Low	No	Maybe	No	No	0.50	This action could indirectly increase distributional equity by minimizing the negative impacts of plastic waste on diverse populations and ecosystems. However, this strategy could also increase costs borne by students.	To ensure procedural equity is enacted with this decision, the entire CU community should be meaningfully engaged. Ensure that extra costs are not borne by students and compliance with Disability Services when making these decisions.
PROCUREMENT	Expand the lifecycle costs of procurement to include a social equity index	High	High	Yes	No	Yes	No	4.00	This action indirectly supports recognition and structural equity by recognizing the potential disparities and inequalities that can arise in supply chains and seeking to address them. This action supports people beyond the CU community in having access to equitable, fair-paying jobs with good working conditions.	

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PROCUREMENT	Retain 10% of vendors who are small business owned or run by people of minority identities; Increase 2% per year through 2030	Medium	Medium	Yes	No	Yes	Yes	4.25	This strategy supports distributional equity by addressing the distribution of economic opportunities and benefits among diverse populations. Increasing the number of BIPOC owned businesses can also start to address structural equity.	
PROCUREMENT	Establish Sustainable materials purchasing guidelines with a list of construction materials with low embodied GHG emissions or energy products with Energy Star rating	Low	Low	No	Maybe	No	No	0.00	This strategy indirectly supports distributional equity by decreasing emissions from materials.	To improve equity, increase the percentage of vendors and look to source local and BIPOC owned materials. There are many local BIPOC owned businesses showcased in websites such as shopbipoc.com and the Colorado Office of Economic Development and International Trade website, among others.
PROCUREMENT	Develop an online sustainability training for Procurement officers and department managers	Low	Low	No	No	Yes	No	1.50		Ensure trainings are available in multiple languages as well as paper format for those who don't have access to or have high comfort levels with technology to support procedural equity.

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PROCUREMENT	Consider centralizing printers and eliminating single-user printers	Medium	Low	No	Maybe	No	No	0.25		Ensure usable printers are repurposed or donated to marginalized communities. If it needs to be disposed of, ensure electronics are disposed of properly. Consider subsidizing centralized printer fees associated with centralized printers for low income and marginalized students, staff, and faculty.
PROCUREMENT	Ensure Extended Producer Responsibility programs are part of the vendor contracting process	Medium	Low	No	Maybe	No	No	0.25	This action can support structural equity through encouraging and creating awareness around circular economy efforts in Colorado through ensuring vendor responsibility which can benefit marginalized communities through providing local jobs. This can also backfire however since producers are required to pay an extra fee for packaged goods.	

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PROCUREMENT	Change the language of offer letters to researchers to encourage a collective and shared mindset when it comes to resources like shared instrumentation	Medium	Low	No	No	No	No	0.75	This strategy supports distributional equity by aiming to address potential disparities in resource availability and reduce the need to buy new equipment. Changing the language of an offer letter is the easiest way to ensure a new researcher is coming into a culture of shared resources and communal space to optimize campus building use and resources.	Unused or surplus instruments can be donated to help build science classrooms across Colorado.
PROCUREMENT	Engage with someone from the system procurement office to address the challenges in the centralized nature of procurement work, which requires critical examination of policy and flexibility, as part of the climate justice and climate equity subcommittee's efforts	Low	Low	No	Maybe	Yes	No	1.00	This strategy indirectly supports structural equity by recognizing and addressing systemic inequalities and structural vulnerabilities within procurement practices.	Strengthen campus-collaboration across all four campuses through working with the central procurement office to standardize sustainability and climate action at the CU System level to support distributional equity. Examination of policy should prioritize procuring from local, BIPOC and marginalized communities.

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COMMUNICATIONS	Include information on campus' GHG inventory into Welcome Week	High	low	No	No	No	No	1.00	Providing transparency within campus operations to provide equitable access to greenhouse gas inventory on campus for all CU community members supports procedural and distributional equity.	An additional action is to include this information beyond Welcome Week to ensure all students, faculty, and staff have a baseline knowledge of the climate action plan, which can help keep accountability on the progress of the plan over the years. Information must be presented in multiple languages spoken on campus.
COMMUNICATIONS	Energy campaign?	High	Low	No	No	Yes	No	2.00	To support recognition and distributional equity, building on continued learning opportunities and creating a safe space where staff can experience a sense of community within the university is key. These spaces can ensure a trusting space where staff can share their needs for the university to implement.	Information must be available in multiple languages spoken on campus and multiple formats like social media, print, and webpage.

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COMMUNICATIONS	Expand “Green Office" Certification for CU offices.	High	Medium	Yes	No	Yes	No	3.50	Ensuring employees know about and participate in the "green office" certification program for office spaces on campus supports procedural equity in learning about "green" practices within office spaces, which they can later take into their careers outside of the university.	Ensure all Green Office certification education and signage is offered in multiple languages.
COMMUNICATIONS	Create and promote the campus online reporting dashboard in regular communication channel	High	Low	Yes	No	Yes	No	3.00	This action supports procedural equity as the reporting dashboard provides transparency and awareness which are key for the campus community to be able to participate in and be a part of the campus sustainability goals.	The reporting should be made available in multiple languages and should also be made available in print on at least a yearly basis and more frequently if a community or individual requests it.
COMMUNICATIONS	Build a Train-the-trainer model that will be governed by the Environmental Center	Medium	Low	No	No	No	No	0.75	This action supports procedural justice as training others on sustainable best practices develops leadership skills while building a network of people who can work towards the university’s sustainability goals. This strategy supports inclusive and accountability practices in training initiatives.	Prioritize BIPOC and low-income people to take part in this program. Prioritize transferable skills that can be used to create a sustainable economy in the workforce. The design of these programs are co-designed with participants to prioritize their needs.

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COMMUNICATIONS	Conduct zero waste trainings for front line staff in preferred language to build community around environmental practices	Medium	High	Yes	No	yes	No	3.75	Providing trainings in staff's native language ensures language justice and promotes recognition equity	To ensure recognition and distributional equity, building on continued learning opportunities and creating a safe space where staff can experience a sense of community within the university is key. These spaces can provide a trusting space where staff can share their needs for the university to implement.
COMMUNICATIONS	Expand funding for Green Labs to increase staffing to achieve deeper efficiencies and system change within processes for research, and to increase the outreach of programming within laboratory buildings across campus.	High	High	No	No	Yes	No	3.00	Green Labs supports distributional and structural equity through programs such as shared instrumentation efforts which prevents use of research money to be spent on science equipment that the university might otherwise have, enabling researchers with less funding to access needed equipment.	Being an R1 university, ensure education on energy and water conservation, shared instrumentation, and space optimization efforts by the Green Labs is available to all members of the CU community. Information about these programs should be shared in multiple languages to increase awareness and knowledge of sustainable best practices and access to resources the campus community may not be aware about. Those who wish to be engaged in the decision-making process around Green Labs should be presented with that opportunity.

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COMMUNICATIONS	Design a sponsorship package specific to the climate initiative on campus	Medium	Medium	Yes	No	Yes	No	3.25	Effective and inclusive communication is essential for advancing procedural and distributional equity through ensuring that all stakeholders have equal opportunities to learn about environmental sustainability efforts and help support desired climate projects they would like to see implemented through the sponsorship package.	
GOVERNANCE	Track annual performance metrics identified in the Climate Action Tracker	Medium	Low	Yes	Maybe	Yes	No	2.25	Addressing the distribution of progress and outcomes in climate action efforts supports distributional equity. This strategy aims to identify gaps, areas of improvements, and equitable distribution if resources and efforts to achieve climate targets	To ensure procedural equity, transparency and accountability within the Climate Action Plan progress and implementation process must be made available for meaningful engagement. Ensure performance metrics are available in multiple languages and the performance is reported annually or upon request.
GOVERNANCE	Encourage the Sustainability Council, Student Government, the Staff Council, and the Faculty Assembly to nominate representatives that will be responsible for implementing the plan	High	Low	No	Maybe	No	No	0.50	Promoting engagement of different stakeholder and ensure inclusive and accountable decision making processes and power structures promoting procedural equity	To prevent exacerbating existing inequity, members should be fairly compensated and rewarded for participation.To achieve procedural equity outcomes, representation on implementation committees should be aimed at diversity across demographics, ranks, disciplines, etc. across campus.

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GOVERNANCE		Medium	Low	No	Maybe	No		0.25	STARS includes specific metrics that can enable identification of disproportionate impacts and/or undue burdens, which has the potential to address distributional equity. Identifying what data is missing from STARS reporting may enable better data gathering around inequity. Meaningful engagement through procedural equity should be done with this action.	To ensure equity, consider additional labor and compensation associated with this effort
GOVERNANCE	Ensure all new policies and procedures are created with a lens on environmental and social considerations	High	High	Yes	No	Yes	No	4.00	Incorporating social considerations into policies strengthens the potential to identify and mitigate sources of inequity. In addition to social considerations, an equity and/ or environmental justice lens provides more robust approaches to evaluating policies and has the potential benefit of alleviating environmental and social burdens on marginalized communities within CU thus promoting structural equity.	add definition of environmental justice

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GOVERNANCE	Centralize transportation services and consider aligning with the Capital Improvement Budget	High	Low	No	Maybe	No	No	0.50	A centralization of transportation services tied with the Capital Improvement Budget improves opportunities for transparency around decision-making and increased opportunities for engagement in public transportation. Paired with other efforts, this may enable identification and mitigation of inequity or unintended consequences to ensure structural equity.	

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GOVERNANCE	Incorporate an accountability process for policy implementation and review	High	High	Yes	No	Yes	No	4.00	Promotes procedural equity to foster inclusive and participatory governance.	Consistent and transparent reporting on CAP progress enables community engagement and increases accountability. To ensure procedural equity in this process, communication should be provided in multiple languages with multiple opportunities for input. Specific groups (e.g., frontline staff) may be targeted for additional input in a way that does not overburden them and their input should be gathered through a democratic process. To ensure equity is considered in such communications, reports should include specific metrics around engagement of marginalized groups and distribution of costs and benefits associated with plan implementation

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GOVERNANCE		High	Medium	Yes	No	No		2.50	Comprehensive review, paired with inclusive and transparent reporting, enables opportunities for community engagement and input around plan progress and policies. Such a review should incorporate procedural and distributional equity to identify areas where equity can be improved.	
GOVERNANCE	Request that the Zero Waste Board of Directors manage decision making in a manner that will cause the campus to achieve zero waste by 2030	High	Low	No	Maybe	No	No	0.50	Decision-making around waste management should include meaningful input and engagement from staff involved in waste management, building design and, as appropriate, communities directly impacted by waste production to ensure procedural equity. Decision-making should also consider increased costs and decrease access that may be associated with waste reduction.	

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
GOVERNANCE	Explore a more robust Green Revolving Fund, designed around savings captured from energy efficiency in specific buildings	High	Low	No	No	No	No	1.00	Addressing the distribution of benefits across different buildings and ensuring energy efficiency initiatives are distributed across various areas promote distributional equity. Such a fund provides additional resources to not only fund climate action but also invest in strategies and approaches that support equity.	Attention should be paid to how funds can be used to support additional actions that prioritize programs and improvements targeting marginalized communities.
GOVERNANCE	Prioritize federal, state, and utility incentives and grants	High	Low	No	No	No		1.00	Prioritizing incentives and grants provide additional resources to not only fund climate action but also invest in strategies and approaches that support equity all promoting distributional equity.	Procedural and distributional equity should be used to gather meaningful engagement on fund use and meaningful distribution of benefits across various marginalized communities. Attention should be paid to how funds can be used to support additional actions that prioritize programs and improvements targeting marginalized communities.

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
GOVERNANCE	Follow the implementation plan within the Climate and Energy Scenario Analysis tool	Medium	Low	No	No	No		0.75	Help understand the systemic drivers of climate change and energy issues addressed structural equity.	Training, workshops, and teaching activities around the tool could also be targeted to staff, students, faculty and others within and beyond the campus community, including stakeholders that might be more difficult to engage. To ensure broad and equitable access, provide resources in multiple languages, and use terms that are widely understood. The CESA tool should be regularly updated to provide transparency around plan progress.
GOVERNANCE	Report on the number of traditionally marginalized students holding positions in Student Government or other dedicated sustainability student positions on campus.	Medium	Low	Yes	No	Yes	No	2.75	Providing meaningful leadership opportunities for students from underrepresented backgrounds enhances procedural equity in decision-making. This goal also requires consideration around recruitment and retention of these students and how to fairly compensate and recognize such service. Having diverse leadership opportunities aids in recognition equity.	

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
EQUITY	Encourage campus clubs to identify a sustainability advocate or representative within each club and meet with each other on a regular basis.	Medium	Low	No	No	No		0.75	Improving opportunities for all student groups to engage with sustainability issues on campus may remove some barriers to participation and engagement around CAP implementation. Ensuring support and engagement from student groups serving diverse communities gives additional voice to these students and aids in procedural equity. A strong and diverse coalition of students across campus in these positions furthers collaboration and empowerment and supports distributional equity.	

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
EQUITY	Track Service Learning hours by sustainability and environmental-justice focused partners and increase by 10% by 2025	Medium	Medium	Yes	No	Yes	No	3.25	Strengthening the University's capacity to train students around sustainability and environmental justice increases the potential for engagement and accountability around climate action planning. Working specifically with environmental justice organizations increases capacity for those organizations to achieve their goals and helps identify partners for future climate justice work and helps ensure distributional equity. To increase impact, career pathways and professional development could be aimed at long-term environmental justice work.	To increase impact, career pathways and professional development could be aimed at long-term environmental justice work.

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
EQUITY	Identify a permanent funding model to address DEI on campus	Medium	High	Yes	No	Yes	Yes	4.75	There are many challenges in integrating equity and justice in all aspects of university operations, procedural equity must be used to achieve this goal. Providing ongoing funding through fundraising and submitting grants ensures capacity across sectors of the university and minimizes overburdening those most passionate about DEI work. It also improves our ability to ensure actions around equity are more widely distributed and acknowledges the need to overcome past injustice by strengthening our capacity to address challenges today ensuring structural equity.	

TABLE 1: EQUITY EVALUATION MATRIX[10]

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EQUITY	Stress the need to honor commitments to support Indigenous students and introduce Indigenous knowledge systems into the university's dominant framework.	Low	High	Yes	No	Yes	Yes	4.50	Improving recruitment, retention, and success of Indigenous students and staff combats inequity, builds diversity, and honors the university's land acknowledgement while providing recognition equity. Improving education across campus strengthens our collective capacity to consider, discuss, and address equity implications specific to Indigenous groups in teaching, learning, research, and university operations to ensure procedural equity. Funding is critical to ensuring this capacity is maintained and expanded across campus.	

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EQUITY	Increase the percent of staff, faculty and students trained in climate emergency preparedness to support self-efficacy when responding to a climate emergency situation.	High	Medium	No	No	Yes	No	2.50	Knowledge, resources, and capacity to respond to climate hazards is not consistent across all individuals or groups. Increasing collective capacity on campus and providing training and resources improves everyone's abilities to safely respond to environmental hazards and emergencies, strengthens the university's ability to support those with the lowest capacity and greatest need and ensures distributional equity.	
EQUITY	Ensure resources go to marginalized community members who seek refuge at the Indoor Practice Facility	Low	High	Yes	No	Yes	Yes	4.50	Providing resources to members of the community who may need shelter during emergencies allows the university to aid those most impacted and in need while creating an opportunity to further engage with and support those individuals through distributional equity.	

TABLE 1: EQUITY EVALUATION MATRIX[10]

SECTOR	STRATEGIES	ACHIEVES BROAD DEMOGRAPHIC REACH (HIGH, MEDIUM, LOW)	PRIORITIZES SUPPORT OR RELIEF FOR THE PEOPLE AND COMMUNITIES WHO NEED IT THE MOST AND ARE ALREADY MARGINALIZED, LOWER-INCOME, DISABLED, COMMUNITIES OF COLOR (HIGH, MEDIUM, LOW)	ENGAGES BLACK, INDIGENOUS, AND PEOPLE OF COLOR (BIPOC), AND OTHER UNDERREPRESENTED AND MARGINALIZED GROUPS, INCLUDING PEOPLE WITH DISABILITIES AND LGBTQIA COMMUNITIES (YES/NO)	IGNORES OR WORSENS EXISTING DISPARITIES OR PRODUCE OTHER UNINTENDED CONSEQUENCES ON OR OFF CAMPUS (MAYBE/NO)	PRIORITIZE IMPROVEMENTS, PROGRAMS, AND/ OR CHANGES THAT ADDRESS THE NEEDS OF UNDERREPRESENTED AND MARGINALIZED COMMUNITIES, ON OR OFF CAMPUSES (YES/NO)	CREATES MATERIAL CHANGES (FUNDING OR RESOURCES FOR EQUITY)? (YES/NO) VS. REPORTING, CULTURE CHANGES, IDEOLOGICAL CHANGES	PRIORITY SCORE	EQUITY IMPLICATION (DESCRIBES THE EQUITY IMPLICATIONS OF A GIVEN STRATEGY AND ITS IMPLICATIONS FOR THE 4 EQUITY PATHWAYS - DISTRIBUTIONAL, PROCEDURAL, STRUCTURAL, RECOGNITION JUSTICE)	EQUITY SUGGESTION (PROVIDES SUGGESTIONS TO IMPROVE STRATEGIES IN TERMS OF EQUITY. IDEALLY, THESE STATEMENTS CAN BE MOVED TO ACTIONS EXPLICITLY UNDERNEATH THE STRATEGY.)
EQUITY	Assess how each component of the plan (including goals, strategies, and overall approaches) influence equity and justice across campus and beyond	High	High	Yes	No	Yes	No	4.00	Assessing each component of the plan helps support structural equity around campus and beyond.	Assessments should include engagement from marginalized groups to ensure they are reflective of community needs and concerns to ensure procedural and distributional equity.
EQUITY	Work with the Basic Needs Center	Medium	High	Yes	No	Yes	Yes	4.75	Aligning climate action with other basic needs assessments and provisioning strengthens the university's ability to incorporate justice and equity across operations including food and housing .	A needs assessment will also help identify where inequity exists on campus and how university actions can start to address inequities to start to address structural equity.
EQUITY	Work with Counseling and Psychiatric Services	Medium	Low	No	No	Yes	No	1.75	Mental health remains a challenge for college students and climate anxiety in particular is a growing concern. Not all within the campus community experience these challenges equally and attention should be paid to how climate action on campus can provide additional opportunities to reflect on and attend to mental health to support recognition and distributional equity.	Ensure those affected by historical injustices are prioritized in counseling and psychiatric services

APPENDIX B: TECHNICAL ANNEX

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*

*Natural gas consumption for 2022 was 9,921,220 therms

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

[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

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 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

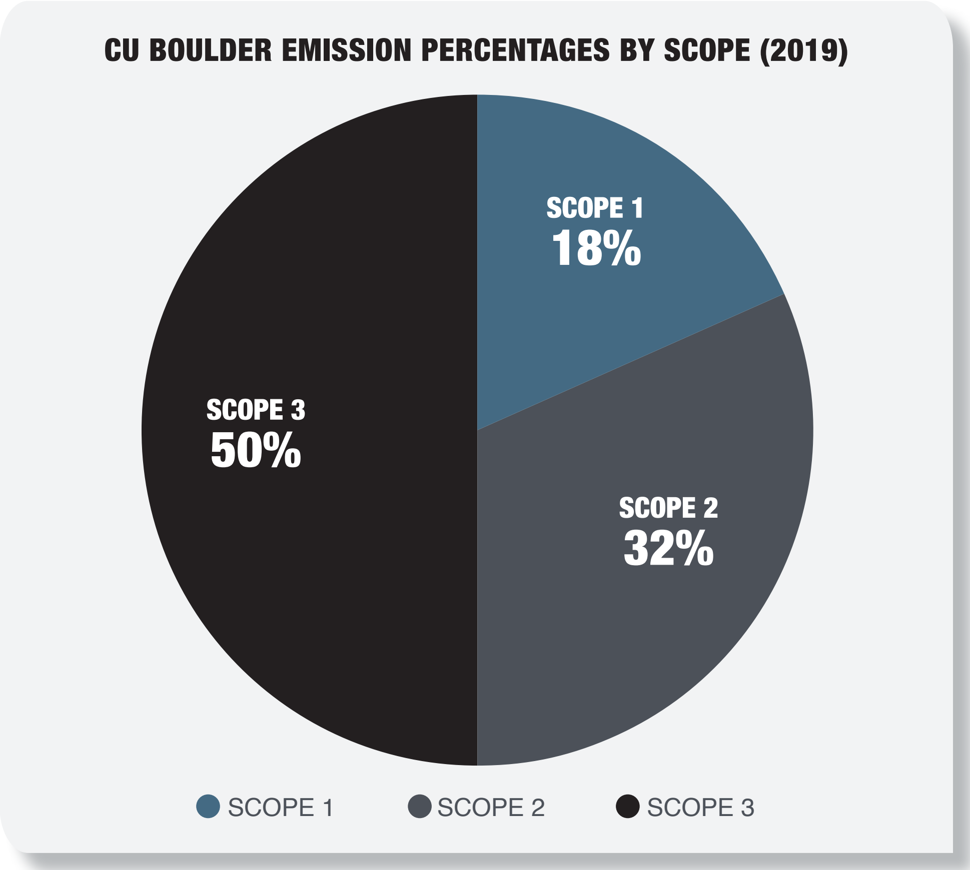
[8] We have used the 100-year GWP of Methane; this choice was not unanimous among the Steering Team members. Using a 100-year GWP (Global Warming Potential) for Methane provides a longer-term perspective, reflecting the cumulative impact of the gas over a century, which can be more consistent with long-term 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..

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. However, we were able to collect accurate data for 2022 natural gas consumption. This was included in the Business as Usual benchmark, so we could model the full reduction of gas usage on campus. 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]

FIGURE 1: EMISSIONS BY SCOPE[11]



[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 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.

FIGURE 2: SCOPE 1 AND 2 EMISSIONS BY SOURCE[12]

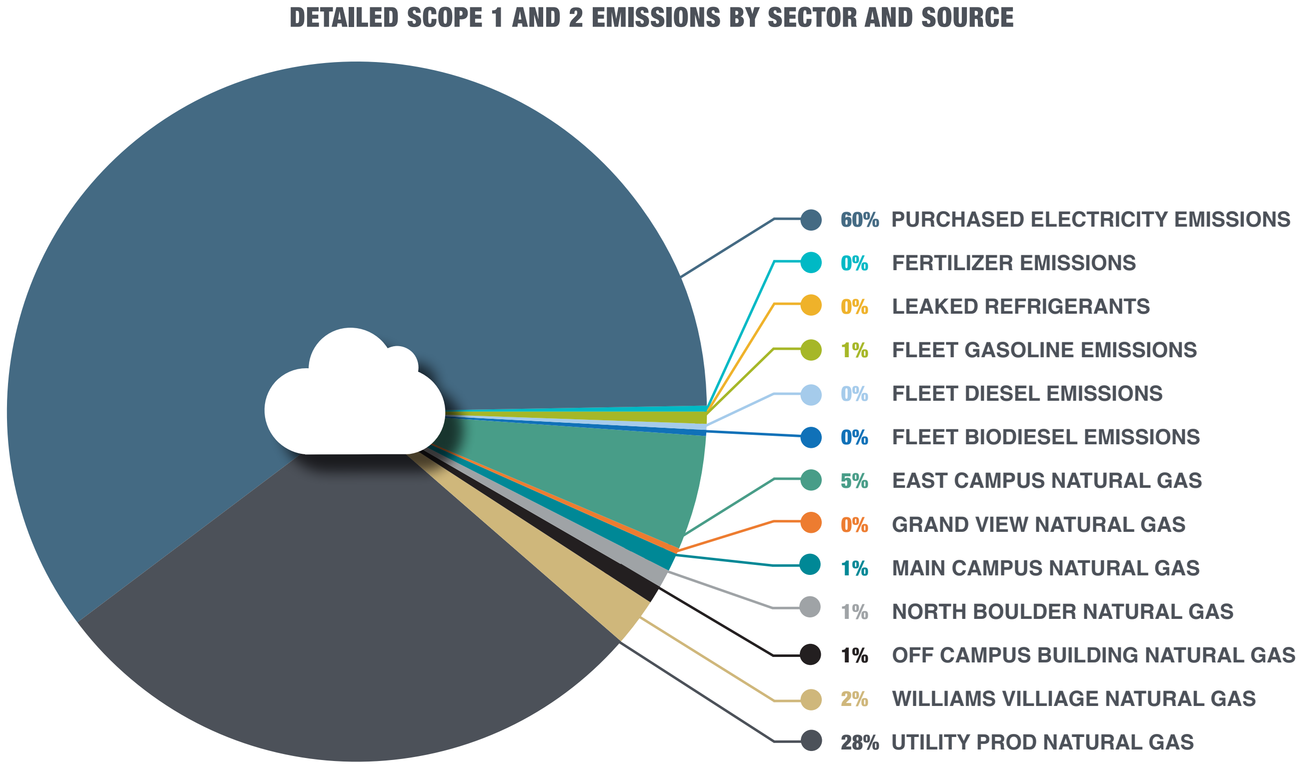
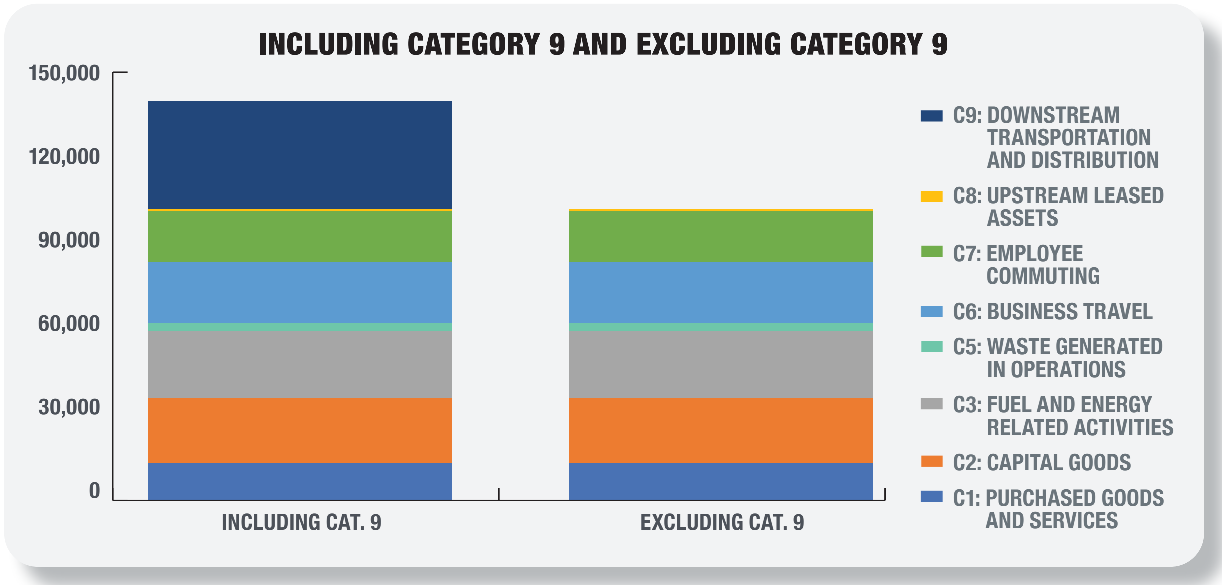


FIGURE 3: SCOPE 3 EMISSIONS BY CATEGORY[13]



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

[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.

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.

Year	Scope 1 & 2 Emissions (MTCO2e)	2030 Scopes 1 & 2 Resulting Emissions - 50% Reduction (MTCO2e)
2005	135,609	67,805
2019	130,741	65,370

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).

[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.

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. Importantly, the BAU 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. The BAU includes a growth rate of 1.3% in campus footprint, beginning in 2035; prior to this date, it includes planned capital building projects. This growth was reflected in increased gas and electricity use, as well as increased demand from the Central Heating System.

An annual growth rate was also applied for certain Scope 3 categories. Specifically, a 1.0% growth rate was factored in for all commuting miles. The 1.3% growth rate of campus square footage was included in the Capital Goods category to establish the reductions of embodied carbon for new buildings.

A "Science-Based Target" (SBT) was also included as a benchmark. An SBT is a target that refers to the emission pathway for an organization, such that it performs its role in reducing global temperature rise to less than 1.5°C. The science-based target for CU Boulder was calculated using the downloadable calculator available from the Science Based Target Initiative (SBTi).[16] There are long term goals and short-term goals aligned with SBT. The short-term goal for CU would be a target of 67.2% reduction by 2035,[17] 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.

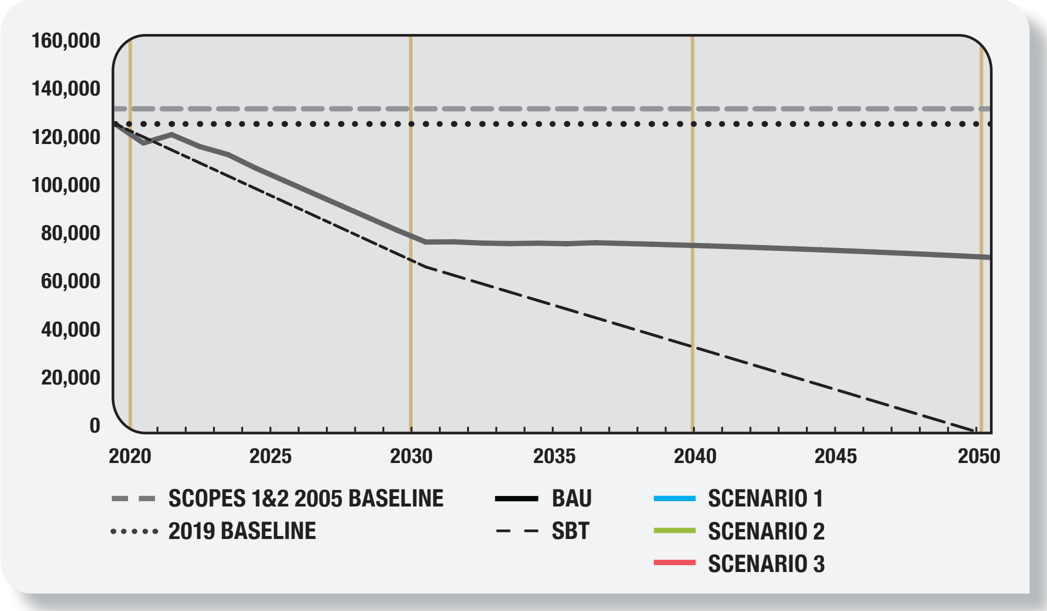
TABLE 5: BENCHMARK DESCRIPTIONS

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

[16] 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.

[17] As reported by the Science-Based Target Setting Tool Version 2.2 with the Absolute Contraction Approach.

FIGURE 4: FIGURE SHOWING BASELINE,BAU BENCHMARKS, AND TARGETS



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.

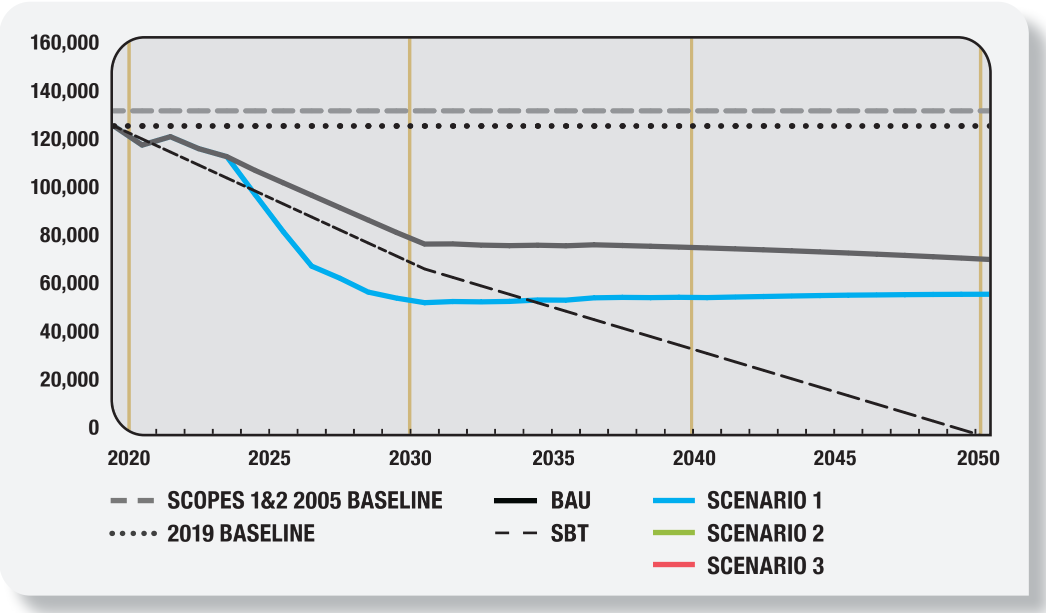
TABLE 6: PROJECT TYPES AND SIMPLE PAYBACK PERIODS

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.[18]

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 leave CU Boulder behind its target. These results are illustrated in Figure 5.

FIGURE 5: GHG REDUCTIONS RESULTING FROM ENERGY EFFICIENCY PROJECTS



[18] 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.[19]

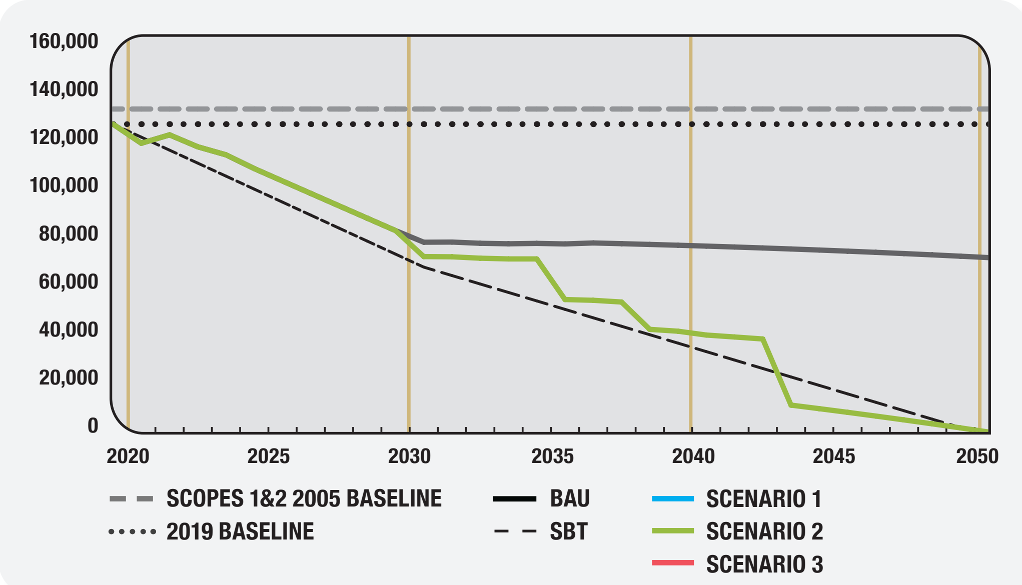
Results of the heating system study, including specific costs of equipment and timing of investment, were not available for this CAP. The upgrade will be very expensive and impact major portions of building operations across the campus. While electric boiler replacements are relatively expensive, the 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.[20]

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, annual target. The series of projects falls behind emission targets in future years, without the additional implementation of the building efficiency projects.

[19] 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.

[20] 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 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.

FIGURE 6: GHG SAVINGS FROM CENTRAL PLANT PROJECTS COMPARED TO BAU AND OTHER BENCHMARKS



NON-CUP DISTRIBUTED ENERGY DECARBONISATION PROJECTS

According to CU Boulder's Energy Master Plan, the central utility plant presently accounts for 80% of natural gas consumption, leaving the remaining 20% to be addressed by decentralized natural gas distribution decarbonization projects. When initiated, these conversions are projected to save 1.9 million therms of natural gas annually.

Given the complexity and uncertainties surrounding project timelines and costs, this plan aggregates the implementation timeline into a single-year framework, without offering a cost estimate.

RENEWABLE ENERGY:
ON-CAMPUS SOLAR PV INSTALLATION

The first strategy evaluated was renewable energy.[21] 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 achieve its intended reduction goals. Even the most accelerated investment pathways do not substantially change emission outcomes.

[21] 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).

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

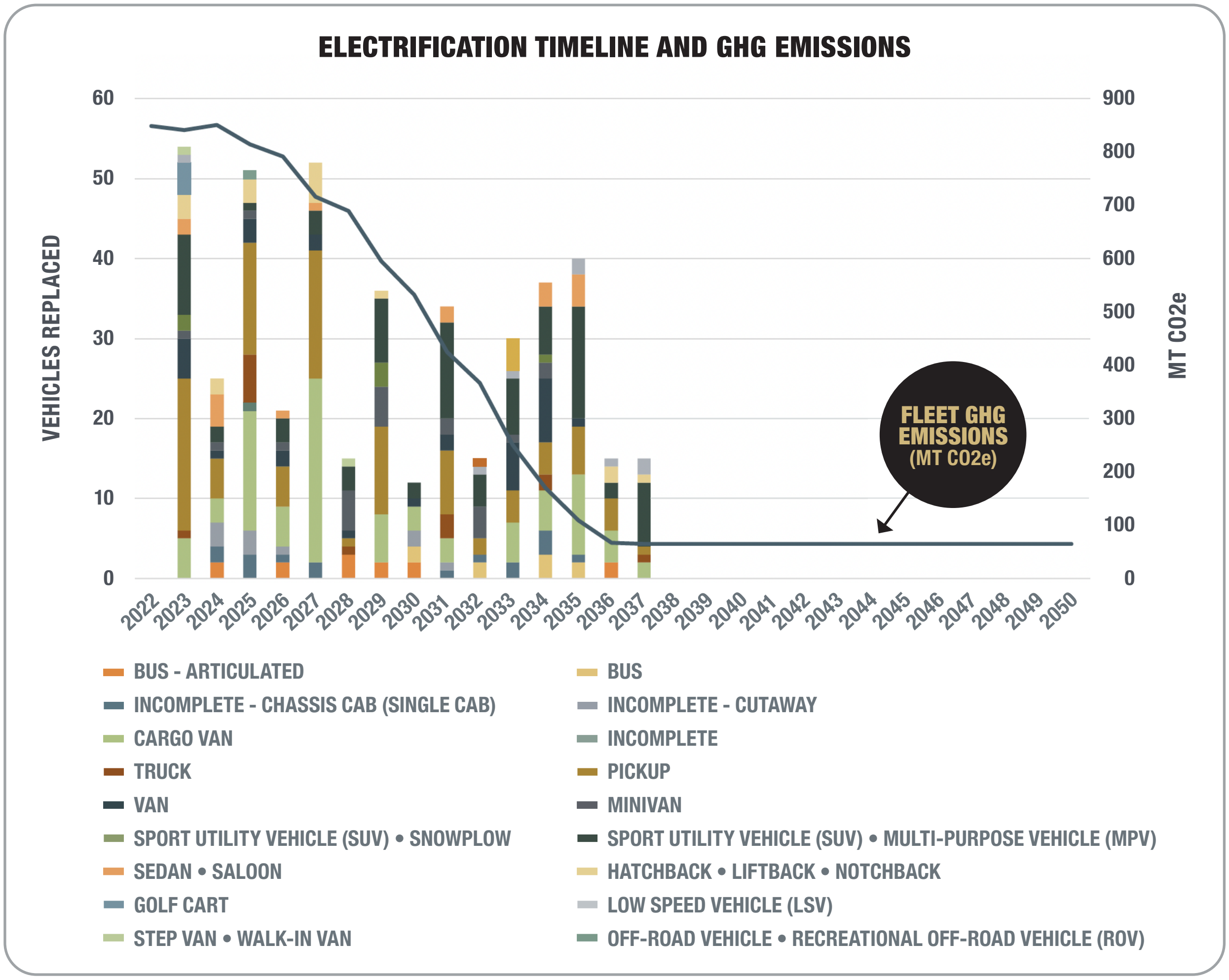
This is not to say that renewable energy installations should not be pursued. The CU Boulder Energy Master Plan highlights the importance of resilience for the campus, which it defines as, "the ability of energy systems to prepare for and adapt to changing conditions and withstand and recover rapidly 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.[22]

[22] CU Boulder Energy Master Plan. 2022.

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 (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.

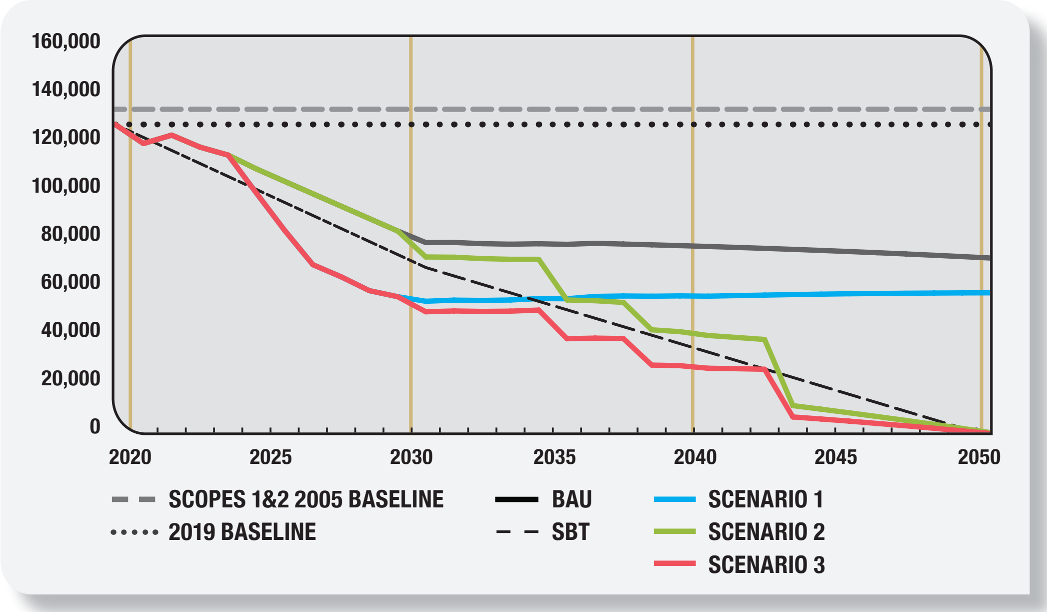
Scenario analysis using the Climate-Energy Scenario Analysis Tool

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 annual targets 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 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 reduced[24]	Energy Efficiency (EE) Measures $/MT CO2e reduced	Renewable Energy (RE) Measures $/MT CO2e reduced	Vehicle Fleet (VF) Replacement Measures $/MT CO2e reduced	Heating System Upgrade (HSU) Measures $/MT CO2e reduced
BAU	--	--	--	--	--
1: All projects (EE, RE, Fleet) except HSU	$12.06	$131	($149)	($2,538)	$52[25]
2: Only HSU	($735)	$76.99	-	-	($893)
3: Scenario 1 plus HSU	($521)	$109.06	($149)	($2,538)	($715)

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.

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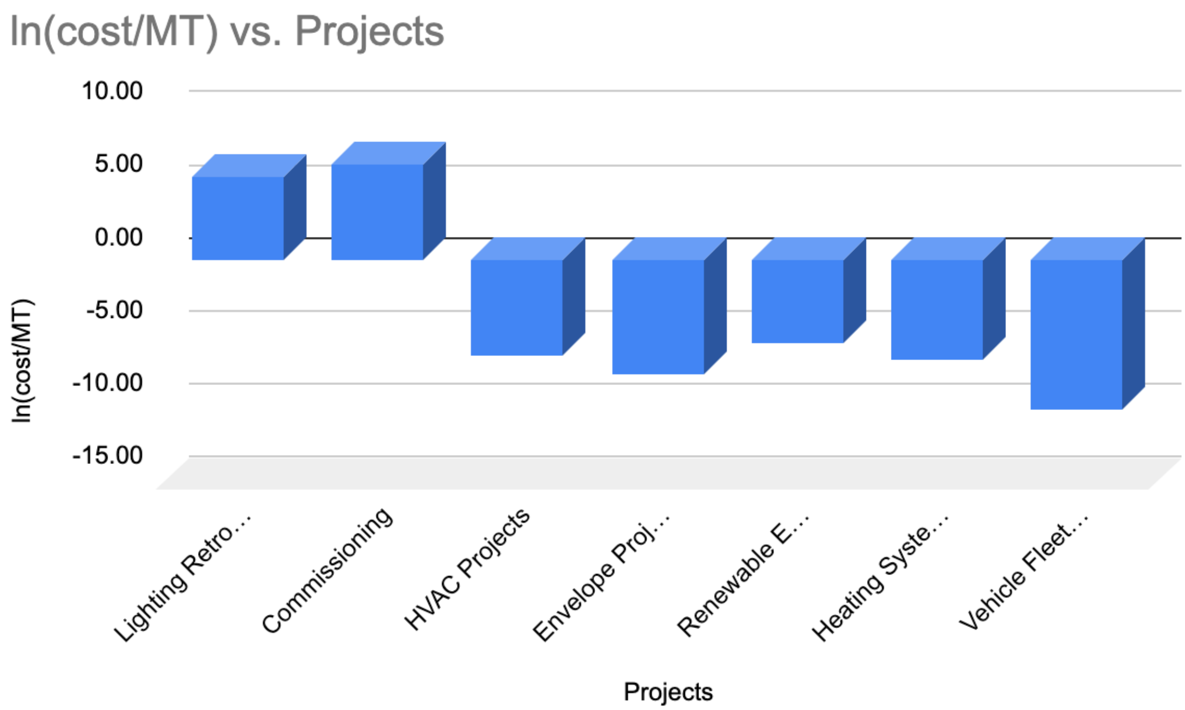
[23] The numbers in this column are not the sum of numbers in the other columns because each strategy.

[24] Savings from Central Plant are the result of the EE projects.

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.

TABLE 9: SCENARIO AND STRATEGY NPV

Scenario name	Scenario NPV ($)	EE NPV ($)	HSU NPV ($)	RE NPV ($)	VF NPV ($)	Total investment ($m)
BAU	$0	$0	$0	$0	$0	$0
Scenario I	$6,337,621	$26,275,797	$17,424,376	($3,008,412)	($34,354,140)	$210
Scenario II	($630,559,186)	$0	($630,559,186)	$0	$0	$1,250
Scenario III	($611,318,140)	$49,852,726	($623,808,314)	($3,008,412)	($34,354,140)	$1,460

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[25], and a 3% annual escalation rate has been included.[26] For electricity, the starting value was $0.078/kWh[27], and a 3% annual escalation.

ADDITIONAL ANALYSIS

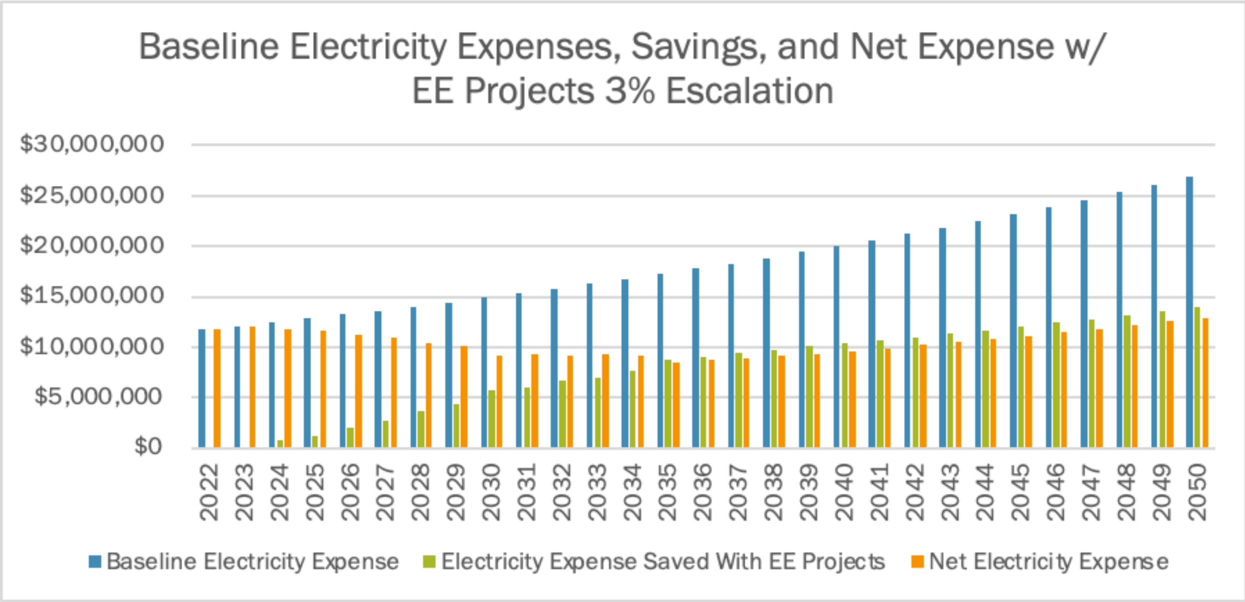
Some energy efficiency projects are expected to net energy savings against a baseline. The following figure shows baseline energy expenses, savings from implementation of EE projects, and net annual electricity expenses for the analysis period. An annual escalation rate of 3% has been added to electricity 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.

25 From CU Boulder campus.

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

27 From CU Boulder campus.

FIGURE 11: COMPARISON OF WITH- AND WITHOUT- EE PROJ-



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)[28], the average cost to reduce each MT of CO2e, 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 $650 million to $1.25 billion. Further, since

[28] 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.

there is no definitive schedule for construction, the total has been divided into five equal portions, each portion being "implemented" incrementally.[29] 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.

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.

Within the body of the climate action plan, there are references to "investment amounts" for specific projects within tables 12, 13, 14, 15, and 18. These figures are estimating the one-time construction costs for the indicated projects. For the figures there are no calculations regarding inflation, and are in 2023 dollar amounts. This is different to the scenario investments which utilize an inflation rate of 3%.

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 $m (incl SCC)	Ave. NPV (SCC)/MT Reduced	Total GHG Reduced (MTCO2e)
Energy Efficiency	101.4	101.4	9.0	36.7	57.4	1.0	197,629.00
Lighting Retrofits	31.9	31.9	2.8	23.1	31.8	315	82,336
Envelope Projects	7.2	7.2	0.6	-4.3	-4.0	-2,488	2,969
Commissioning	3.6	3.6	1.8	2.3	2.7	699	3,887
HVAC Projects	58.7	58.7	5.2	6.8	16.2	-670	90,073
Vehicle Fleet Replacement	18.3	18.3	NA	-16.3	-15.7	-27,150	5,273
Renewable Energy	NA (PPA)	NA (PPA)	NA	-3.0	0.7	-298	20,066
Heating System Upgrades	125.00	250	14-27	-173.2	-157.2	-877	138,348
Decade Total Cost ($m)	245	370	10	-165	-125	-30,469	342,952
Average cost per year ($m)	41	62	2	-27	-21	-5,078	57,159

[29] 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.

TABLE 11: ESTIMATED IMPLEMENTATION OF PROJECTS RECOMMENDED FOR 2031-2040

Projects for Implementation 2031-2040							
Project	First Costs ($m) low	First Costs ($m) high	Cost per Sq Ft ($)	NPV ($m)	NPV in $m (incl SCC)	Ave. NPV (SCC)/MT Reduced	Total GHG Reduced (MTCO2e)
Energy Efficiency	16.5	16.5	1.5	-10.4	10.2	-8217	2781
Lighting Retrofits	NA	NA	NA	NA	NA	NA	NA
Envelope Projects	16.5	16.5	1.5	-10.4	10.2	-8217	2781
Commissioning	NA	NA	NA	NA	NA	NA	NA
HVAC Projects	NA	NA	NA	NA	NA	NA	NA
Vehicle Fleet Replacement	8.5	8.5	NA	-6.2	-5.8	-25,534	5,434
Renewable Energy	NA	NA	NA	NA	NA	NA	NA
Heating System Upgrades	262.50	500.0	30-57	-265.1	-243.9	-980	256,118
Decade Total Cost ($m)	288	525	1	-282	-240	-34,731	264,333
Average cost per year ($m)	28.8	52.5	0.1	-28.2	-24.0	-3,473	26,433

TABLE 12: ESTIMATED IMPLEMENTATION OF PROJECTS RECOMMENDED FOR 2041-2050

Projects for Implementation 2041-2050							
Project	First Costs ($m) low	First Costs ($m) high	Cost per Sq Ft ($m)	NPV ($m)	NPV in $m (incl SCC)	Ave. NPV (SCC)/MT Reduced	Total GHG Reduced (MTCO2e)
Energy Efficiency							
Lighting Retrofits	NA	NA	NA	NA	NA	NA	NA
Envelope Projects	NA	NA	NA	NA	NA	NA	NA
Commissioning	NA	NA	NA	NA	NA	NA	NA
HVAC Projects	NA	NA	NA	NA	NA	NA	NA
Vehicle Fleet Replacement	15.8	15.8	NA	-11.9	-11.7	-245,216	2,825
Renewable Energy	NA	NA	NA	NA	NA	NA	NA
Heating System Upgrades	262.50	500	30-57	-188.0	-159.9	-747	462,928
Decade Total Cost ($m)	278	516	0	-200	-172	-245,963	465,753
Average cost per year ($m)	27.8	51.6	0	-20	-17	-24,596	46,575

Total implementation investment has been estimated as follows:

TABLE 13: TOTAL COST ESTIMATE TO IMPLEMENT SCENARIO 3

Total Program Cost ($m)	811	1,411
Average Program Cost per year ($m)	31.2	54.3

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	369.7	31.9	7.2	3.6	58.7	18.3	N/A PPA	250.0

APPENDIX C:

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 them through its operations, procurement and other activities. This Annex contains a summary of Scope 3 emissions, followed by a detailed account of CU Boulder's inventory approach for each scope 3 category. It also describes the intent of the Campus relative to Scope 3 inventory and targets, and a series of concrete steps CU Boulder can take to achieve its goals and improve the inventory and target setting in future years.[1]

Importantly, CU Boulder is not seeking to establish a science-based target at this time, nor is it seeking full conformance with the GHG Protocol Scope 3 Standard. Currently, SBTi does not include universities in its target validation program.[2] We have sought guidance from these Protocols 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.

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, especially 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.

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[1] This inventory does not include CU Athletics, which is a separate organization from CU Boulder Campus.

[2] SBTi. Who is Eligible to Join the SBTi". https://sciencebasedtargets.org/how-it-works. 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.

When a company's or institution's Scope 3 emissions account for more than 40% of their total emissions, 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 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.”[3]

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 CU Boulder 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 CU Boulder has limited influence to affect emissions.

[3] Science Based Targets. 2020. Science-Based Target Setting Manual.

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.[4] 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.

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] GHG Protocols

Table 1: 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[5] 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[6] 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 included in Category 1	2
5	Waste generated in operations	2,595	Disposal and treatment of waste generated	Direct data obtained	3
6	Business travel	19,954	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	35,189	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[7]
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[8]	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	Estimate; Data are not transparent at a University system level (University of Colorado)	1[9]

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

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

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

[8] Category 1 includes lifecycle emissions of sold products, which includes end-of-life treatment.

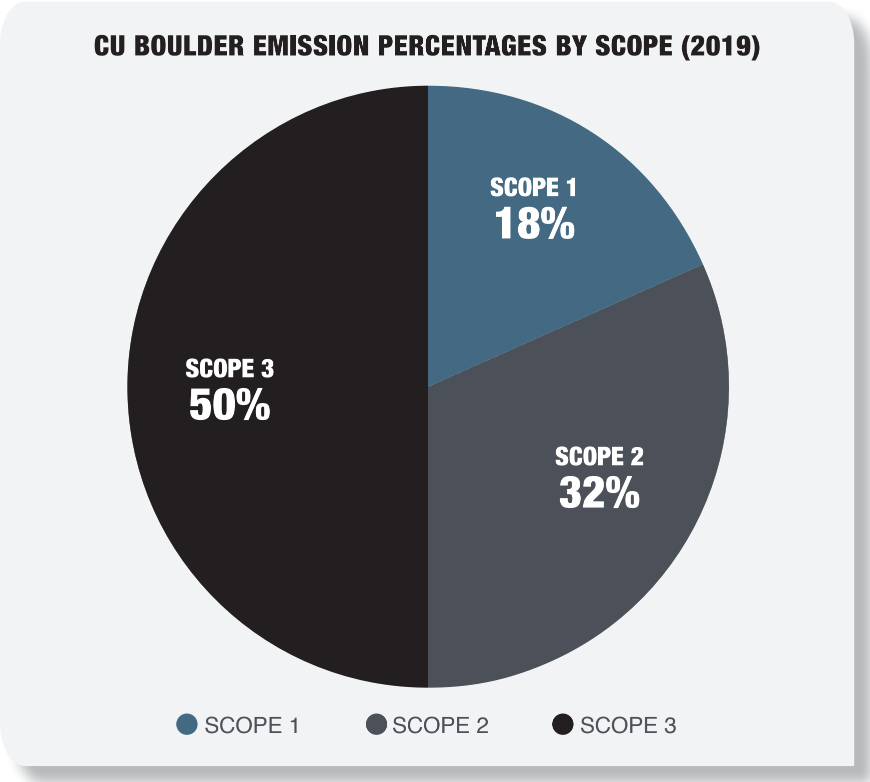
[9] Investments are managed at the University system level (University of Colorado), which further outsources to the CU Foundation. CU Boulder does not control or advise on the investment portfolio.

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.[11] Figure 1 shows the breakdown of measured Scope 3 emissions for CU Boulder in 2019.

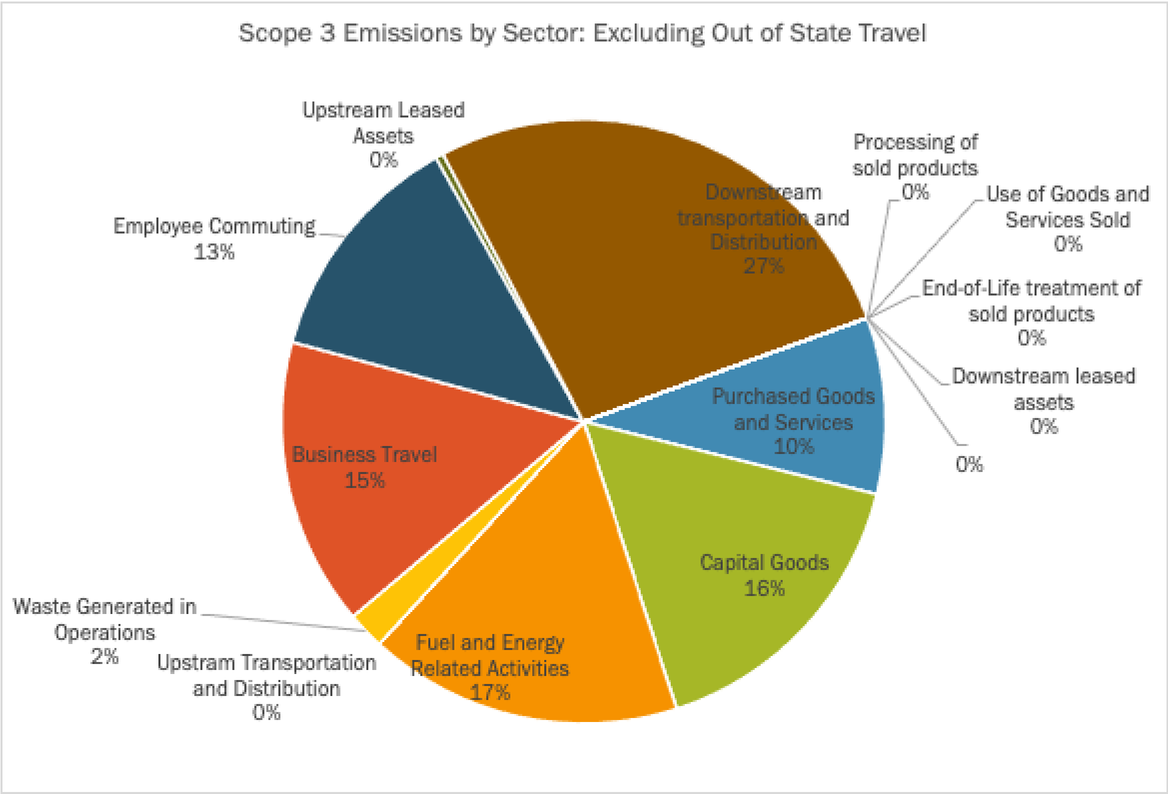
FIGURE 1: REPORTED EMISSIONS BY SCOPE



[11] 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 1 shows the 2019 breakdown by category. The primary contributor is out of state travel (Downstream transportation and distribution), followed by Fuel and energy related activities (FERA), capital goods and paid air travel.

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[12]:

- 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.
- 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 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.

[12] SBTi Guidance.

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.[13]

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.[14] 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[15]	5,400,486	0.187	1,010
Athletics, Apparel and Linen[16]	9,472,393	0.188	1,781
Books, subscriptions and library services[17]	17,640,772	0.737	3,299
Food related products and service[18]	20,783,109	0.155	3,221
IT hardware and maintenance[19]	5,400,486	0.183	2,905

[13] As an example, Stanford University has counted 1,065 Stanford-defined categories, and measured Category 1 emissions at 402,153 MTCO2e.

[14] https://ghgprotocol.org/sites/default/files/2022-12/Chapter1.pdf

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

[16] Emission factor from: https://www.climatiq.io/data/explorer?search=clothing&data_version=4.4

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

[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

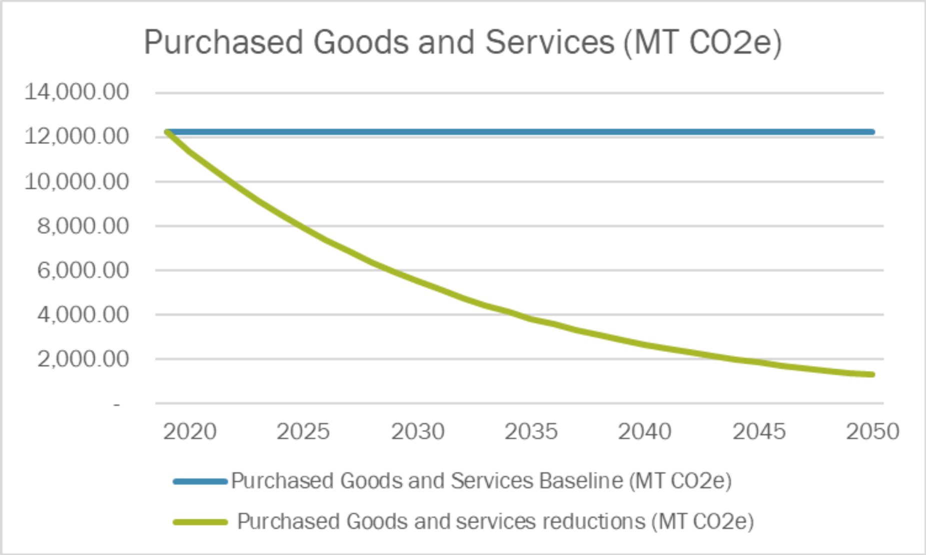
Reducing emissions in this category will mean making strategic decisions in the selection of suppliers, and engagement with existing partners. The process will need to begin by developing an emissions total based on supplier's actual emissions, rather than on spend data. CU Boulder will be gradually 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.

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

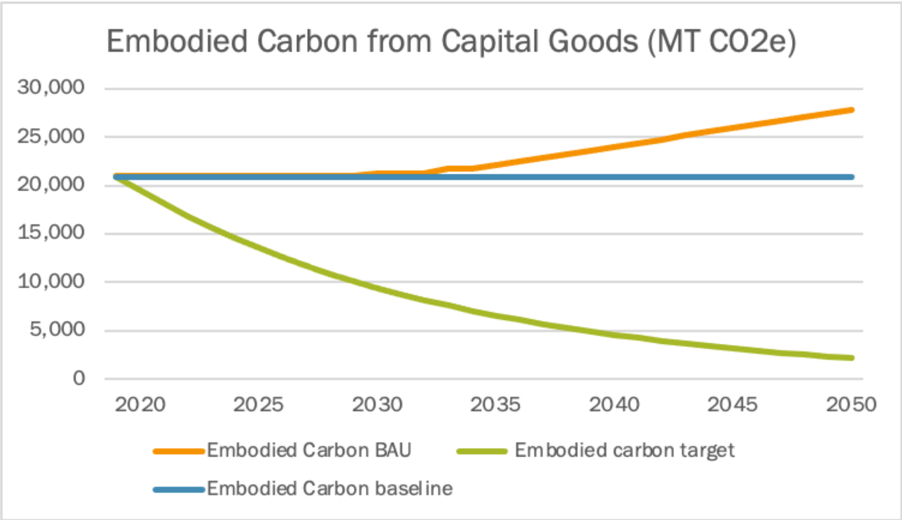
CATEGORY 2: CAPITAL GOODS. These emissions include those produced in the extraction, production, and transportation of capital goods purchased or acquired. In the absence of a thorough record of all capital goods, the analysis included construction of CU building stock and campus fleet purchases. To 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[20] 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.

[20] Rocky Mountain Institute. 2011. "Green Footstep; Calculations and data sources." P 13.

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 demand of steel, aluminum, cement, and plastic.[21] 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[22] or ILFI ZC[23] methodologies)
- Prioritize low carbon construction techniques
- Align with Buy Clean Colorado
- Update targets annually

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

[22] 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.

[23] 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.

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%.[24] 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.[25] 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 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.

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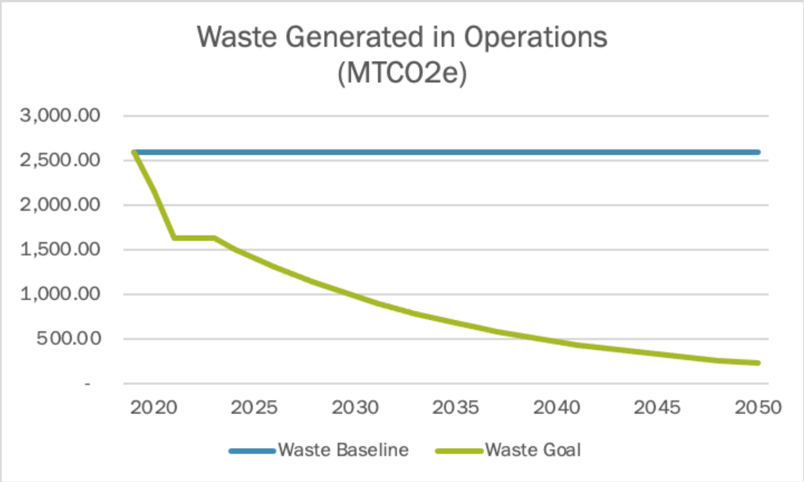
[24] Disclosure by VitalMetrics https://sustainable.stanford.edu/sites/g/files/sbiybj26701/files/media/file/scope-3-emissions-from-fuel-and-energy-activities-march-2023.pdf

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

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 Recycling Operations Center (ROC) 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

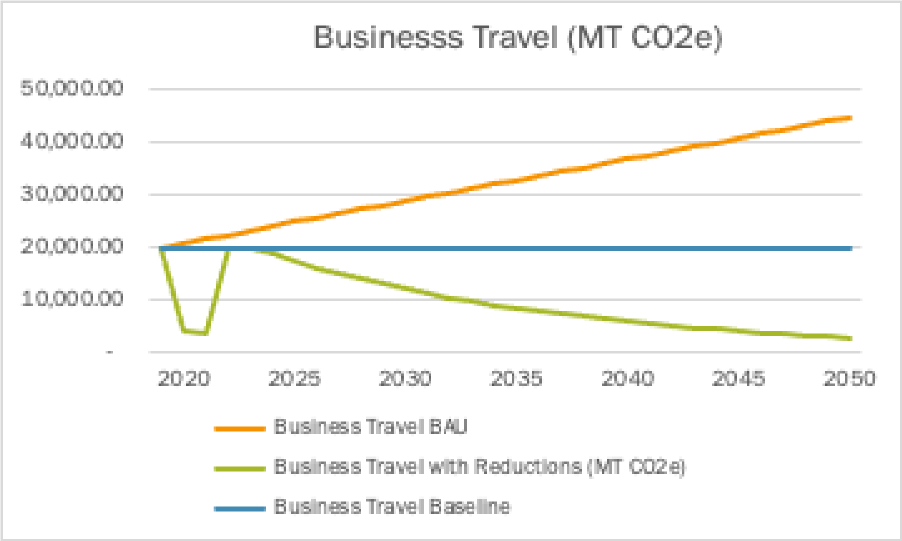
Waste management can disproportionately expose low-income communities, communities of color, and other marginalized communities to environmental hazards from landfills and pollution. Accordingly, the University is collaborating with waste management authorities and community organizations to ensure responsible 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 0.130 kg/mile traveled (EPA, medium-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.[26] 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.

FIGURE 6: PAID BUSINESS TRAVEL AND POTENTIAL REDUCTIONS



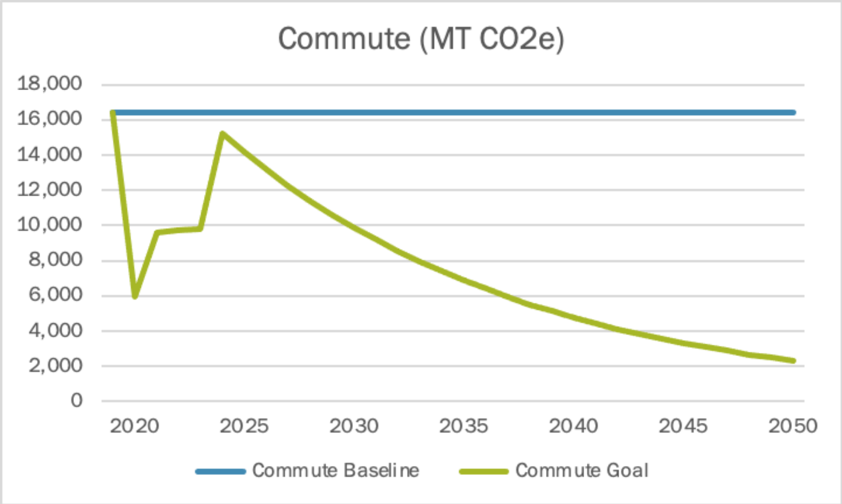
[26] Stanford University has adopted a value of 2.7 and published this comparison of values: https://sustainable.stanford.edu/sites/g/files/sbiybj26701/files/media/file/s3-radiative-forcing-rfi-memo_public.pdf.

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.[27]

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.

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

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 35,000 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.[28]

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.[29] The CU Boulder 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.[30] This category is relevant to producers of goods and services that directly cause emissions from their use. As an educational institution, CU Boulder does not fit this profile, and this category has not been included.

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[28] 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 a 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.

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

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

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.[31] CU Boulder 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.[32] CU Boulder 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.[33] CU Boulder does not grant such licenses, and therefore this category has not been included.

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

[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.

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[34] 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.[35] 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).[36] This has been the approach to approximate CU Boulder'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.[37] 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 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 CU Boulder vs. 66,000 students system-wide). Under this assumption, CU Boulder's share of the fossil fuel investments would be $146 million (=0.54*$270 million).

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[34] 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.

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

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

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

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,[38] meaning CU Boulder'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,[39] meaning CU Boulder'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.

CU ATHLETICS

For this iteration of the CAP, Scope 3 emissions of 6,474 MTCO2e[40] from Athletics have not been included in the formal inventory. Analysis on the disaggregation of these emissions into the 15 categories of Scope 3 was not completed in time for the CAP's publication, but will be a priority for the Scope 3 Action Plan. Scope 3 Emissions reported by the Athletics department includes: athletes travel, waste disposal, material use, sponsorship and advertising, construction and operation, and "other" emissions. Relevant categories that are not included are: fan travel, shipment of goods, merchandise and equipment production, and investments.

TARGET REDUCTIONS

CU Boulder 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.

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

[39] 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.

[40] CU Boulder Reporting Questionnaire to the Sports for Climate Action Framework. 2022.

[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.

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. However, EV adoption rates of new vehicles will not abate emissions from the stock of existing vehicles on the road. Instead, additional strategies will need to be developed in concert with commuters, public transit authorities, and many others. To illustrate the pathway to zero Scope 3 emissions, 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 could 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.

FIGURE 8: SELECTED SCOPE 3 CATEGORIES AND TARGETS

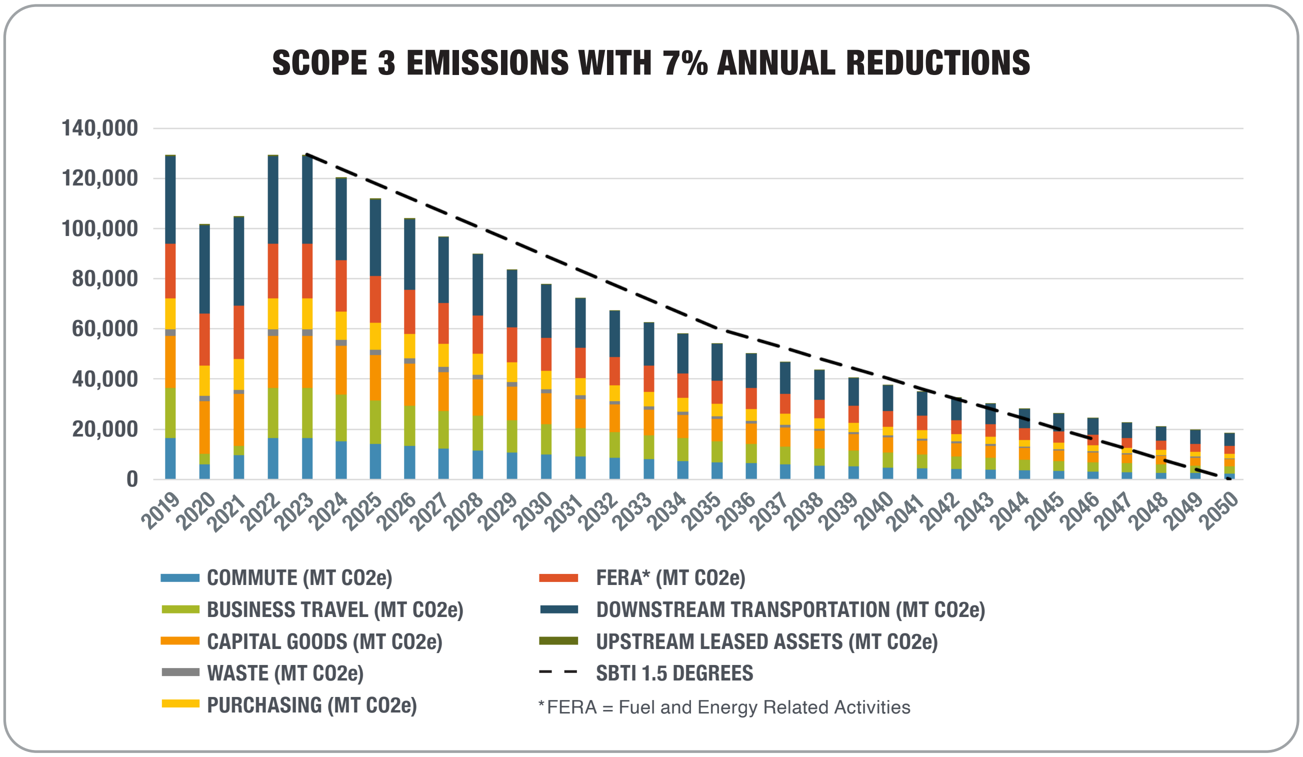


TABLE 4: EMISSION FACTORS FOR SCOPE 3

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	0.1302368	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 Carbon[49]	367	9.4	vehicle	3,449	IEA Data
ICE Embodied Carbon[50]	367	6	vehicle	2,502	IEA Data
RFI[51]		2.7	NA	i.e	UNFCCC Guidance

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

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).

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.

APPENDIX D:

RENEWABLE ENERGY METHODOLOGY AND ASSUMPTIONS

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.

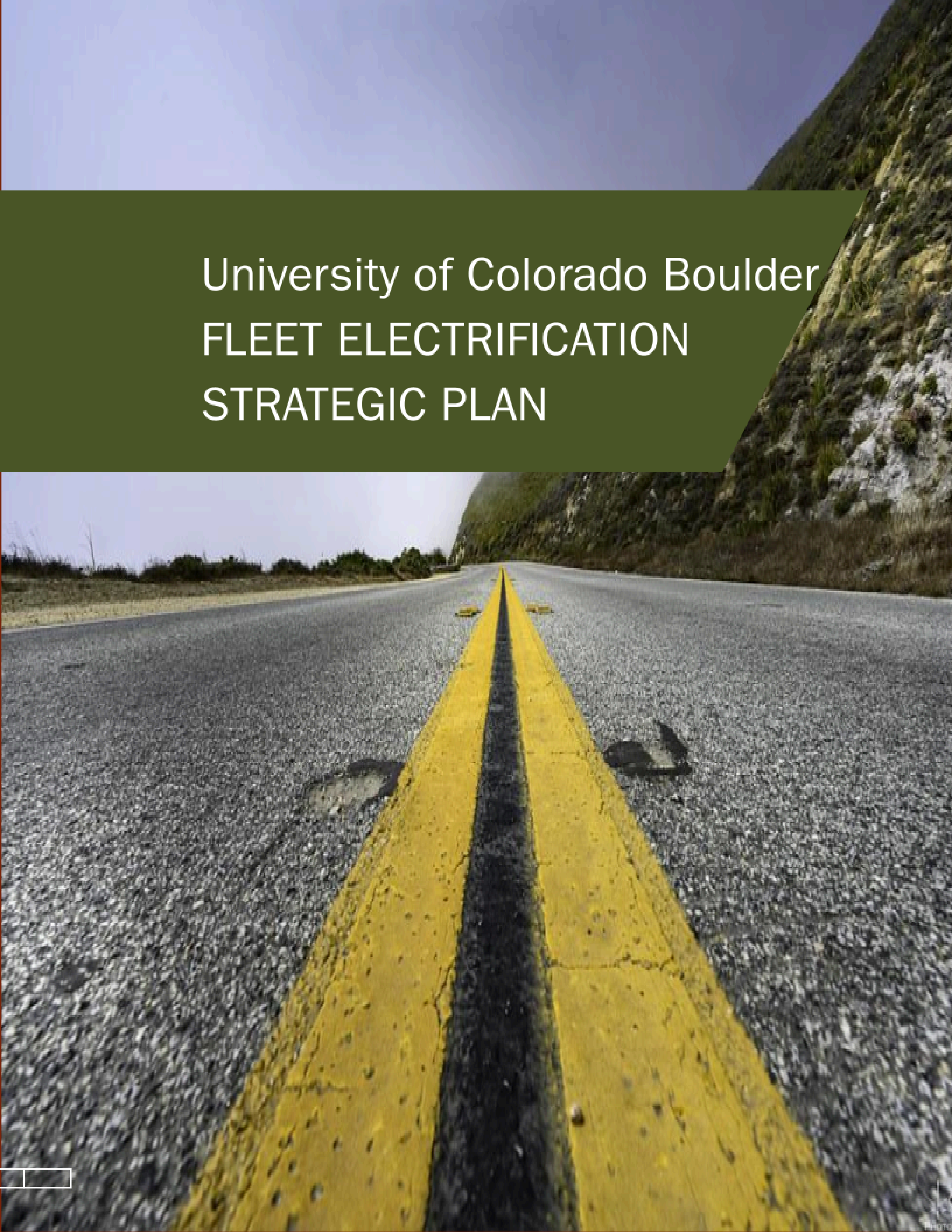
PVT PRICING

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.

APPENDIX E:

FLEET ELECTRIFICATION STRATEGIC PLAN

University of Colorado Boulder FLEET ELECTRIFICATION STRATEGIC PLAN



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March 2023

Cover photo by Robert Smrekar on Flickr.

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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 %)	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

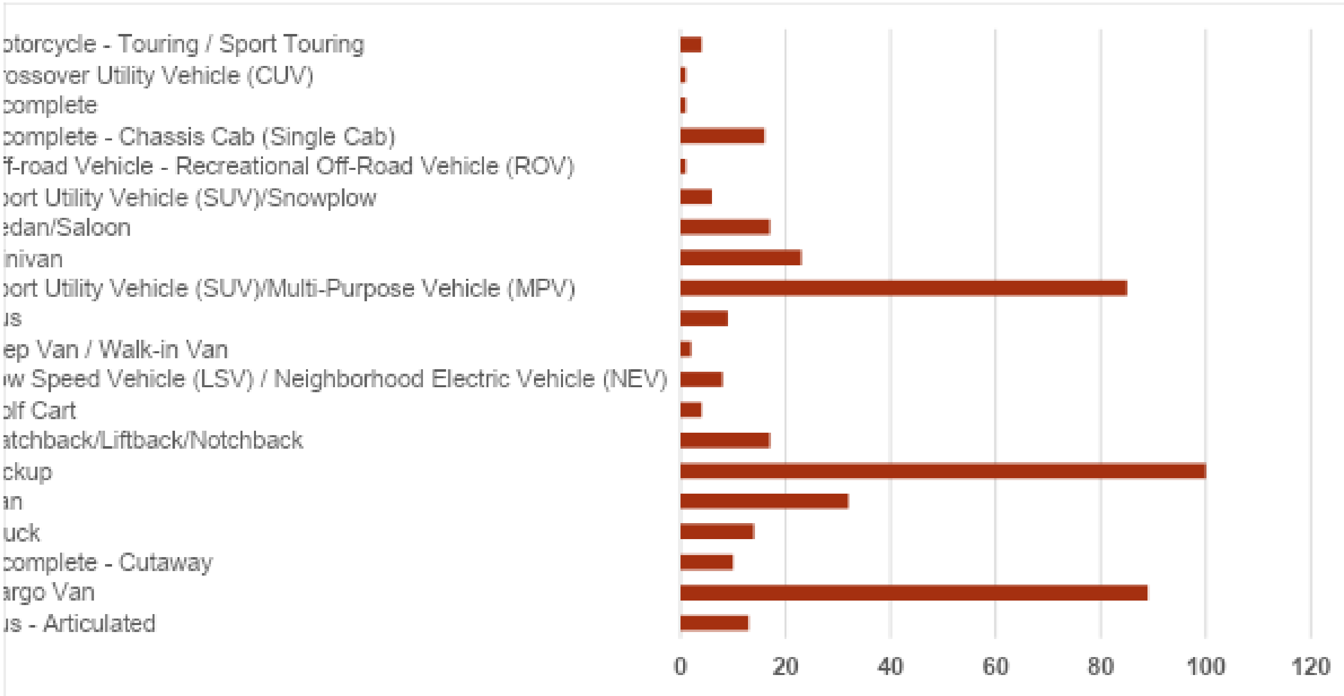
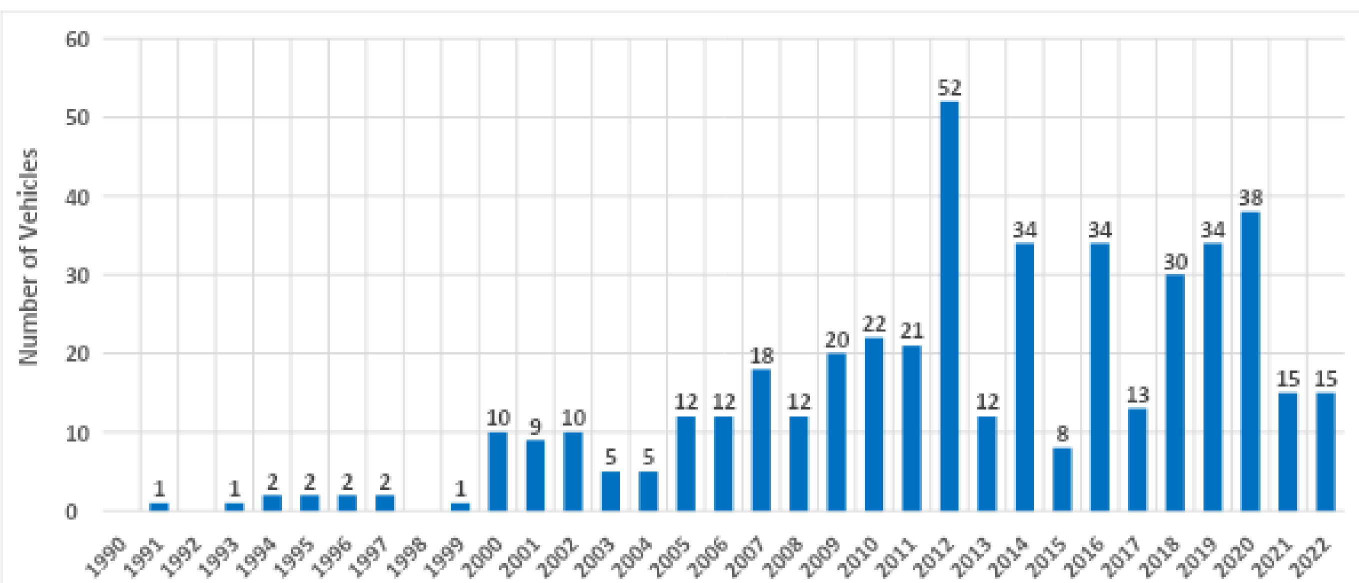


Figure 3 shows a count of all vehicles by their model year. Newest model years are shown first, followed by progressively older model years from left to right.

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

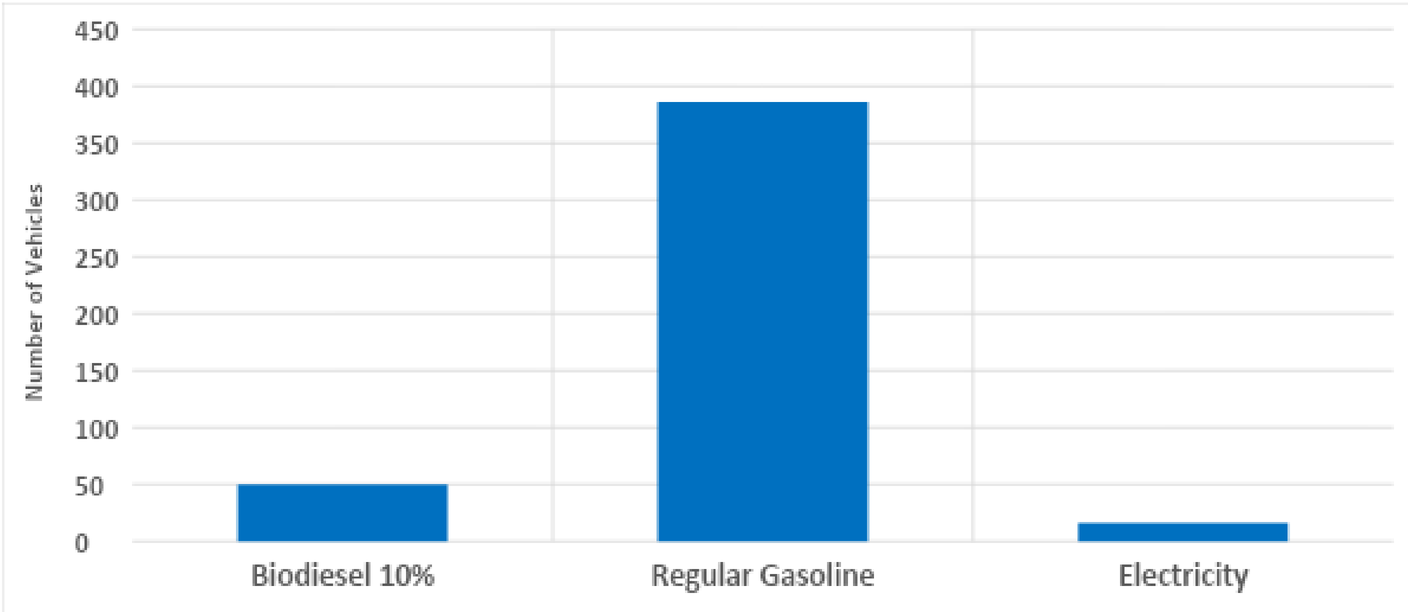


Table 1 summarizes the entirety of the University's fleet and includes the number of assets in each University department, total annual mileage, and average annual vehicle mileage by department. Among the University's various departments, the Facility Management Department has the largest fleet with 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.

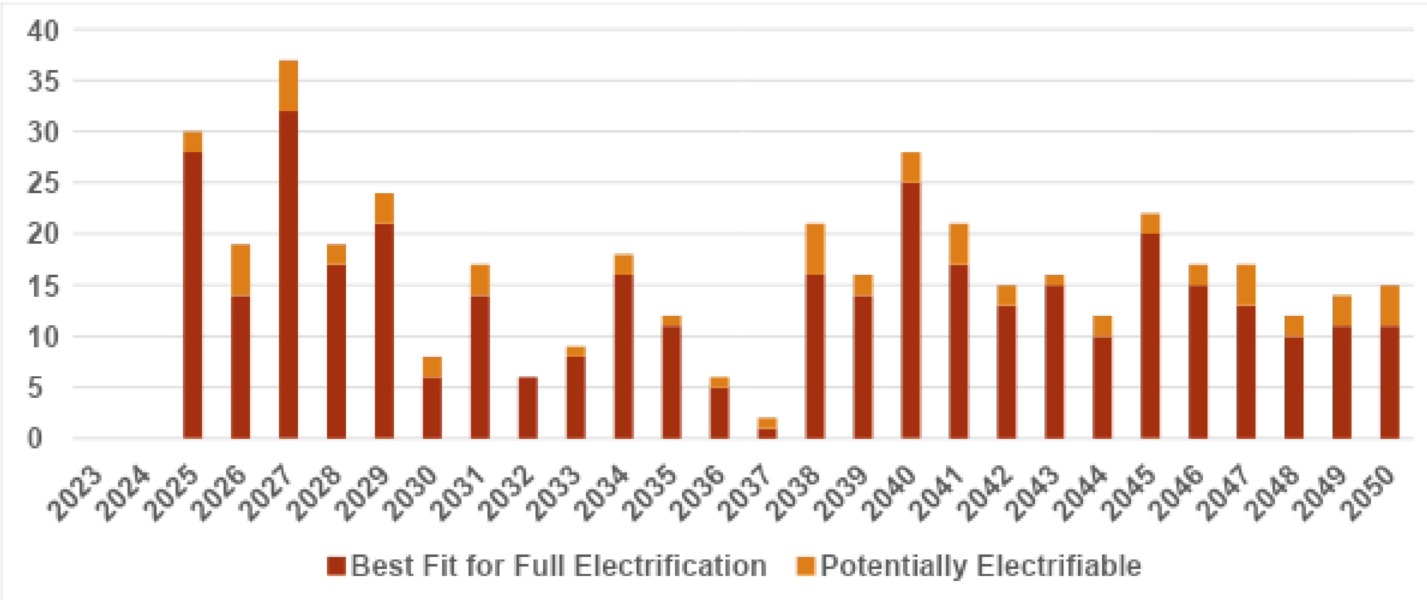
While the Fleet Electrification Methodology is presented as a linear process, in order to have the highest confidence in its procurement decisions and to adapt to an evolving market, it is recommended that Step 2 and Step 3 (above) are completed each year as the vehicles in the electrification timeline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

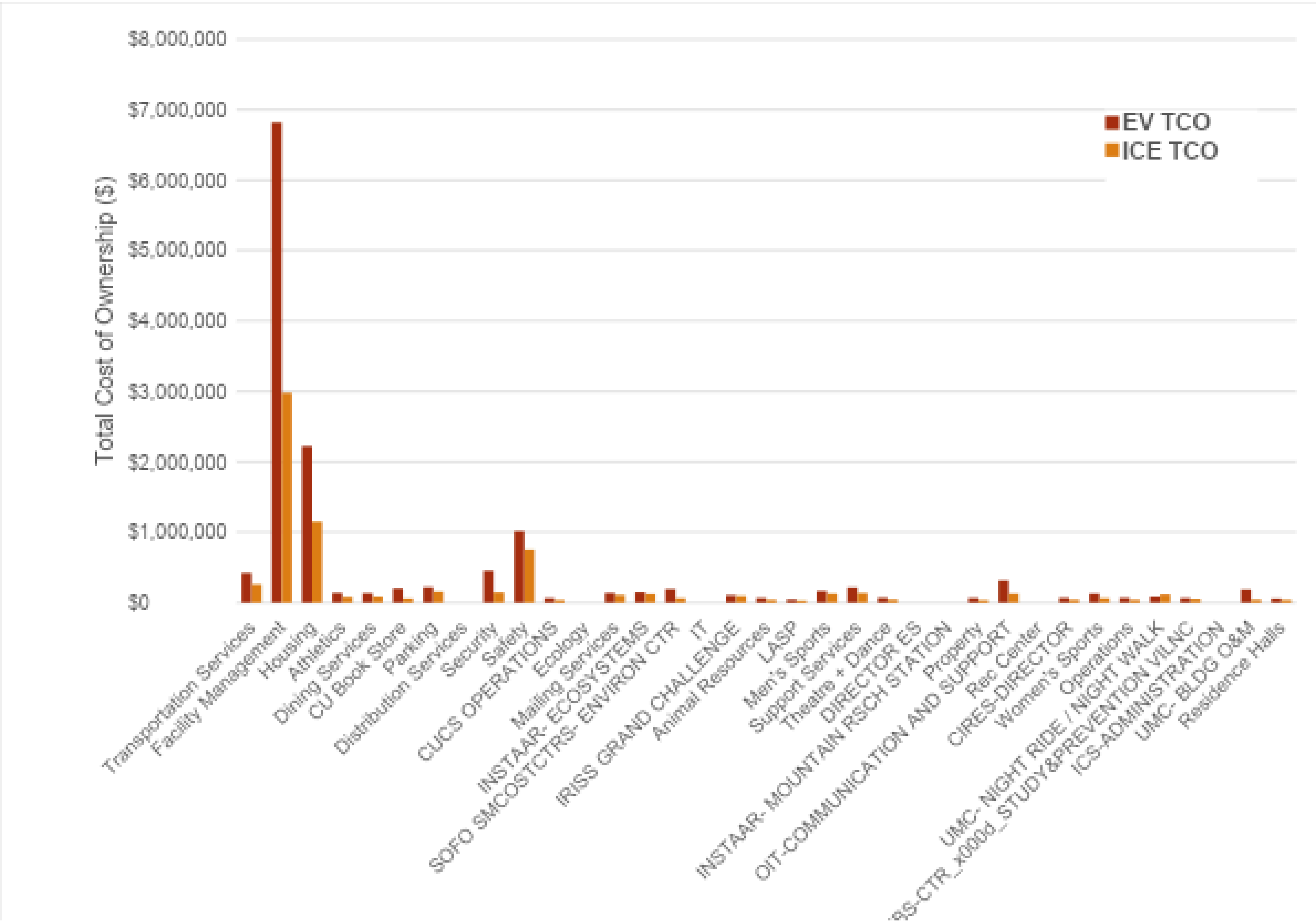


Table 2: TCO of Near-Term Vehicle Purchases (2025-2035) – Best Fit

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

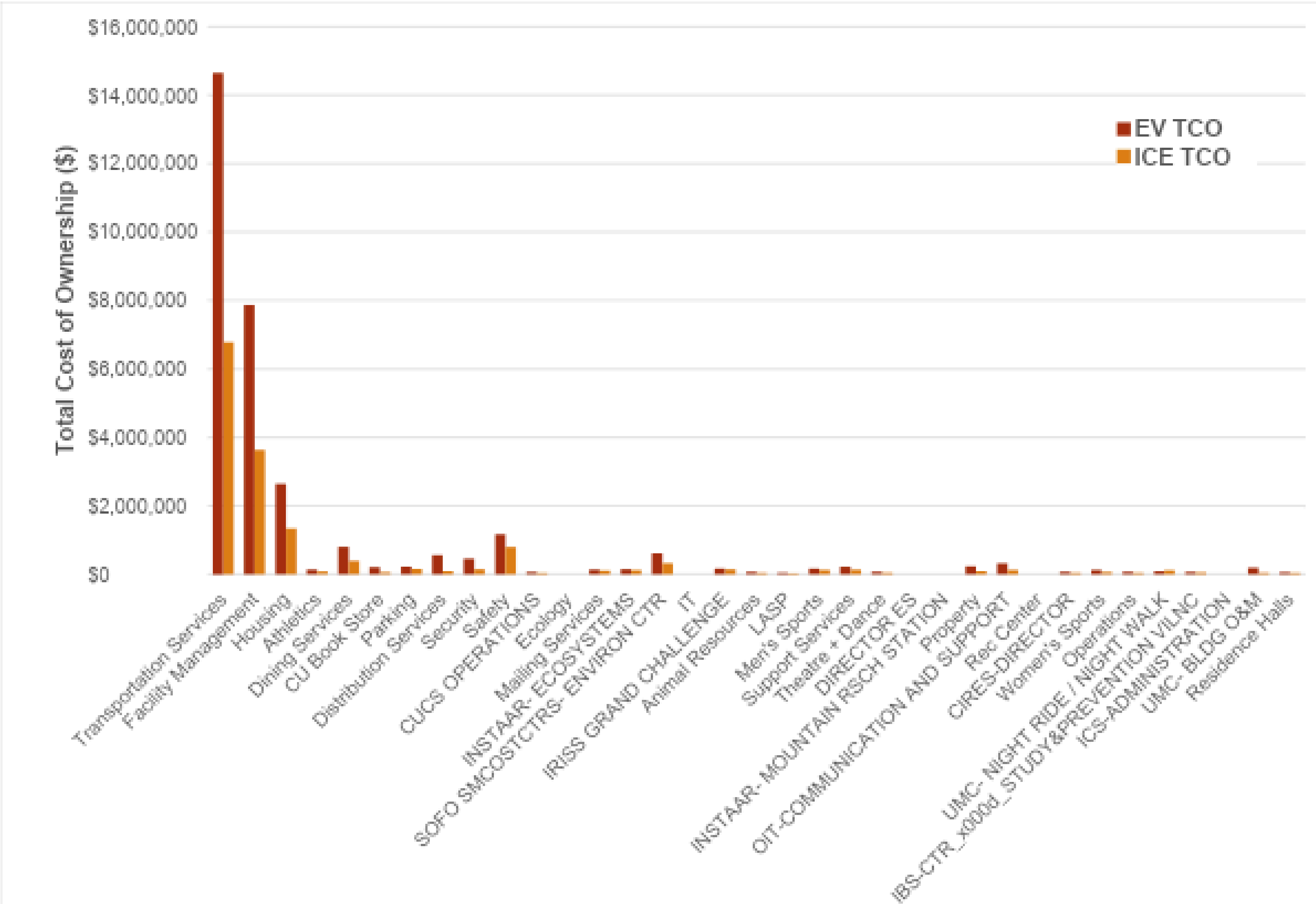


TABLE 3: TCO OF NEAR-TERM VEHICLE PURCHASES (2025-2035) – POTENTIAL ELECTRIFICATION

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

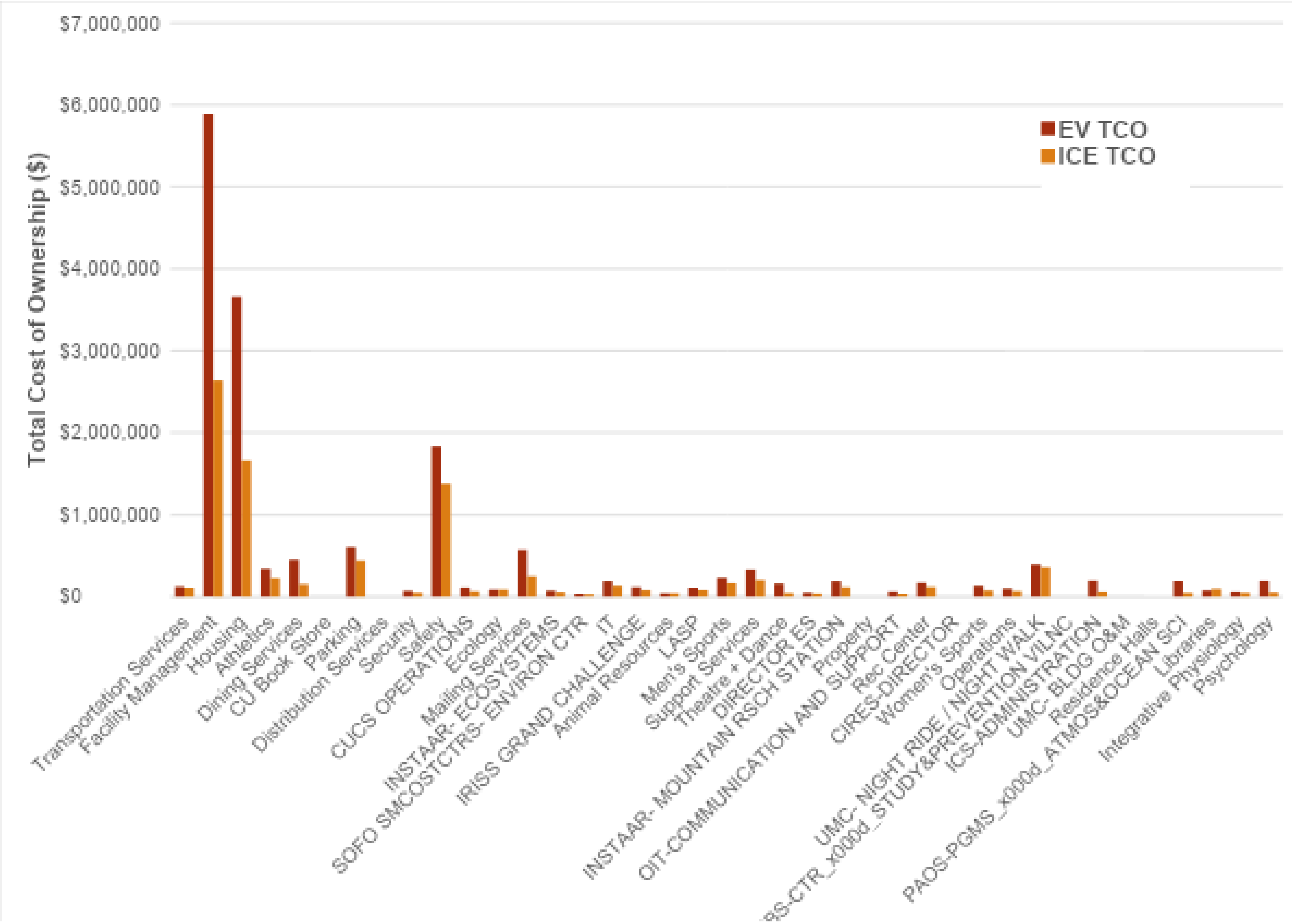


Table 4: TCO of long-Term Vehicle Purchases (2035-2050) – Best Fit

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

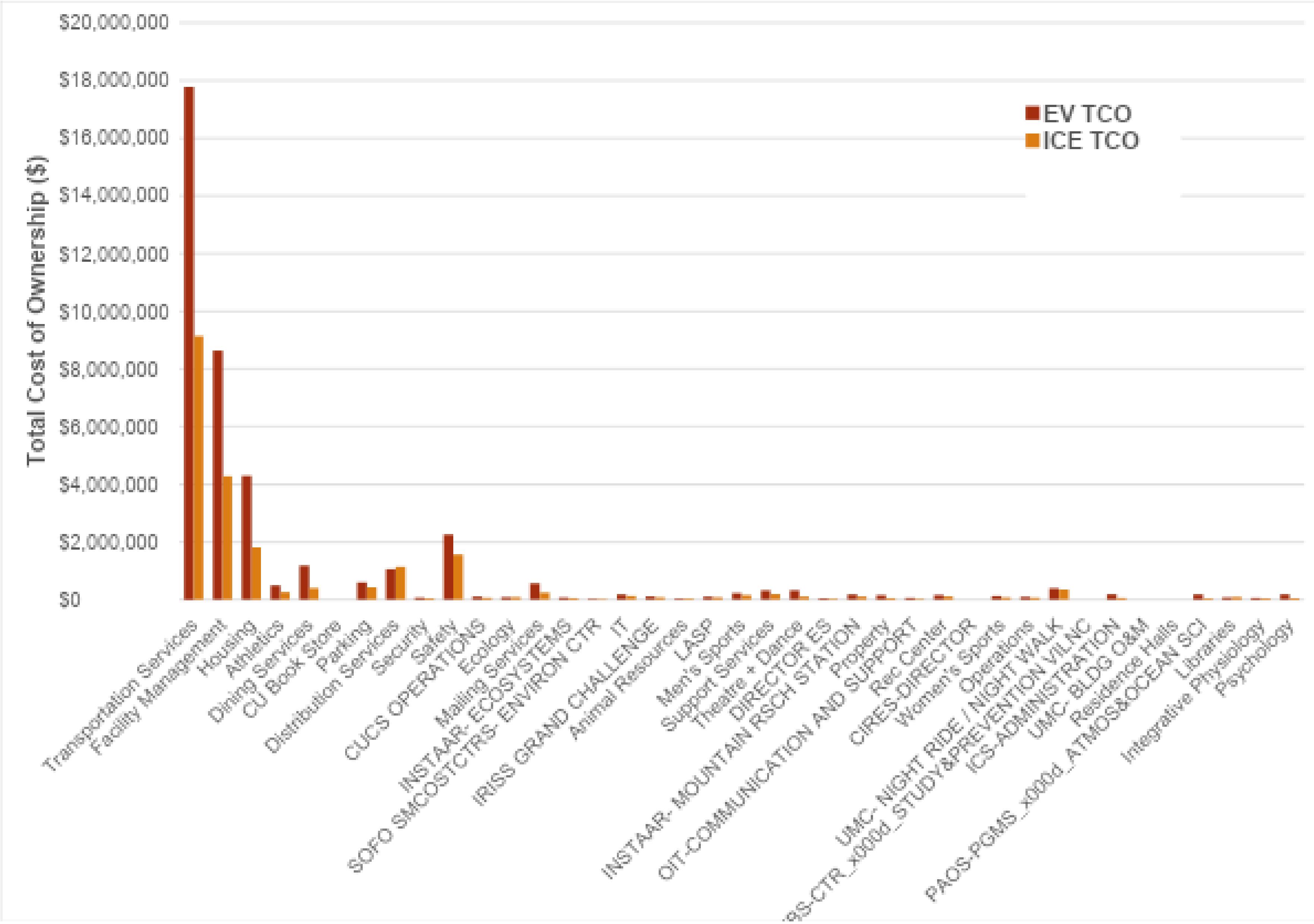


Table 5: TCO of long-Term Vehicle Purchases (2035-2050) – Potential Electrification

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

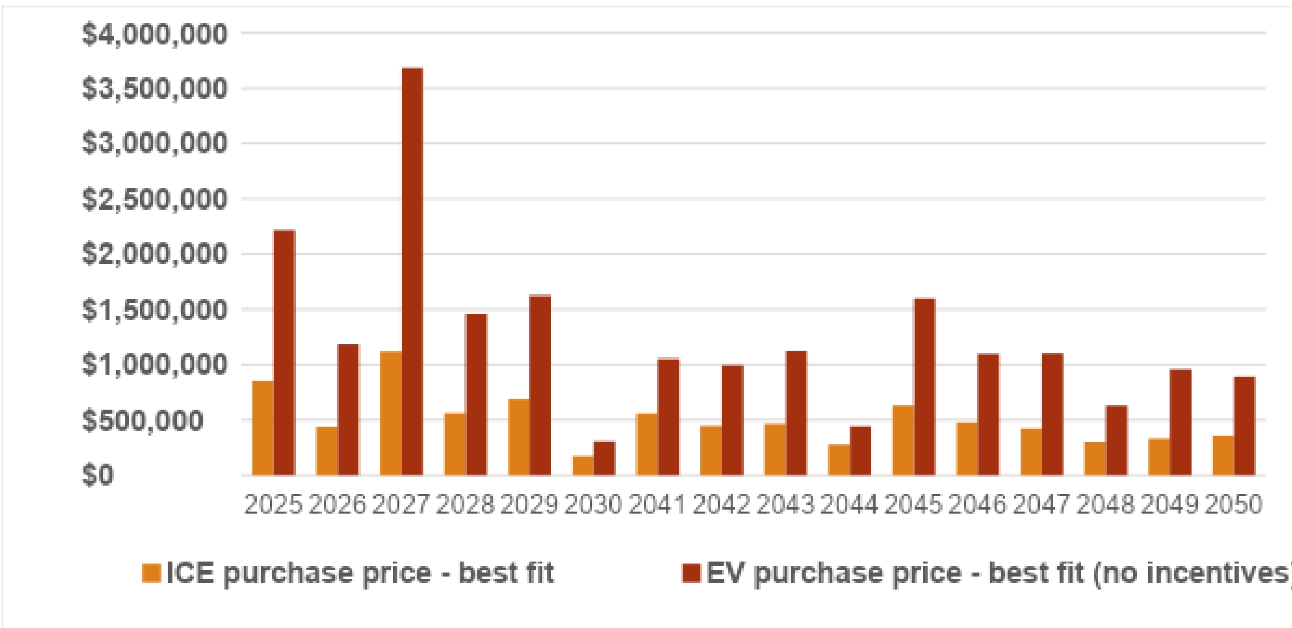
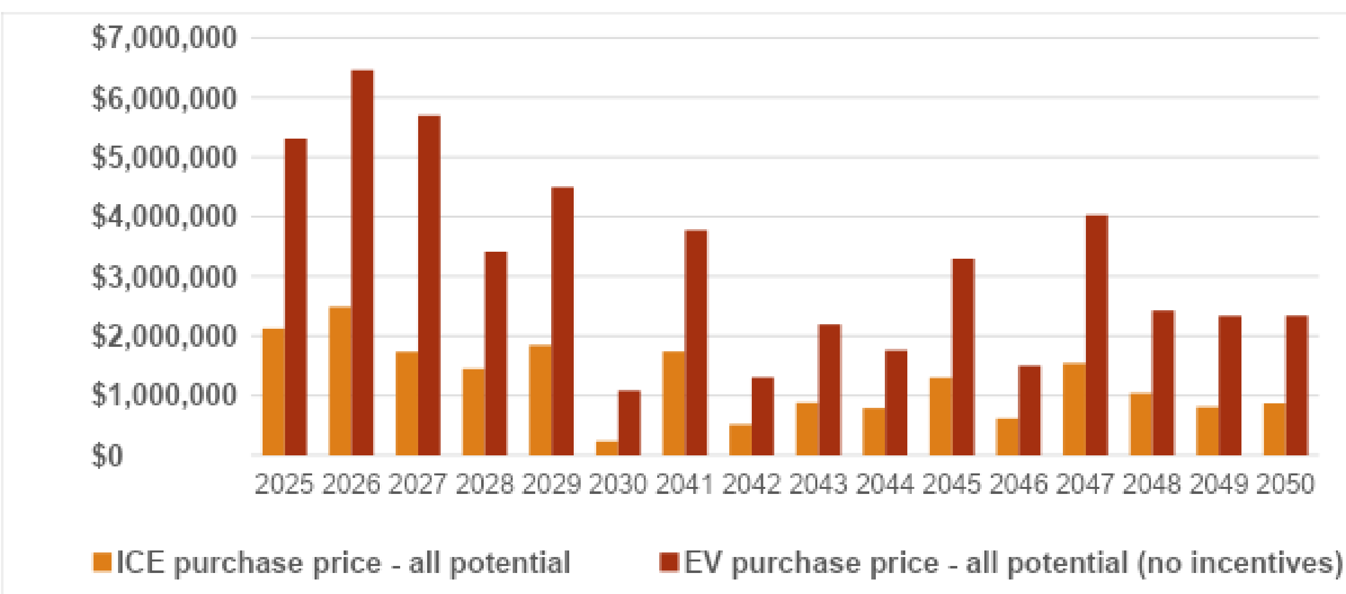


Figure 12: Estimated Capital budget needs – Potential Electrification



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]

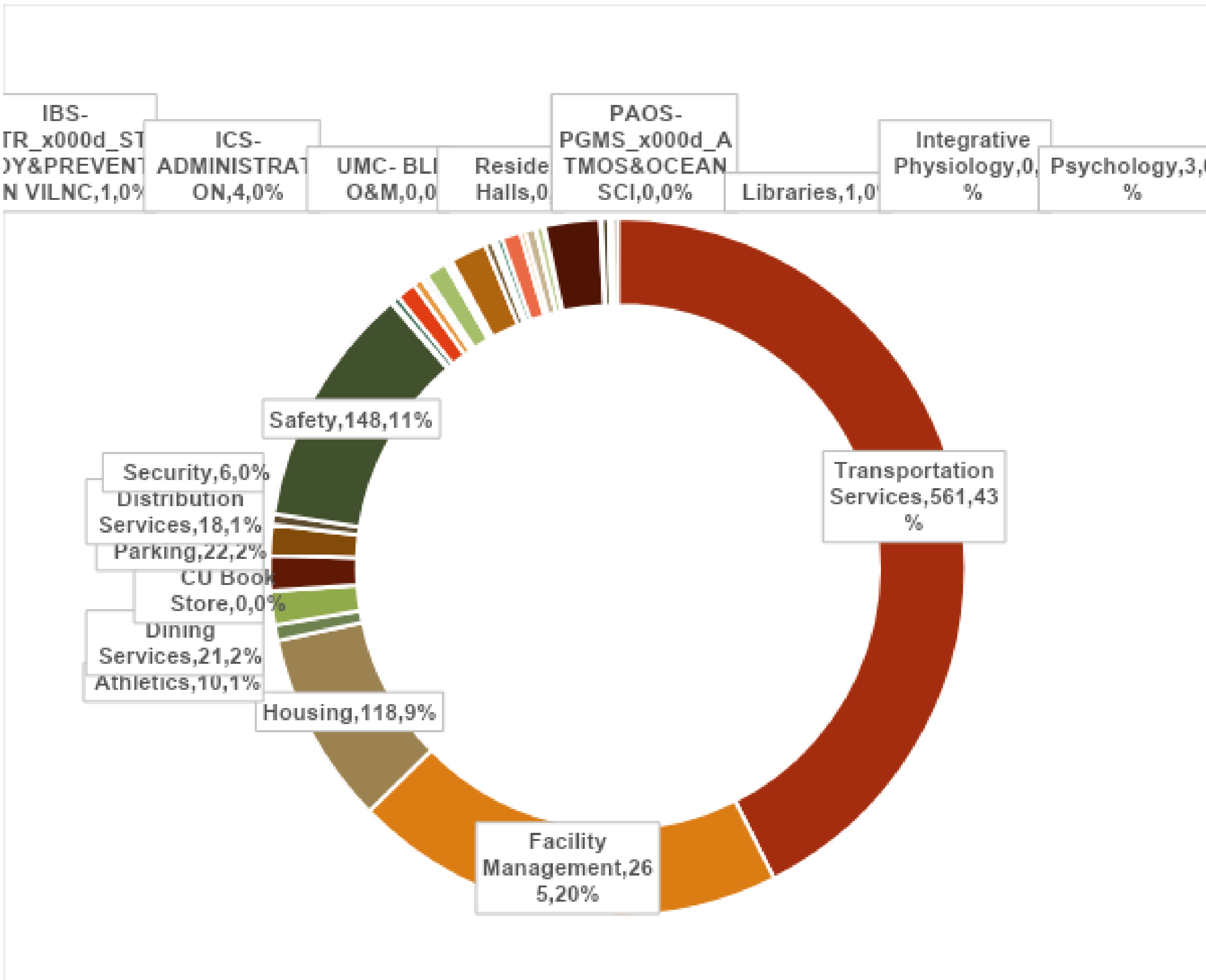
There are two common types of leasing: fleet leasing or lease financing. Fleet leasing refers to a contract the enables vehicle leasing, often a large number of vehicles, that encompasses maintenance costs, fuel costs and other services. It is appealing for fleets that do not have in-house maintenance 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

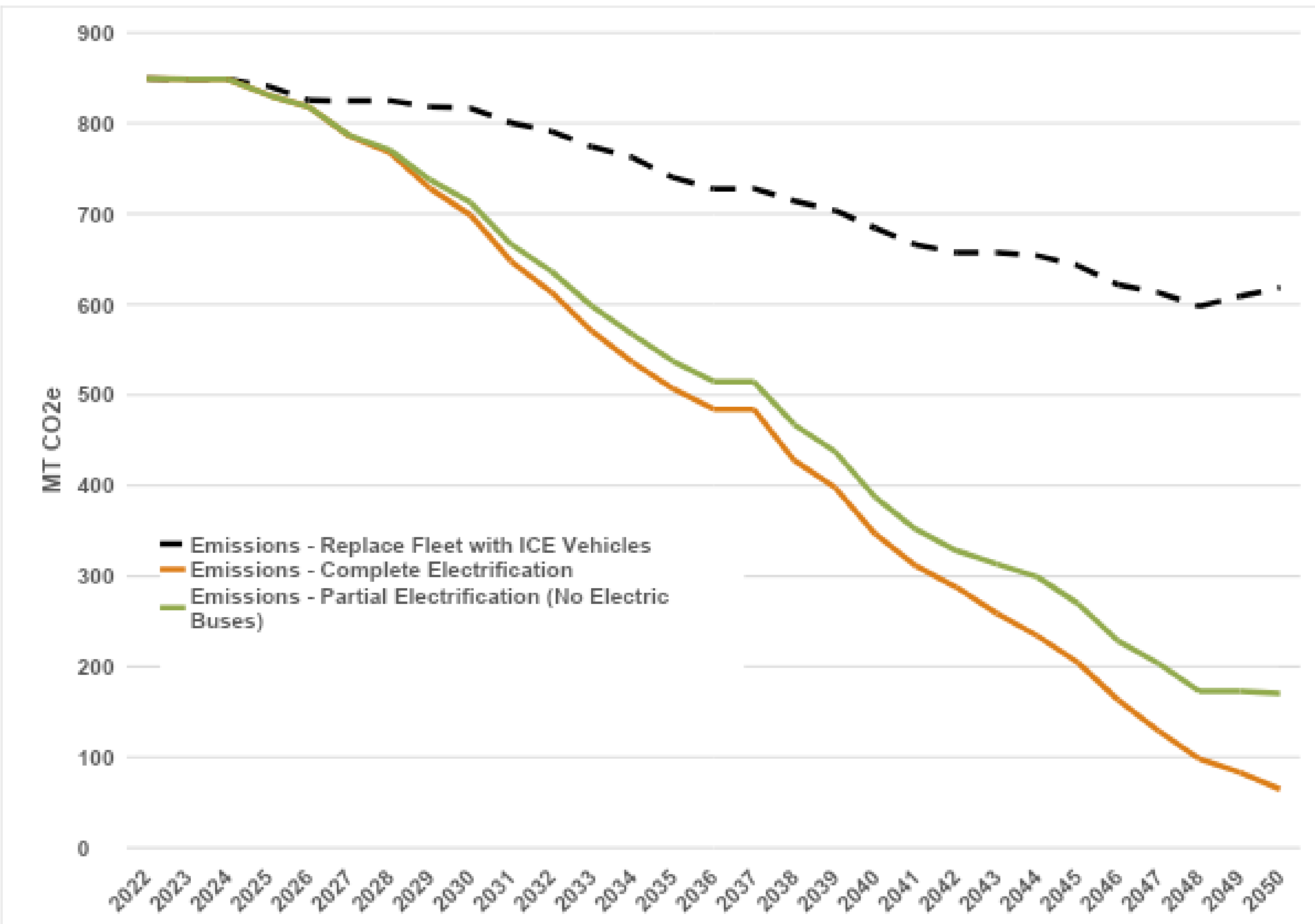


The expected carbon reductions from fleet electrification are presented below based on the Fleet Replacement and Electrification Timeline. **Figure 14** includes projected carbon reductions under three electrification scenarios matching those discussed previously in this report.

[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
TRANSPORTATION 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	$3,082,623	$2,813,569	$35,143	$32,076
HOUSING	34	72	$1,999,749	$1,754,416	$27,674	$24,279
SAFETY	33	94	$670,410	$320,443	$7,107	$3,397
TRANSPORTATION 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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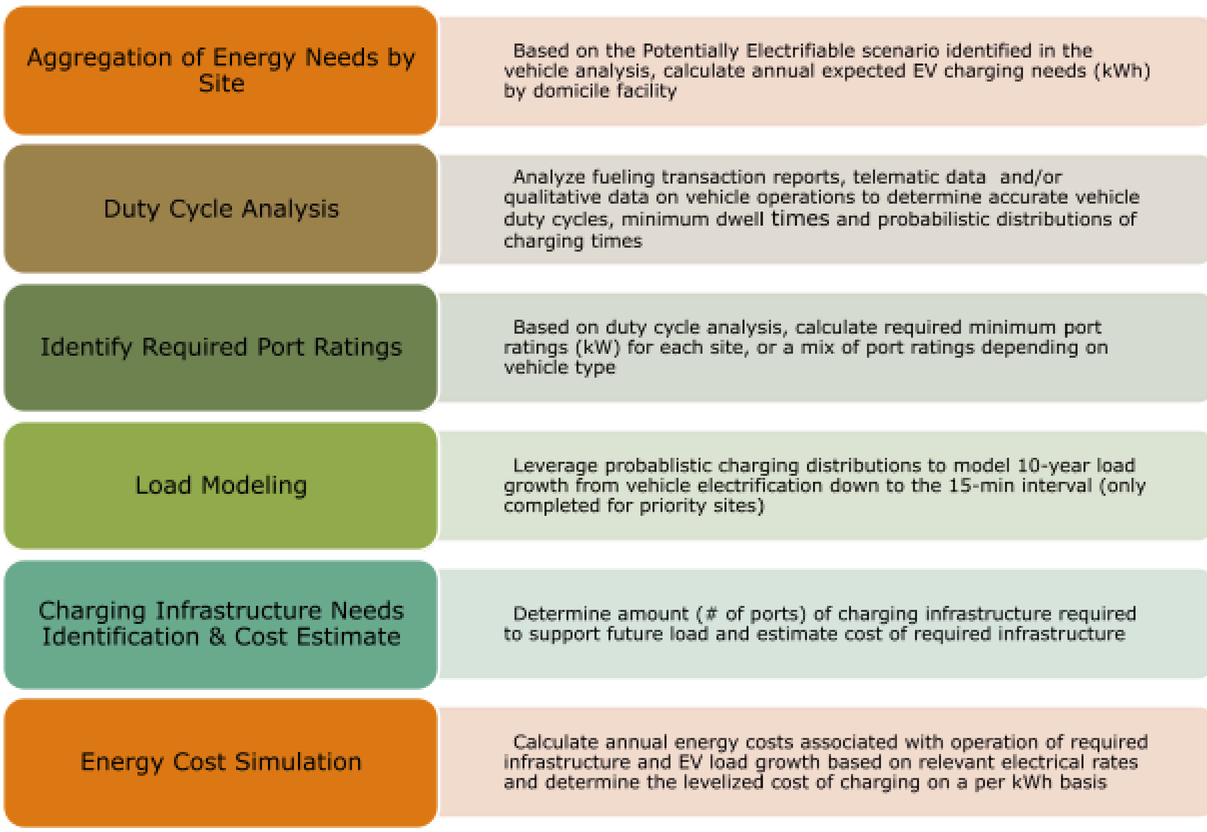
METHODOLOGY

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

[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)

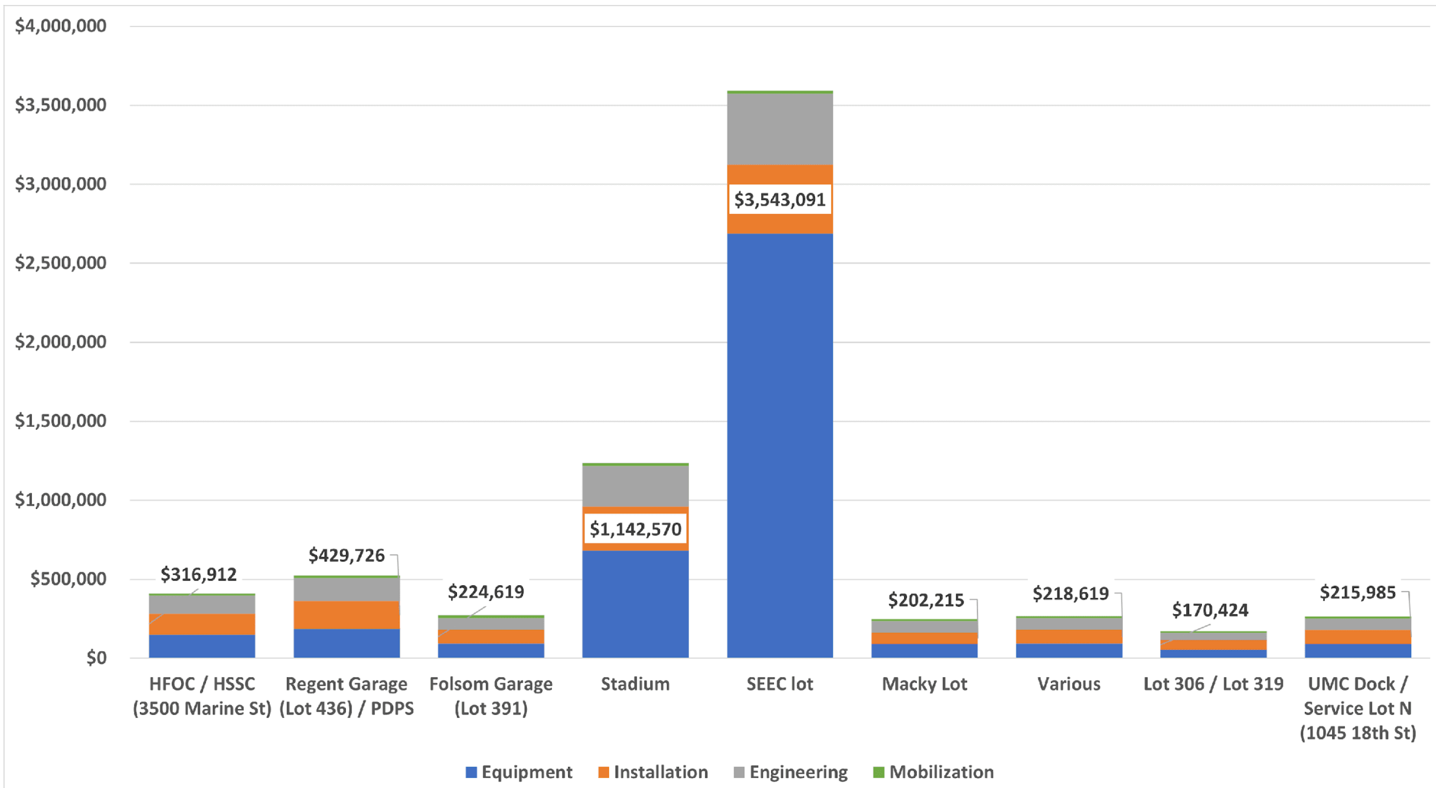
SITE	2030			2040			2050		
	# OF EVs (% OF TOTAL)	# OF PORTS	VEHICLE TO PORT RATIO	# OF EVs (% OF TOTAL)	# OF PORTS	VEHICLE TO PORT RATIO	# OF EVs (% OF TOTAL)	# OF PORTS	VEHICLE TO PORT RATIO
HFOC / HSSC (3500 MARINE ST.)	28 (36%)	2 x 6.6 kW 6 x 11.5 kW 1 x 25 kW	3.1	47 (61%)	2 x 6.6 kW 6 x 11.5 kW 1 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.

APPENDIX F:

FUNDING CLIMATE ACTION

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 sizable 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/ft^2	$1.82/ft^2	$1.88/ft^2
Partially Qualifying Property	Envelope	10%	$0.60/ft^2	$0.61/ft^2	$0.63/ft^2
	HVAC and HW	15%			
	Lighting	25%			
Interim Lighting Rule		25%-40% lower lighting power density (50% for warehouses)	$0.60/ft^2***	$0.61/ft^2***	$0.63/ft^2***

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.