



A Proposal for Measuring and Assessing Progress of Vermont's Climate Action Plan

**Technical and Cost Proposal
November 17, 2023**

Submitted to:

Vermont Agency of Natural Resources
133 State Street, 5th Floor
Montpelier VT 05633-8000
Attention: Jane Lazorchak, Director of the
Climate Action Office

Submitted by:

Mathematica
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November 17, 2023

Jane Lazorchak
Director of the Climate Action Office
Vermont Agency of Natural Resources
133 State Street, 5th Floor
Montpelier VT 05633-8000

RE: RFP for Measuring and Assessing Progress of Vermont's Climate Action Plan

Dear Jane Lazorchak:

The Vermont Agency of Natural Resources (the Agency) has requested technical support services to develop a tool to measure and assess indicators of progress related to reducing greenhouse gas emissions and increasing resilience and adaptation to a changing climate in Vermont, as well as the implementation of actions in the Climate Action Plan (CAP). Mathematica and our partner Ascent Environmental are submitting our single volume proposal via email.

We see this endeavor as an important step to helping Vermont, a leading state in climate action, achieve the ambitious GHG requirements of Global Warming Solutions Act (GWSA). Our proposal sets forth a plan to help the Agency initiate Phase 1 of the policy-decision support tool that will provide a deeper understanding of the state's progress toward meeting the objectives outlined in the GWSA. Mathematica brings extensive experience collaborating with government agencies, private sector organizations, partners, and communities in developing evaluation strategies to assess complex issues and produce relevant and action-oriented insights. Our project team recognizes that for climate mitigation, adaptation, and resilience to be effective and responsive to local needs, the Agency requires a robust data governance plan and team, reliable data to describe emission pathways, metrics and indicators to track GHG trends, and a logic model to translate plans to measurable action. In collaboration with Ascent Environmental, our team brings in-depth knowledge across the full range of climate mitigation, adaptation and resilience analytics to support the development of a measuring and progress tool that informs climate policy decisions. We hope to work closely with the Agency, to develop recommendations that offer the confidence and clarity needed to find out what to do, how to make it happen, and where to go next.

We look forward to working with you on this important project. If you have any questions regarding our submission, please email rfpcenter@mathematica-mpr.com or, if you need to speak to someone directly, call Susan Boudreau, Mathematica's vice president of legal and contracts strategy, at (609) 297-4536.

Sincerely,



Erin Taylor
*Senior Vice President, Managing Director of Health
Policy Assessment*

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I. Technical Response

A. Provide details concerning your form of business organization, company size and resources

Mathematica is an employee-owned organization dedicated to improving public well-being by harnessing the highest standards of quality, objectivity, and excellence to develop information and analysis. Mathematica has more than 1,900 social scientists, survey researchers, climate experts, data scientists, policy and data experts, information technology professionals, communications specialists, support staff, and administrators committed to providing policymakers, program officials, and practitioners across the public, private, and nonprofit sectors with the information needed to improve public well-being. Mathematica's mission is to improve public well-being and build a more equitable and just world. To advance this mission, Mathematica works at the intersection of data science, social science, and technology to deliver evidence-based solutions that improve programs, refine strategies, and deepen understanding. Mathematica brings extensive experience collaborating with government agencies, private sector organizations, partners, and communities in developing evaluation strategies to assess complex issues and produce relevant and action-oriented insights.

Mathematica business profile

- Founded in 1968
- Employee owned since 1986; employee stock ownership plan created in 2005
- Number of employees: 1,900
- Office locations: Princeton, NJ (headquarters); Cambridge, MA; Washington, DC; Ann Arbor, MI; Chicago, IL; Oakland, CA

Additionally, we are partnering with Ascent Environmental (henceforth "Ascent") to expand our deep bench of subject matter expertise in climate mitigation and adaptation analytics. Ascent is an innovative full-service planning, climate change, urban design, environmental, and natural resources consultancy with a staff of 130 professionals headquartered in California with staff across the US. Ascent offers the nimble responsiveness of a small business along with a depth of expertise and resources well beyond the size of the firm. Primarily working with public sector clients, their broad spectrum of planning and environmental services, including climate action, climate adaptation, sustainability, land use planning, urban design, transportation, and environmental compliance, allows Ascent to provide a comprehensive approach to current challenges. Using the latest analysis tools and techniques is also central to Ascent's practices, resulting in efficiency, clear presentation of data and results, and effective, feasible, and defensible solutions.

B. Describe capabilities and particular experience relevant to the RFP requirements

Mathematica and Ascent's expertise and experience across the full range of climate mitigation, adaptation and resilience analytics equip the project team to develop a tool for the Vermont Agency of Natural Resources (the Agency) to monitor and evaluate progress on the key strategies outlined in the Initial Vermont Climate Action Plan (CAP). Ascent's staff bring experience and expertise in climate action planning, including data collection, preparation of emissions inventories and inventory updates, preparation of greenhouse gas (GHG) emissions forecasts, GHG reduction target setting, GHG reduction measures analysis, CAP implementation and monitoring, public outreach, identification of co-benefits, and preparation of climate vulnerability assessments and climate adaptation strategies. Mathematica's long history of evaluation design and data systems experience and expertise compliments Ascent's expertise and will ensure that the partnership has the

necessary capacities to compile the data and frameworks that form the foundation of a measuring and progress tool that supports the Agency and its partners with climate policy decisions.

1. Relevant project experience

Through our experience and expertise (Exhibit 1), Mathematica and Ascent bring the right blend of skills and principles needed to meet the Agency's objectives:

- **Demonstrated experience and efficiency in climate change and adaptation underpin our approach.** For the past 13 years, Ascent has been assisting California Air Resources Board with preparation of environmental documents for cornerstone regulations implementing the Cap-and-Trade Regulation, California's 2022 Scoping Plan for Achieving Carbon Neutrality, Low Carbon Fuel Standard, Advanced Clean Cars Program, among others, which provides them with an in-depth understanding of GHG-related regulations and programs in the state and how they translate to project- and plan-level reductions.
- **Decades of experience developing logic models and metrics to translate complex data into practical insights for policymakers.** Mathematica worked with the Children's Investment Fund Foundation (CIFF) to assess city-level CAPs produced by C40 member cities across the US, Europe, and the Global South. Our assessment focused on cities' uptake of cross-sectoral climate action planning, implementation of CAPs, and the quality of monitoring systems.
- **Deep expertise in developing data systems, tools, and digital infrastructure to support decision making, track and visualize outcomes, and identify vulnerabilities.** For example, Mathematica is building a state-of-the-art online tool for USAID to help calculate emissions reductions in the AFOLU sectors, which will enable users to customize their inputs and outputs and access geospatial visualizations of their projects. Similarly, for Mathematica's Transitions to Community Living project with the state of North Carolina, Mathematica worked closely with DHHS staff to develop an outcomes dashboard that enables North Carolina's DHHS staff to monitor their progress in achieving their Olmstead Plan.
- **Proven partnerships with Vermont and other state and local agencies (outlined in Exhibit 5), providing equity related to distributional analysis; community engagement data analytics; stakeholder engagement; and developing governance plans, logic models, metrics, and indicators to inform action.** Ascent's long-standing relationship with the San Diego Association of Governments (SANDAG) showcases Ascent's capability to develop a regional framework that leverages research and regional capacity to create consensus based GHG inventory methodologies and reduction measures for combating climate change and reducing GHG emissions.

Exhibit 1. Relevant project experience

Project	Client; period	Brief description	Relevant capabilities
Regional Climate Action Planning Framework & Monitoring	SANDAG	Ascent was retained by SANDAG to standardize and streamline climate action planning in the San Diego region. Ascent assisted SANDAG in developing a regional framework that leverages research and regional capacity to create consensus-based GHG inventory methodologies and reduction measures for combating climate change and reducing GHG emissions. The regional framework is intended to guide local governments in developing consistent GHG emissions inventories and projections, streamline data collection, set consistent GHG reduction targets that align with state targets, quantify GHG reduction measures, and develop CAPs consistent with CEQA, as desired by member agencies.	Climate adaptation planning, climate action evaluation, climate indicators and metrics, climate mitigation
Imperial County Regional Climate Action Plan	Imperial County Transportation Commission (ICTC) and Southern California Association of Governments (SCAG)	Ascent worked with SCAG and ICTC to develop a regional climate action plan for addressing GHG emissions and applying framework components consistently at the local level to develop jurisdiction-specific profiles and plans. Ascent team led a robust public outreach effort to reach all sections of the community and developed a regional CAP that is sensitive to the economic conditions in the region.	Climate adaptation planning, engagement with multiple local and regional agencies, climate indicators and metrics
California Air Resources Board Greenhouse Gas Regulatory Program	California Air Resources Board (CARB)	CARB embarked on a series of regulatory actions to implement Assembly Bill 32, Senate Bill 32, and management authorities. Since 2010, Ascent has successfully completed over a score of complex Functional Equivalent Documents (FEDs) and Environmental Analyses (EAs) under CARB's CEQA-certified regulatory program.	Climate action evaluation, climate mitigation, engagement with state agencies
Catalyzing State Medicaid Leadership on Climate Change Mitigation	Commonwealth Fund; 2023	Mathematica documented findings from more than 200 sources, including information from grey literature and recently published studies, into a comprehensive extraction template we developed based on our client's priorities and needs. Our team synthesized findings from this landscape scan and facilitated outreach to key interest holders and climate actors within state agencies. We conducted numerous interviews and focus groups with these agencies and climate actors, which informed the development of seven public-facing products that inspired, informed, catalyzed, and equipped state Medicaid agencies to lead on health care sector decarbonization.	Climate mitigation, systematic review, interviews, and engagement with state agencies

Project	Client; period	Brief description	Relevant capabilities
Agriculture, forestry, and land use (AFOLU) project	U.S. Agency for International Development (USAID)	Mathematica currently works with USAID to develop a GHG emissions calculator for AFOLU projects to help USAID and its partners synthesize and analyze vast amounts of geospatial data to estimate the climate impact of planned activities, policies, and investments. The calculator will also inform the design of future programs and solutions to meet the emissions reduction targets in the USAID Climate Strategy 2022–2030.	Climate mitigation, GHG expertise, climate indicators and measurement, data processing, and tool development
Evaluation of Climate Action Plans and C40's Thematic Networks	Children's Investment Fund Foundation (CIFF)	Mathematica worked with the CIFF to assess city-level climate action plans (CAPs) produced by C40 member cities across the United States, Europe, and the Global South. CIFF provided funding for the C40 network to support cross-city learning for policies and programs to reduce emissions and improve resilience. Our assessment focused on cities' uptake of cross-sectoral climate action planning, implementation of CAPs, and the quality of monitoring systems.	Climate adaptation planning, climate action evaluation, climate indicators and metrics, climate mitigation, and interviews
Transforming Public Health Data Systems (TPHD) initiative	Robert Wood Johnson Foundation	We are evaluation partners on the Robert Wood Johnson Foundation's TPHD initiative. The initiative funds grantees with the aim of tackling root causes of systemic public health inequities by dismantling structural issues within the public health data infrastructure. As part of this work, we worked across the portfolio of grantees to map data systems, developed nested logic models that feed up to a program-level theory of change, and mapped indicators to the logic models. We now use the data collected under these indicators to carry out the evaluation.	Developing theories of change and/or logic models, interviews, and workshops
North Carolina's Transitions to Community Living Project	North Carolina's Department of Health and Human Services (DHHS)	As part of Mathematica's Transitions to Community Living project with the state of North Carolina, Mathematica worked closely with DHHS staff to develop an outcomes dashboard that enables North Carolina's DHHS staff to monitor their progress in achieving their Olmstead Plan. As part of the project, we process more than half a dozen data sources for DHHS, ranging from Medicaid beneficiary-level data, claims data, institutionalization data, and survey data to develop more than 100 quality metrics to help the state accomplish goals as they relates to its Medicaid populations with an existing disability. This process is automated using cloud technologies to seamlessly produce dashboard and analytic-ready data sets quarterly that North Carolina uses to improve existing processes and programs.	Indicator development, dashboard design, and data management systems

Project	Client; period	Brief description	Relevant capabilities
Centers for Medicare & Medicaid Services' Core Set Quality Measures	Centers for Medicare & Medicaid Services (CMS)	Mathematica's Core Set project with CMS processed several self-reported and administrative data sets to manage, validate, and prepare the Medicaid Core Set Quality Measures for CMS and public consumption. Our automated extract, transform, and load process is run daily to ingest external data sets and process them into our Common Core Set Data Measure Model, runs a set of validation rules to ensure the quality of the data ingested, and automates a set of metadata that researchers and analysts use to help manage the ingested data.	Indicator development, dashboard design, and data management systems

2. Personnel expertise and experience

Mathematica and Ascent have assembled a team of experts who bring complementary skills to support the design of a tool for monitoring and evaluating progress on key strategies and activities outlined in the Initial Vermont CAP. Exhibit 2 outlines the proposed team for this contract, including their subject matter expertise and relevant research and lived experience. The team will be led by a Project Director who will collaborate closely with Project Advisors and Project Manager*. Task leads will oversee the planning and execution of activities under each of these interrelated tasks.

Mathematica's partner, Ascent, expands our expertise in Vermont-specific climate change mitigation, adaptation, and resilience actions, with focus on applying its deep knowledge of GHG inventories and projections across sectors and climate action planning. Ascent will support Mathematica with the facilitation of stakeholder activities (Tasks 1, 2, and 3) and contribute to the development of key performance indicators and metrics (Task 2). Ascent will also support the development of the final memo and recommendations to the Agency (Task 4) by reviewing and offering feedback relevant to staff expertise. Together, we are uniquely positioned to support the tool design, as exemplified by the subject matter expertise, relevant research and lived experience of the key personnel.

Exhibit 2. Staff qualified to lead a successful project

Name	Project role	Expertise
Dheeya Rizmie, Ph.D., Environmental & Health Economics, Imperial College London, researcher (Mathematica)	As the project director, Dr. Rizmie will provide leadership for all tasks.	Dr. Rizmie brings nearly a decade of experience researching and publishing around the impact of environmental shocks on health and health systems using econometric evaluations and public health consultations. She conducted the first large-scale, population-wide assessment of extreme temperatures on inequalities in excess emergency hospital admissions in England across vulnerable and socio-economically-deprived populations. Dr. Rizmie currently leads the development of a strategy and learning Implementation plan (including developing theories of change and progress indicators) for a large foundation's climate and health portfolio. She was the modeling lead for Mathematica's ClimaWATCH tool.

Name	Project role	Expertise
Anthony D'Agostino, Ph.D., Sustainable Development, Columbia University, senior researcher (Mathematica)	As the senior advisor, Dr. D'Agostino will provide subject matter and technical expertise and quality assurance throughout the project.	Dr. D'Agostino brings 16 years of experience conducting research on a range of mitigation and adaptation topics in academic, consulting, and multilateral settings. He leads the development of a new USAID-funded, AFOLU sector-focused GHG calculator that will facilitate estimating impacts and reporting to USAID headquarters. He has previously led projects funded by the CIFF that evaluated C40's programming on city-level GHG accounting and the development of climate action plans. He brings expertise in climate data and geospatial data analysis. His prior experience includes positions at United Nations Environment Programme (Bangkok), World Resources Institute (GHG Protocol), and the Center on Food Security and the Environment (Stanford).
Hannah Kornfeld, M.S., AICP, City and Regional Planning, California Polytechnic State University, climate action project manager (Ascent Environmental)	As the Task 2 Co-Lead Ms. Kornfeld will provide subject matter and technical expertise.	Based in Vermont, Ms. Kornfeld, is a climate action project manager with experience in developing and managing climate action and adaptation planning efforts. She serves as the climate action and adaptation planning practice leader at Ascent. Ms. Kornfeld has expertise in creating carbon neutrality plans and assisting local agencies with some of their most challenging climate change projects. Using her technical expertise in greenhouse gas quantification, she works to bridge the gap between technical analyses, ever-evolving climate regulation, and local policymaking through crafting first-of-their-kind mitigation strategies. Ms. Kornfeld is a Vermont native and was selected to participate in the Vermont Council on Rural Development's Climate Catalyst Leadership Program and serves as an advisor for the Vermont Energy Education Project Youth Climate Leaders Academy.
Poonam Boparai, M.S., Environmental Engineering, University of Illinois, regional director (Ascent Environmental)	As an advisor, Ms. Boparai will provide subject matter and technical expertise to support quality assurance across Tasks.	Ms. Boparai has more than 15 years of experience in the public and private sectors conducting climate action planning and air quality and GHG analyses. Her skill set combines technical expertise with a keen understanding of planning and environmental policy. She leads climate action planning processes informed by robust technical analysis and inclusive, meaningful engagement of agency and key community interest holders to develop effective and locally appropriate and effective climate mitigation and adaptation policies and plans. She has successfully applied her expertise in assisting agencies across California with air quality and climate change policy development, analysis methodologies, GHG reduction strategies, and development of GHG thresholds of significance.
Areen Sattar, B.A., Computer Science, Smith College, information technology (IT) product manager (Mathematica)	As the Task 1 lead, Ms. Sattar will lead the development of the Data Governance Team (DGT) and data governance plan (DGP).	Ms. Sattar is a seasoned IT product manager with a strong background in data management and a focus on enhancing the impact of health care programs. She has played a pivotal role in managing and executing comprehensive data management plans that facilitate the collection, secure storage, and insightful analysis of program data submitted by grant recipients to the Center for Medicare and Medicaid Innovation. Her commitment to data quality and program improvement is underscored by her role in managing communication between project teams and participating organizations, ensuring seamless collaboration and alignment on upcoming tasks. Her expertise in data management and dedication to health care innovation was further demonstrated when she presented at a CMS-sponsored webinar on maximizing data quality.

Name	Project role	Expertise
Nathan Chesterman, M.S., Natural Resources and Environment, University of Michigan, research analyst (Mathematica)	As the Task 2 co-lead, Mr. Chesterman will lead the development of the logic model and metric creation.	Mr. Chesterman has seven years of experience in monitoring, evaluation, and learning for programs at the intersection of natural resource conservation and climate change resilience. He served as an analyst for the Youth & Agri-Food Systems Foresight Analytics project, which mapped over 100 indicators from more than 15 data sources to an agri-food systems model to provide insights to agricultural policymakers and entrepreneurs. He previously worked on the USAID Measuring Impact II project, for which he supported biodiversity and climate change resilience programs with theory of change development. Mr. Chesterman brings experience facilitating collaborative processes to build logic models and develop indicators that meet key interest holders' information needs.
Courtney Cappalli, B.A., Environmental Science, University of Iowa, managing consultant (Mathematica)	As the Task 3 lead, Ms. Cappalli will lead the development of the data mapping.	Ms. Cappalli brings experience in Medicaid policy, social and environmental determinants of health, and climate change. She served as an analyst for the Catalyzing State Medicaid Leadership on Climate Change Mitigation project, which aimed to inspire, inform, and equip state Medicaid agencies to take a leading role in reducing harmful GHGs produced by the health system. She has experience leading literature reviews and environmental scans, synthesizing policy findings, and facilitating focus groups, including as mitigation analyst for a project that provided policy options to mitigate climate change for the Washington State Health Care Authority.
Alex Bauer, M.A., Organizational Leadership and Learning, George Washington University, analyst (Mathematica)	As the Task 4 lead, Mr. Bauer will lead the development of the infrastructure recommendation memo.	Mr. Bauer has more than five years of experience providing coaching, technical assistance, and evaluation support to state and local human services agencies. He has designed and facilitated workshops that draw on adult learning principles and human-centered design (HCD) techniques to help identify challenges, co-create solutions, develop logic models, and conduct strategic planning. He has helped numerous human services agencies develop, implement, test, and refine various interventions and services to improve outcomes. He currently leads efforts in partnership with the American Human Services Association to help human services agencies integrate environmental justice principles into their programming.
Kai Elwood-Dieu, B.S., Interactive Media and Business, New York University, software engineer (Mathematica)	Mr. Elwood-Dieu will be a member of the Task 1 and Task 3 teams.	Mr. Elwood-Dieu has expertise and experience working on data visualization and full-stack development. He has worked on complex data dashboards and data visualization projects in roles at Politico and the Texas Tribune, including one investigating the impact of renewable energy projects in Texas.
Evan Christo, B.E., Environmental Engineering, Dartmouth College, research associate (Mathematica)	Mr. Christo will be a member of the Task 2 and Task 3 teams.	Mr. Christo brings a strong quantitative skill set from his engineering background and an applied knowledge of climate action from his time as an internal sustainability consultant at the San Mateo County Community College District. At Mathematica, he researched the need for localized climate data to support locally led adaptation efforts and is currently involved in project work and business development efforts in the energy and climate-health sectors.

*The Project Manager will be identified upon award.

C. Technical approach

Task 0: Project Management

Mathematica understands the success of this project depends on a team with high-level expertise in climate change mitigation, adaptation and resilience actions, Vermont-specific data sets, and data management system design. Achieving the Agency's goals for this project will require a strong management plan executed by a dedicated project leadership team with experience completing timely and cost-efficient work of the highest quality. We will use Mathematica's project management framework, outlined in the following subsections, to meet the specific management needs of this project, including clear project management and communication guidelines.

Integrated project management system

Mathematica's project managers know how to identify and respond to unanticipated challenges that arise throughout a project's life cycle—from the project's start through planning, execution, and closure. Mathematica's integrated project management system will enable Dr. Rizmie and the Project Manager to accurately schedule work, appropriately allocate staff, regularly monitor budget forecasts, and precisely evaluate project performance. We will use these tools to incorporate the subcontractor's schedule and expenditure data, enabling us to centrally manage all project activities.

Effective communication

Mathematica recognizes the success of this project depends on effective communication within our team, with the Climate Action Office (CAO) director, and with the stakeholder groups (such as the DGT). The Project Manager will serve as the primary point of contact for the CAO director. Dr. Rizmie and the Project Manager will hold 30-minute meetings, twice per month, with the CAO director to review deliverables, discuss task progress and timelines, and identify key decision points. Dr. Rizmie will also hold internal project meetings to monitor progress, ensure coordination, troubleshoot any issues, and plan future work. We will engage the CAO director in all major decisions and solicit input and direction before finalizing deliverables. Mathematica's climate leadership team will meet and communicate regularly with Dr. Rizmie and the Project Manager to ensure we understand the Agency's needs and priorities in designing and executing our work.

Rigorous quality assurance

Mathematica has well-defined procedures for conducting effective quality assurance reviews of all products, whether developed by Mathematica or a subcontractor. All deliverables undergo at least one review by an expert not involved in day-to-day project work. These reviews focus on whether the deliverables are of high technical quality and meet the client's needs.

Proposed work plan

Mathematica understands the Agency's need to rapidly achieve the goals set forth in this request for proposals; thus, our proposed work plan emphasizes producing the work products and deliverables necessary to inform the Agency's decisions. Exhibit 3 provides this overview, which we will refine based on feedback received during the kickoff meeting and deliver the final work plan to the Agency two weeks after the initiation of the project.

Exhibit 3. Proposed project timeline

Activity	Month								
	1	2	3	4	5	6	7	8	9
Task 0: Project Management									
Kickoff meeting and biweekly check-ins	◆ ◆	◆ ◆	◆ ◆	◆ ◆	◆ ◆	◆ ◆	◆ ◆	◆ ◆	◆ ◆
Work plan	■ ★								
Project management									
Project progress presentations		◆				◆			◆
Task 1: Data Governance									
Systematic review of data sources									
Data Governance Team	◆ ◆ ◆								
Data Governance Plan	◆ ◆ ◆ ■ ★								
Task 2: Logic Model Development and Metric Creation									
Scope logic model development process and use cases									
Develop draft logic model and refine with the design team		◆ ◆							
Map indicators to the logic model and refine with the design team		◆ ◆							
Develop framework use cases and categories		■ ★							
Task 3: Data Mapping									
Stakeholder work sessions and data manager interviews		◆ ◆	◆ ◆	◆ ◆	◆ ◆	◆ ◆			
Producing and delivering the data map									
Task 4: Infrastructure Recommendations									
Infrastructure recommendations memo									■ ★
Infrastructure recommendations presentations									◆ ◆

■ Draft deliverable ★ Final deliverable ◆ Meeting or engagement activity Ongoing work

Engagement strategy grounded in HCD principles

Across all tasks, Mathematica will employ an engagement strategy grounded in HCD principles. HCD is an evidence-based methodology for developing innovations and improvement through ongoing, structured, and authentic engagement with the key interest holders most closely connected to a problem. HCD methods go beyond typical stakeholder engagement strategies in that they treat key interest holders as equal partners, draw on the innate creativity of each member, and invite key interest holders to share their ideas and reflections about ways to solve problems or refine existing processes. Our team will employ HCD techniques such as [affinity clustering](#); [round robin](#); and [rose, thorn, bud](#) to invite key interest holders to share their ideas and reflections to solve problems or refine existing processes. To capture key takeaways from discussions, inform the deliverable, and ensure we accurately reflect key perspectives, we will use digital collaboration tools such as MURAL. Exhibit 4 provides a comprehensive summary of all engagement activities across tasks.

Exhibit 4. Proposed engagement activities

Meeting focus	# of Meetings	Participants	Objectives
Task 0: Project Management			
Kickoff	1	CAO director	Initiate project and discuss assumptions to support development of the project's work plan
Biweekly meetings	Up to 18	CAO director	Review interim deliverables, discuss tasks underway and timelines, identify key decision points, and determine what presentations are necessary
Presentations	3	CAO director, Agency staff	Presentations on project progress delivered at 2, 6, and 9 months
Task 1: Data Governance			
Kickoff	Shared meeting with Task 0	DGT, CAO director, Agency staff	Share systematic review process and criteria and present key findings
Data scoping meetings	2-3	Agency staff	- Review and gather feedback on content areas of the data governance plan - Review staff roles needed to actualize the data governance plan
DGP development meetings	2-3	DGT, CAO director, Agency staff	- Gather feedback on the draft data governance plan to include in the final review - Review the final revisions to the data governance plan and receive sign off from the DGT
Task 2: Logic Model Development and Metric Creation			
Logic model refinement and indicator validation meetings	4	DGT, relevant Agency staff, and Science & Data (S&D) subcommittee	- Form the logic model design team and identify user personas for developing use cases - Review revised logic models for emissions-reductions pathways - Review revised logic models for resilience and cross-cutting pathways - Review revised set of indicators for all logic models
Task 3: Data Mapping			
Working sessions	3	DGT	Identify gaps in the data currently available and define gaps with specific metrics and indicators, as informed by the logic models
Interviews	7	Data managers	- Gain a further insight into GHG data landscape including specific data source locations and assessments of each data source's accuracy, completeness, reliability, relevance, and timeliness - Evaluate the applicability of the available data sources against the metrics and indicators defined by the logic models - Continue to identify data gaps and specify data sources to fill those gaps
Task 4: Infrastructure Recommendations			
Presentations	2	DGT; S&D subcommittee	Share recommendations for Phase 2 based on the objectives and goals identified in Tasks 1 through 3

Equity-centered approach

The Initial Vermont CAP established an equity-centered, “do no harm” approach grounded in research illustrating the disproportionate impacts of climate change on historically marginalized

communities. Mathematica and Ascent recognize an equity-centered approach is critical to develop the tool and will apply our deep understanding of [culturally responsible and equitable evaluation, data collection, and survey operations](#) and participatory methods of data collection, analysis, and dissemination to the tasks. Equitable outcomes are not a given, but rather must be explicitly defined, planned for, and prioritized throughout the climate action planning process. When equity is put front and center, climate adaptation and resilience strategies can address and lessen existing social, racial, and health disparities. When equity is left out or minimized, planning processes can unintentionally widen the gap and worsen these disparities.

Understanding the local context

Our team recognizes the value of understanding the local context of climate action in Vermont and having team members who have expertise in both the subject matter and the state. Our team will take into account the following policy changes and climate efforts in Vermont since CAP was adopted in 2021 to ensure the tool is agile and responsive to new programs and data inputs:

- Vermont Affordable Heat Act was passed
- California's Advanced Clean Cars II regulations were adopted
- California's Advanced Clean Trucks regulation was adopted
- Vermont Building Energy Code was updated
- Vermont Road Usage Charge Study (Vtrans)
- Carbon Reduction Strategy (Vtrans)
- Vermont Smart Growth, VMT and GHG Research (Vtrans)

Task 1: Data Governance Plan

A comprehensive data governance strategy will ensure effective design, development, and continual maintenance of the tool as a data-driven decision-making interface for Vermont and the public. The DGP will detail data policies to efficiently and securely collect and store data elements (such as the GHG inventory) that can ultimately connect with interoperable systems (for example, the tool) to support [existing and future reporting products](#).

Mathematica will draw on its substantial experience of climate policy work, technology standards and processes, and stakeholder engagement practices to deliver a robust DGP created in collaboration with the DGT.

Systematic review of data sources

The systematic review will examine legislative and regulatory requirements at the state and agency levels to document management and security policies. We will review three to five existing tools and/or frameworks relevant to Vermont, along with available GHG inventories, that the Agency and CAO provide to our team.

Example existing datasets for review

- [Historical climate data \(e.g., temperature, precipitation\) and future climate scenarios available from NOAA](#)
 - [Vulnerable infrastructure from Vermont Transportation Resilience Planning Tool \(Vtrans\)](#)
 - [Housing Data from Vermont Housing Finance Authority](#)
 - [Flood Ready Vermont Atlas](#)
 - [Vermont Heat Vulnerability Index from VT Dept of Health](#)
 - [Vermont Social Vulnerability Index from VT Dept of Health](#)
-

The project team will also review existing water quality data and ongoing University of Vermont Extension analysis of agricultural policies in the CAP to ensure continuity in approach. Our review will help us identify recommendations for the DGT and DGP in Task 1 and will inform development of the logic models and evaluation of future data needs, discussed further in Tasks 2 and 3.

Ensuring that data are curated and organized so they are understood, well managed, and fit for use is critical for making informed decisions. To organize findings and draw out information during the systematic review, we will develop a structured extraction template, which will evaluate each data source on key criteria: ownership, collection, storage, security requirements and access. The team will share findings of the systematic review with the CAO director and the Agency to inform recommendations for the DGT and potential content for the DGP.

Data Governance Team

The DGT will consist of members with knowledge in evaluating data ownership, collection, storage, security, access, and usability. To determine team members, we will use findings from our extraction template combined with CAO director and Agency recommendations. Mathematica will employ our engagement strategy outlined in Task 0 to conduct and facilitate two or three 60-minute meetings with the Agency and CAO director to discuss recommendations for the DGT and proposed content for the DGP. During the initial meeting, Mathematica will present consolidated findings from the structured extraction template, explain criteria used to evaluate each of the three to five relevant tools and frameworks, and collaborate on DGT recommendations. For the second and potential third meeting, Mathematica, the Agency, and CAO director will continue finalizing members of the DGT and proposed content for the DGP. The team will employ our previously stated engagement strategy to capture key takeaways from discussions, inform the deliverables, and ensure we accurately reflect key perspectives.

Data Governance Plan

Strong data governance policies and procedures will also support the Agency's vision for bringing together disparate climate data sources into a unified data management system that is highly scalable, maintainable, and interoperable with research and data analytic needs. The team will use findings from the systematic review to draft the DGP in collaboration with the CAO director and in alignment with strategies and practices identified by the DGT. It will be critical to understand the processes involved in operating the data sources and collaborate with the people who own or use the data to effectively create a DGP that centers sustainable data management and accessible data for educational and decision-making purposes. The DGP will also support the identification of team roles necessary for implementing the policies and procedures.

Data Governance Plan

The DGP will be a collection of documents that speak to the establishment of five items:

1. Standards and processes for managing changes to the data and to ensure sustainability over time.
 2. Standards and processes for sharing data
 3. Security standards to protect data and implement privacy standards
 4. Data storage and retention policies
 5. Strategies for long-term data quality and usability
-

When Mathematica, the Agency, and the CAO director finalize a list of proposed members of the DGT, Mathematica will facilitate outreach to members and schedule two or three 60-minute meetings. During the initial meeting, Mathematica will present proposed contents of the DGP and

gather additional input and recommendations from members of the DGT. As part of the collaboration process, and to ensure we accurately reflect key perspectives, we will invite the DGT to provide input on the draft DGP as we develop it with the Agency and CAO director (second and third meetings).

Task 2: Logic Model Development and Metric Creation

A collaborative multistep process will characterize our support under Task 2, building upon work conducted on Task 1 to set up the DGT and conduct the systematic review of Agency materials related to strategies and actions under pathways in the CAP.

Scope logic model development process and use cases

As the logic models are the backbone for the data management and eventual decision-support tool, it is critical that key interest holders in the CAP buy into the process and feel reflected in its outcomes. To ensure the logic model design process is collaborative, we will hold up to four meetings with the DGT, S&D subcommittee, and Agency staff to identify a group of key interest holders to involve throughout the process, called the design team (see Exhibit 4 for Task 2 stakeholder meetings and objectives). The design team will be the group of key interest holders with whom we meet periodically to guide us through the process of developing the logic model. We will begin with a process scoping meeting with these key interest holders with two primary objectives:

- **Objective 1: Scope the logic model creation process.** We will present a road map for the process of developing logic models and indicators. This will include an overview of our approach to engaging the design team as creative partners in the process over a series of three meetings, using Mathematica's engagement strategy.
- **Objective 2: Collaboratively develop user personas to inform use cases.** It is crucial that we develop the logic models with end users' needs in mind. To this end, we will apply key interest holders' expertise to develop robust user personas for at least five key constituencies: local- and state-level policymakers, local- and state-level elected officials, civil society organizations and nongovernmental organizations, members of Vermont's business community, and the general public. For each audience, we will aim to answer two central questions: (1) What are their information needs related to policies and programs under the CAP? and (2) How do we envision them using the decision support tool to fill their information needs? We will reference these user personas as we develop the logic models and indicators and will use them as inputs to develop comprehensive use cases.

Develop draft logic model and refine with the design team

We will begin by using the CAP and other materials reviewed as part of the systematic review under Task 1 to develop a set of draft logic model diagrams associated with strategies, actions, and subactions carried out under the CAP. Given the volume and complexity of actions carried out under the CAP, we will develop at least one logic model per emissions reduction sector (transportation, buildings, electricity, and other non-energy emissions), as well as one high-level logic model that represents the theory of change across the entire portfolio of strategies and actions. To ensure we prepare the Agency to monitor important implementation milestones and assess the validity of program logic, we will include potential co-benefits and negative externalities, as well as potential unexpected pathways in the logic models.

After developing our set of draft logic models, we will employ the engagement strategy outlined in Task 0 to ensure logic models reflect the complete and shared vision of the Agency and its partners' theory of change under the CAP. We anticipate completing this process at least twice due to the complexity of the pathways under the emissions reductions sectors and adaptation and resilience pathways. The anticipated outcome is a set of finalized logic models and a shared identification of the highest-priority actions under each pathway in the CAP, which will serve as inputs metric identification.

Map indicators to the logic model and refine with the design team

Every linkage in the logic models represents an assumption that the program or policy in question will achieve anticipated changes. Recognizing this, we will strategically use outputs from the systematic review conducted under Task 1 to develop indicators and metrics and map them to prioritized actions and outcomes in the logic models. Doing this will enable the Agency and other users of the decision-support tool to use it to understand the extent to which their programs have achieved implementation milestones and expected and unexpected outcomes, and ultimately to measure the success of their programs in contributing to Vermont's goals of reducing emissions and improving community adaptation and resilience.

Example performance indicators and data sources

- Energy burden data (Efficiency Vermont)
 - Clean energy jobs (VT Dept of Public Service)
 - Electric Vehicle adoption rates (Drive Electric Vermont and Vermont DMV)
 - Direct current Fast Charger installations within 30 miles of all residents (Drive Electric Vermont and US DOE's Alternative Fuel Station Locator)
 - Vehicle miles traveled (Regional planning commissions)
-

Mathematica, in partnership with Ascent, will draft performance indicators (used to understand program implementation fidelity and quality of outputs) and outcome indicators (used to understand if intended or unintended outcomes are taking place) for these steps in the logic model. Due to the volume of indicators, we anticipate aggregating indicators within themes informed by the systematic review conducted in Task 1 and the logic model. As we develop indicators, we will map data sources identified via Task 1 to the indicators to enable Task 3 to support the refinement of the indicator measurement methodologies and identify and fill data gaps. Should the data mapping process in Task 3 identify a mismatch between the draft indicator and the data available, we will collaborate with the DGT and Agency staff to identify solutions and adapt accordingly. We will use our engagement strategy outlined in Task 0 to work with the design team to iteratively refine, validate, and finalize our draft indicators and initial data mapping.

Develop framework use cases and categories

We will further refine the user personas developed during the Task 2 scoping meetings to build a set of up to four use cases to supplement the data mapping process and infrastructure recommendation. For each user persona, we will develop a story to describe who they are, their concerns related to climate change and community resilience, the information they will seek from a decision-support tool, and how accessing the tool will enable them to make informed decisions. When we complete Task 2, the Agency will receive a summary of the framework use cases (up to two pages each) and logic models, including the identified metrics, indicators, and data needs.

Task 3: Data Mapping

The success of using the results and deliverables of Tasks 1 and 2 depends on an intuitive data map that evaluates the applicability of existing data, identifies data gaps and data sources to fill them, and describes how we will extract and transform data. In consultation with the DGT and applying the logic models and expertise of internal and external data managers, we will draw on our experience developing secure, scalable, and flexible data-driven tools, dashboards, and data management solutions to produce a data map that informs the metrics and indicators, data sources and data characteristics developed and selected for the tool.

Stakeholder work sessions and data manager interviews

We will work with the DGT to assess the relevance and viability of data sets currently used in the GHG inventory, as they relate to the overarching goals of the tool. We will host up to three working sessions with the DGT to identify gaps in the data that are currently available and define those gaps with specific metrics and indicators, as informed by the logic models.

With the currently available data, data gaps, and metrics and indicators in mind, we will work with the DGT and Agency Project Manager to solicit recommendations for data managers with familiarity and knowledge of and expertise in both the GHG inventory and additional data sources that the tool can use to maximize users' utility. We will host up to seven interviews with data managers to seek input on available and potential data sources with the following objectives in mind:

- Gain further insight into the GHG data landscape overall, as it relates to Vermont, including specific data source locations and assessments of each data source's accuracy, completeness, reliability, relevance and timeliness.
- Evaluate the applicability of the available data sources against the metrics and indicators defined by the logic models.
- Continue to identify data gaps and specify data sources that have the potential to fill those gaps.
- Define and outline data source-specific processes to extract data from the source to be loaded to the tool's data management application.

Producing and delivering the data map

With the knowledge gained through the working sessions and data manager interviews and using the DGP and logic models produced in Tasks 1 and 2, we will develop a data map that outlines a data pipeline used to build the tool's data management application. We will deliver the data map in the form of a data dictionary, which will define the metrics and indicators by emissions reduction sector, the data sources used to calculate these metrics, and relevant data characteristics for each.

In addition to drafting the plan for extracting data from its source, transforming the data for use, and loading the data into the tool, the data map will consider the data validation necessary to ensure data quality. We will conduct data analysis in preparation for the tool to display meaningful metrics and indicators through data visualizations and custom data sets. By executing the activities outlined in Task 3, Mathematica can be proactive with solutions and troubleshoot potential technical issues in Phase 1 before they arise in Phase 2.

Task 4: Infrastructure Recommendations

Task 4 will support the Agency in cataloguing and reducing GHG emissions by providing it with an action-oriented plan for implementing the tool and describing a vision and foundation for Phase 2. To wrap up Phase 1, the project team will provide the Agency with a short memo and set of slides discussing learnings, considerations, and recommendations for the tool in Phase 2 based on the work completed under Tasks 1 through 3 of Phase 1. The memo will also consider the near- and long-term priorities of the Agency, the DGT, and other key interest holders. In support of the memo, and to enable the Agency to share this work with various audiences, we will also develop a short set of slides presenting the same information but tailored for the DGT, S&D subcommittee, and other key interest holders. While we will work to distill our key learnings, we will ensure the level of detail supports the Agency in developing the specifications and planning for tool development.

D. Past and Current Vermont Projects

Exhibit 5 provides a list of all Mathematica's current or past Vermont projects.

Exhibit 5. Vermont-related projects successfully conducted by Mathematica

Project	Client; period	Description
Outpatient Capacity Assessment	Vermont Green Mountain Care Board (GMCB); 2022–2024	The GMCB has funded this project to provide an assessment of outpatient capacity and technical assistance to support its certificate of need (CON) program. In this project, Mathematica, and our partner Ascendient, provide technical assistance to help prepare for, enhance, and vet CON applications. The team will also analyze capacity to assess Vermont's ability to meet the demand for outpatient surgery and provide recommendations on GMCB data collection processes.
Vermont Health Care Expenditures and Low-Value Care Comparative Analyses	Vermont GMCB; 2022–2023	In this project, Mathematica will perform analysis of comparative health care spending per capita, including an analysis of potentially avoidable service use and/or low-value care. To benchmark health care spending in Vermont, Mathematica compared the total of cost of care growth to the state's economic growth and to health care spending in comparison states. In addition, Mathematica will calculate a measure of low-value services and potentially avoidable use (for example, hospital readmission) using Vermont's all-payer claims database overall and by region, payer, and provider.
All-Payer Model (APM) and Accountable Care Organization (ACO) Oversight Technical Assistance	Vermont GMCB; 2022–2024	Mathematica will provide technical assistance to the GMCB to support the development of Vermont's next iteration of its APM. The primary foci will be to provide policy expertise, conduct data analysis, and assist with stakeholder engagement to develop a global payment methodology for hospitals, which will be a core component of the new APM. Mathematica will also assist with helping GMCB negotiate the terms of the APM with the Centers for Medicare & Medicaid Services (CMS). Other activities on the project include providing technical assistance to support the state's ACO budget review and ACO certification processes and providing technical assistance and program support for the current APM.

Project	Client; period	Description
Hospital Budget Review Process: Assessment and Recommendations	Vermont GMBC; 2022–2024	Mathematica will support GMBCB to develop and prioritize recommendations for changes to the hospital budget process. Mathematica will recommend modifications to statutes and rules, GMCB policies, and GMCB regulatory guidance that addresses the Board's mission and duties, with emphasis on balancing cost containment, quality, commercial consumer affordability, and sustainability in an environment of payment and delivery system reform. The GMCB can use this guidance for the hospital budget process over time with minimal modifications, such as to establish targets, caps, or benchmarks when needed. A Proposal for Data Analysis and Community and Provider Engagement to Support Hospital Transformation contains proprietary data that can be used only for evaluation and award purposes.
Economic Burden of Untreated Perinatal Mood and Anxiety Disorders (PMADs) in Vermont	Vermont Department of Health, Division of Maternal & Child Health, 2022–2024	Mathematica will conduct a study for the Vermont Department of Health, Division of Maternal & Child Health to produce accurate, relevant, and understandable estimates about the costs of PMADs in Vermont. The team will develop an evidence-based mathematical model to calculate the societal costs of PMADs in Vermont, which will account for medical and nonmedical treatment costs due to shorter- and longer-term consequences on maternal and child health. Through the study findings, Mathematica will highlight the costs and consequences of PMADs.
Statewide Analytics Vendor Related to the All-Payer ACO Model	Vermont GMCB; 2018–2024	In this project, Mathematica, in conjunction with subcontractor Onpoint Health Data, will produce monitoring and performance reports for health care cost, quality, and population health measures using an all-payer claims database, validate Vermont's performance calculations produced by CMS, and provide analytical support to evaluate payer-differential and ACO rates. Based on the Vermont All-Payer ACO Model agreement between Vermont and CMS, Vermont is exploring new ways of financing health care with Medicare's participation, through an ACO-based delivery model. The All-Payer ACO Model is an alternative payment model for ACOs that enables the three main payers of health care in Vermont—Medicaid, Medicare, and commercial insurance—to pay for health care differently from fee-for-service reimbursement and provides an opportunity for alignment across payers. The agreement contains a number of reporting requirements that will be essential for the state and CMS to monitor and evaluate the model. This monitoring and evaluation activity will also inform the state's policy decisions. Project activities include calculating all-payer total cost, ACO attribution rates, payer differential, and population health and quality measures; developing data visualizations; and facilitating change management activities. We could perform additional analyses based on the state's needs.

Project	Client; period	Description
Five-year grant to develop, implement, and evaluate a Transition Work-Based Learning Model	State of Vermont, Department of Disabilities, Aging, and Independent Living, Division of Vocational Rehabilitation (DVR); 2017–2021	The DVR received a five-year grant from the U.S. Department of Education, Office of Special Education and Rehabilitative Services, Rehabilitation Services Administration to develop, implement, and evaluate a Transition Work- Based Learning Model. Vermont DVR piloted the Linking Learning to Careers (LLC) model to provide work-based learning experiences in integrated settings under the vocational rehabilitation (VR) program, enrolling 800 high school VR clients (students with disabilities) statewide. The goal of the demonstration was to improve students' post-school outcomes. The LLC innovation connected regional community college career consultants with state VR services and school programming. Providing the following services enhanced these immediate connections: (1) a targeted continuum of work-based learning opportunities, including at least one employer-paid position in integrated, competitive jobs; (2) two statewide assistive technology specialists; (3) college mentors; (4) expanded postsecondary college courses during high school; and (5) additional transportation funding and training. Mathematica evaluated the intervention on youths' early career outcomes using a randomized controlled design that produced evidence that met the What Works Clearinghouse design standards. We also provided Vermont DVR with regular formative assessments based on management information system data. The five-year contract culminated in a set of reports documenting the findings of the formative and summative evaluations. We used the RAPTER® platform and licensing agreement for enrollment and random assignment, released three issue briefs on LLC implementation, and conducted an ongoing formative assessment for the client.
Evaluation Services Related to the State Innovation Model Grant	Vermont GMCB; 2013–2014	Mathematica evaluated payment and delivery reform initiatives funded by Vermont's State Innovation Models (SIM) Grant. Specifically, we developed performance measures, benchmarks, and an evaluation framework for payment and delivery system reform pilots that used three payment models (bundled payments, shared savings programs, and pay for performance programs). Mathematica evaluated the payment models' effects on health care expenditures, health outcomes, coordination and quality of care, and the unintended consequences of payment reform. The evaluation provided the state with evidence to determine the success of the SIM project and pilots, expand successful project initiatives and pilots, improve project initiatives and pilots, and eliminate project initiatives and pilots that did not improve health and lowering cost. The team used a mixed-methods approach of quantitative analysis of claims and other data, surveys of physicians and other health care personnel, and focus groups and key informant interviews with key interest holders. Mathematica also documented Vermont's implementation of SIM infrastructure-strengthening initiatives, such as the expansion of electronic health records, improvements in providers' use of data, and expanded tools to measure patients' experiences.

E. References

Mathematica	
Project title: Regional Climate Action Planning Framework & Monitoring	
Client: San Diego Association of Governments (SANDAG)	
Point of contact	Name: Jeff Hoyos Title: Senior Regional Planner Phone number: 619.699.1932 Email: jeff.hoyos@sandag.org Address: 401 B Street, Suite 800, San Diego, CA 92101
Project title: Hospital Budget Review Process: Assessment and Recommendations	
Client: Vermont Green Mountain Care Board	
Point of contact	Name: Alena Berube Title: Strategic Advisor on Health Policy & Finance Phone number: 802-272-5599 Email: Alena.Berube@vermont.gov Address: Green Mountain Care Board, 144 State Street, Montpelier, VT 05602
Project title: Transitions to Community Living Project	
Client: North Carolina's Department of Health and Human Services (DHHS)	
Point of contact	Name: Janie Shivar, MSW Title: Clinical Project Manager Phone number: 919-855-4800 Email: janie.shivar@dhhs.nc.gov Address: 916 Richardson Dr., Raleigh, NC 27699-2101

II. Price Schedule

PRICE SCHEDULE

A. Fixed Price Deliverables:

Deliverable Description	Fixed Price
Phase 1, Task 0 - Program Management	\$47,752
Phase 1, Task 1 - Data Governance Plan	\$58,645
Phase 2, Task 0 - Logic Model Development and Metric Creation	\$60,182
Phase 2, Task 1 - Data Mapping	\$82,794
Phase 3, Task 0 - Infrastructure Recommendations	\$32,588
Total Project Cost	\$281,961

B. Hourly Labor Rates:

Service Category/Title of Positions	Hourly Rate
Sr. Fellow/Sr. Director	\$381.24
Subject Matter Expert II	\$256.12
Subject Matter Expert I	\$203.06
IT Subject Matter Expert I	\$202.37
IT Analyst	\$149.55
Analyst	\$136.76
Administrator	\$123.91
Associate	\$103.87

C. This contract can be extended up to one (1) additional 24-month period with mutual agreement between both parties at a rate not to exceed 6%.

Name of Bidder: Mathematica

Signature of Bidder: 

Date: 11/17/2023

III. Certificate of Compliance

CERTIFICATE OF COMPLIANCE

For a bid to be considered valid, this form must be completed in its entirety, executed by a duly authorized representative of the bidder, and submitted as part of the response to the proposal.

- A. **NON COLLUSION:** Bidder hereby certifies that the prices quoted have been arrived at without collusion and that no prior information concerning these prices has been received from or given to a competitive company. If there is sufficient evidence to warrant investigation of the bid/contract process by the Office of the Attorney General, bidder understands that this paragraph might be used as a basis for litigation.
- B. **CONTRACT TERMS:** Bidder hereby acknowledges that is has read, understands and agrees to the terms of this RFP, including Attachment C: Standard State Contract Provisions, and any other contract attachments included with this RFP.
- C. **WORKER CLASSIFICATION COMPLIANCE REQUIREMENT:** In accordance with Section 32 of The Vermont Recovery and Reinvestment Act of 2009 (Act No. 54), the following provisions and requirements apply to Bidder when the amount of its bid exceeds \$250,000.00.

Self-Reporting. Bidder hereby self-reports the following information relating to past violations, convictions, suspensions, and any other information related to past performance relative to coding and classification of workers, that occurred in the previous 12 months.

Summary of Detailed Information	Date of Notification	Outcome

Subcontractor Reporting. Bidder hereby acknowledges and agrees that if it is a successful bidder, prior to execution of any contract resulting from this RFP, Bidder will provide to the State a list of all proposed subcontractors and subcontractors' subcontractors, together with the identity of those subcontractors' workers compensation insurance providers, and additional required or requested information, as applicable, in accordance with Section 32 of The Vermont Recovery and Reinvestment Act of 2009 (Act No. 54), and Bidder will provide any update of such list to the State as additional subcontractors are hired. Bidder further acknowledges and agrees that the failure to submit subcontractor reporting in accordance with Section 32 of The Vermont Recovery and Reinvestment Act of 2009 (Act No. 54) will constitute non-compliance and may result in cancellation of contract and/or restriction from bidding on future state contracts.

D. Executive Order 05 – 16: Climate Change Considerations in State Procurements Certification

Bidder certifies to the following (Bidder may attach any desired explanation or substantiation. Please also note that Bidder may be asked to provide documentation for any applicable claims):

1. Bidder owns, leases or utilizes, for business purposes, space that has received:

- ☒ Energy Star® Certification
- ☒ LEED®, Green Globes®, or Living Buildings ChallengeSM Certification
- ☐ Other internationally recognized building certification:

2. Bidder has received incentives or rebates from an Energy Efficiency Utility or Energy Efficiency Program in the last five years for energy efficient improvements made at bidder's place of business. Please explain:

Non-applicable

3. Please Check all that apply:

- ☐ Bidder can claim on-site renewable power or anaerobic-digester power ("cow-power"). Or bidder consumes renewable electricity through voluntary purchase or offset, provided no such claimed power can be double-claimed by another party.
- ☐ Bidder uses renewable biomass or bio-fuel for the purposes of thermal (heat) energy at its place of business.
- ☐ Bidder's heating system has modern, high-efficiency units (boilers, furnaces, stoves, etc.), having reduced emissions of particulate matter and other air pollutants.
- ☐ Bidder tracks its energy consumption and harmful greenhouse gas emissions. What tool is used to do this? _____
- ☐ Bidder promotes the use of plug-in electric vehicles by providing electric vehicle charging, electric fleet vehicles, preferred parking, designated parking, purchase or lease incentives, etc..
- ☒ Bidder offers employees an option for a fossil fuel divestment retirement account.
- ☒ Bidder offers products or services that reduce waste, conserve water, or promote energy efficiency and conservation. Please explain:

We conserve water and electricity. Some of the buildings that we lease also conduct waste diversion programs that utilize recycling programs that divert approx. 45% of building waste from landfills.

4. Please list any additional practices that promote clean energy and take action to address climate change:

Please see Attachment A for more information

E. Executive Order 02 – 22: Solidarity with the Ukrainian People

- ☒ By checking this box, Bidder certifies that none of the goods, products, or materials offered in response to this solicitation are Russian-sourced goods or produced by Russian entities. If Bidder is unable to check the box, it shall indicate in the table below which of the applicable offerings are Russian-sourced goods and/or which are produced by Russian entities. An additional column is provided for any note or comment that you may have.

Provided Equipment or Product	Note or Comment

Bidder Name: Mathematica Inc. Contact Name: Tamara Barnes
 Address: 600 Alexander Park Fax Number: N/A
Suite 100 Telephone: (609) 275-2202
Princeton, NJ 08540 E-Mail: Legal@mathematica-mpr.com
 By:  Name: Tamara Barnes, Chief Compliance Officer
 Signature of Bidder (or Representative) (Type or Print)

END OF CERTIFICATE OF COMPLIANCE

Attachment A

Executive Order 05 – 16: Climate Change Considerations in State Procurements Certification



Current Sustainability Practices in Place at Mathematica....

- Waste Diversion Programs in place at a few sites. Through recycling practices, this program reduces the amount of waste that is sent to landfills. The recycled materials (paper, glass, plastics, cardboard) are diverted and processed for reuse.

At the Princeton Site the following upgrades have been implemented over the last few years:

- Restroom Automation Equipment – AutoFlush, AutoFaucet, AutoSoap.
- Light Fixture Upgrades – Replaced pendant, fluorescent and HID fixtures with LED fixtures.
- Bike Rack installation.
- Green Cleaning Supplies – Since 2008, our janitorial vendor has utilized only Green cleaning supplies and recycled paper products that meet or exceed EPA guidelines.
- Electronic Recycling Events
- Rain Sensors for irrigation System
- Office Light Sensor Switches

Appendix A

Reporting Requirements

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Evaluation of Climate Action Plans and C40's Thematic Networks

Final Report

November 2020

Anthony Louis D'Agostino, Sara Bryk, Sam Studnitzer, and Anu Rangarajan

Submitted to:

Children's Investment Fund Foundation
Project Officer: Shishusri Pradhan
Contract Number: 51023

Submitted by:

Mathematica
505 14th Street, Suite 800
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Telephone: +1-609-799-3535
Project Director: Anthony Louis D'Agostino, PhD

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We would like to thank the numerous people who took the time to share with us their experiences and observations on climate action planning and participation in C40's thematic networks, including Alex Johnson, Alison Brizius, Amalie Østergaard, Aubrey Germ, Jørgen Abildgaard, Andrea Magarini, Anna Mitchell, Bjorn Hugosson, Carina Borgstrom-Hansson, Carl Spector, Cecile Faraud, Chris Derksema, David Gordon, Dolly Oladini, Drew Kodjak, Fernanda Barbosa, Helen Ho, Hrönn Hrafnisdóttir, Irene Skoula, Irma Ventayol, Irma Soldevilla, Isabel Riboldi, Jenn Hatch, Jonathan Walter, Kate Nobel, Kathryn Goldman, Katie Shammass, Kevin Austin, Lisa McNeilly, Manuel Olivera, Maribeth DeLorenzo, Mariola Panzuela Malgosa, Mark Brostrom, Max Jamieson, Michael Bankole, Michael Doust, Milag San-Jose Ballesteros, Monica Abril, Natalie Isaac, Nick Godfrey, Nik Midlam, Philipp Rode, Ratih Puspitasari, Roland Hunziker, Sabrina Dekker, Shayna Hirshfield-Gold, and Stefania Amato.

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List of acronyms

ASAP	Action Selection and Prioritization
BAU	Business as usual
BEIS	United Kingdom Department for Business, Energy and Industrial Strategy
C40	C40 Cities Climate Leadership Group
C2I	Cascade to Impact
CAP	Climate Action Plan
CBE	Consumption-based emissions
CFF	C40 Cities Finance Facility
CFO	Chief Financial Officer
CIFF	Children's Investment Fund Foundation
CLIC	Climate Leadership in Cities
CNCA	Carbon Neutral Cities Alliance
CSP	City Solutions Platform
CUT	Coalition for Urban Transitions
DAC	Development Assistance Committee
D2020	Deadline 2020
E&B	Energy & Buildings Initiative
ECWD	Empowering Cities with Data
ESAO	East, Southeast Asia, and Oceania
EU	European Union
EV	Electric vehicle
FSCI	Financing Stable Cities Initiative
GCOM	Global Covenant of Mayors
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GHG	Greenhouse gas
VAC	Heating, ventilation, and cooling
ICCT	International Council on Clean Transportation

Acronyms

KH	C40 Knowledge Hub
KII	Key informant interview
KPI	Key performance indicator
LEED	Leadership in Energy and Environmental Design
MDB	Multilateral development bank
M&E	Monitoring and evaluation
NDC	Nationally determined contribution
NQR	Network Quarterly Report
OECD	Organisation for Economic Co-operation and Development
ODA	Official development assistance
PS	Participation Standards
RD	Regional director
RE	Renewable energy
SC	Steering Committee
SDG	Sustainable Development Goal
SuDS	Sustainable urban drainage system
TA	Technical assistance
TfL	Transport for London
2CAP	C40-Arup Partnership Climate Action Pathways
UCLG	United Cities and Local Governments
ULEZ	Ultra Low Emission Zone
UNFCCC	United Nations Framework Convention on Climate Change
USDN	Urban Sustainability Directors Network
WHO	World Health Organization
ZEBRA	Zero Emission Bus Rapid-deployment Accelerator
ZEV	Zero emission vehicle



Executive summary

The Children's Investment Fund Foundation (CIFF), one of C40's strategic funders, commissioned Mathematica to conduct an independent evaluation of two major components of C40's direct support: the development and execution of city-level climate action plans (CAPs) that comply with the 1.5°C target enshrined in the Paris Agreement, and the thematic networks through which cities engage in peer-to-peer exchange and collaborative learning across a range of climate policy domains. This report is the result of three complementary data collection components, including 40 semi-structured key informant interviews with city officials, C40 technical staff and leadership, researchers, and representatives of other organizations who engage cities in climate policy; quantitative analysis of climate data that cities have reported to the CDP platform; and a review of nine CAPs against a newly created assessment framework. The evaluation's scope entailed assessing the current status of both climate action planning and thematic network activities, appraising the outputs resulting from their efforts, and diagnosing opportunities for improvement.

Climate action plans



C40's leadership and resources have been instrumental in mainstreaming a target of cities achieving carbon neutrality by 2050, establishing the frameworks for developing plans in service of that goal, and mobilizing assistance to support cities as they concretize their action plans and push actions forward. Although fewer than 15 of C40's member cities have thus far published a 1.5°C CAP, all 96 are expected to by Q2 2021. The CAPs are city-led vision documents that reflect local priorities and vary dramatically in their specificity of expected mitigation and adaptation actions, monitoring plans, and approach to coordinating climate action across agencies and higher levels of government. Many CAPs emphasize the equity aspect of their climate policy vision, such as redressing inequities that climate change may otherwise exacerbate, and have engaged in broadband consultations to seek public buy-in. Cities' engagement with C40 in the development and design of their plans has differed dramatically, owing to many factors, such as varying levels of experience in climate action planning and overall resource availability. Engagement for some cities has been limited to receiving grants to hire external consultants for targeted work, while others are participating in a complete technical assistance program with an embedded city advisor.



As cities have only recently begun publishing Paris-compliant CAPs, robust evidence is yet to be available about the most binding constraints to achieving decarbonization targets. Interviewees and CAPs indicate access to finance and limited city powers are among the more significant challenges in actualizing CAP plans, for which C40 runs initiatives such as the Cities Finance Facility and the City Diplomacy program to respectively address those challenges. Achieving CAP objectives will require cities to broadly share zero carbon strategies. Therefore, collaboration with regional and national government counterparts, the private sector, and citizen stakeholders will be

essential. Cities are tending to prioritize their climate actions in the most emissions-intensive sectors over which they possess mayoral powers and are focusing their initial efforts on actions to be undertaken in the next 5–10 years.



Member cities will continue to regularly report greenhouse gas (GHG) emissions to assess their overall progress; in the last two years, about three-quarters of all C40 members have publicly submitted data to CDP. However, only a handful have listed climate actions that if fully implemented would reduce their current emissions by at least 50 percent. Because the overwhelming majority of climate actions are reported as currently in an implementation phase, CDP submissions do not provide much information about the mitigation contribution of planned actions that are not yet underway. As a result, CDP data submissions underestimate cities' combined current and planned mitigation actions. In addition to GHG monitoring, cities plan to track key performance indicators at the sector level, such as buildings' average energy consumption per square meter and the zero-emissions vehicle share. Cities currently lack a standardized framework to guide data collection efforts and recommendations on how data analysis should inform course-correction and action timetables.



Throughout the stages of CAP planning and design, execution, and progress monitoring, cities will be accumulating substantial knowledge about best practices and lessons learned, some of which will appear as knowledge products on the recently launched C40 Knowledge Hub website. Although these publicly available resources will aid both C40 and non-C40 cities, city officials will continue to rely on their personal contacts developed through network participation as a key source of information-sharing and advice.

C40's thematic networks



C40's 17 thematic networks continue to engage cities in peer-to-peer learning through webinars, deep dive phone calls, study tours, trainings, and annual workshops. Network size varies between 14 and 39 members each, and cities participate in an average of four networks. Member cities define the networks' strategies and objectives, which are frequently informed by the relevant C40 declarations. Each declaration may overlap with multiple networks. Consequently, network activities are also built around Paris Agreement targets.



C40 is on the cusp of adapting its organization-level Participation Standards to the networks, which will require that cities demonstrate they are converting network resources into climate action progress to maintain their membership. The Air Quality network is piloting the establishment of network-specific standards that more broadly are envisioned to focus network attention on a small number of high-value actions that generate synergies across cities with similar workplans. C40 has refreshed how it monitors network effectiveness, and the organization's recently developed tracking tools focus on routinely assessing cities' remaining barriers to actions that are pertinent to a given network. Systems are in place to facilitate peer-to-peer conversations where productive, and to coordinate with other networks and C40 service delivery components on areas ranging from improving GHG inventory data quality to pre-procurement discussions with businesses.



Knowledge transfer both among cities and between C40 and the cities is a core objective throughout all network activities. Networks actively generate case study and topical content to be included in the Knowledge Hub, which is a starting point for interested cities

to understand policy options, timelines, organizational structures, and the impacts of possible actions. Although the networks are vehicles for publicly documenting best practices and lessons learned, city officials report that much of their learning comes from in-person events and the trust that repeated interaction builds among peers to also share failings and mistakes that fellow network members can avoid duplicating. City officials are aware of which peer cities with comparable governance arrangements have been most successful in pursuing climate policies of interest, and actively leverage C40’s network staff to facilitate connections when relationships do not yet exist.

Summary and recommendations

Interviewees across all stakeholder groups praised C40 for what they say is some of the most innovative global climate work taking place at the city level. C40 staff are committed and passionate about the organization’s mission, and city officials have come to rely on C40’s agenda-setting, frameworks, and coalition-building capacities. C40’s theory of change revolves around advancing science-based climate policy through programs at both political and technical levels and is responsive to the reality that mayoral leadership and effective technical capacity are pre-conditions for cities to contribute their share in advancing mitigation and adaptation progress. As with even the most effective efforts, there is always room for efficiency gains and further fine-tuning. In Table ES.1, we summarize our key recommendations for C40 to strengthen its climate action planning and thematic network activities. Although we believe that C40 is positioned to lead on many of these recommendations, others will be best led by the cities themselves. By diffusion through C40 networks, such cities can leverage individual changes into large-scale action. We recognize that resource availability will limit which recommendations can be pursued but believe that ongoing dialogue among C40, its member cities, and its funders will both establish priorities and allocate leadership.

Table ES.1. Summary of recommendations for climate action planning and thematic network activities

Maturity stage	Climate action planning	Thematic networks
Planning and design	Support cost estimate planning earlier in CAP formulation	Continue exploring regional network models to leverage economies of scale and common policy approaches
Execution	- Build implementation-stage resources, tools, and supports, such as C40 Cities Finance Facility, to prepare for eventual demand surge - Support cities in identifying best practices for addressing consumption-based emissions	
Progress monitoring	- Seize opportunities to rigorously monitor pilot programs to identify the most cost- and carbon-effective approaches before scaling citywide - Develop standardized guidance on key performance indicator identification, data collection, and prioritization	- Continue to prioritize measuring C40’s contribution to alleviating barriers to action instead of outputs, and rely more on qualitative data collection - Tighten coordination across C40 service delivery components with respect to information and data requests
Knowledge transfer	Formalize more opportunities for intra-regional collaboration and lesson-sharing	- Retool C40’s website to more effectively drive Knowledge Hub traffic - Provide more tools and links to existing resources on Knowledge Hub



I. Introduction

At the United Nations Framework Convention on Climate Change's (UNFCCC) COP21 meeting in 2015, heads of state signed the Paris Agreement, which committed them to "pursue efforts" to restrict global temperature growth to 1.5°C above pre-industrial levels. Though lacking any enforcement mechanism, the agreement requires signatory countries to submit and periodically update nationally determined contributions (NDCs) that outline their emissions reduction plans.

The NDCs submitted to date fall short of achieving the Paris targets, with existing pledges and targets setting a course for 2.8°C of warming by 2100.¹ Major emitters like China and India continue to register significant greenhouse gas (GHG) emissions growth. Insufficient progress by national actors, coupled with increasingly dire scientific predictions on the possible impacts of exceeding the 1.5°C threshold (e.g., IPCC 2018), have laid bare the need for climate action to be undertaken at all governance levels.

Spurred by this urgency and the slow response of federal governments, cities have become outspoken actors by setting ambitious emission reduction targets themselves. C40, a network of global megacities committed to fighting climate change, has been one of the most visible organizations to engage, support, and amplify city-level climate action. Through the Deadline 2020 (D2020) modeling work jointly conducted with Arup, C40 developed a framework for cities to develop mitigation pathways that are compatible with the targets of the Paris Agreement (C40 and Arup 2016a).

The Children's Investment Fund Foundation (CIFF) commissioned Mathematica to evaluate two components of C40's service delivery that lean heavily on the D2020 work. We first examine the processes and outputs of the climate action planning activities that C40 has organized, as well as a subset of plans published both by C40 and non-C40 cities to assess whether plan targets are consistent with D2020 objectives. The second evaluation focus examines the current status of the 17 thematic networks that C40 manages, through which cities with shared interests in specific sectors, such as buildings or transportation, engage in peer-to-peer learning, collaboration, and lesson-sharing among members.

The evaluation's scope prioritized assessing the current status of these two strands of programming, appraising the outputs resulting from their efforts, and identifying opportunities for improvement. As such, this report builds upon earlier independent evaluations and studies of C40 that have addressed the organization's role and position in global climate governance (COWI 2013), overall effectiveness (Attström et al. 2016), and an earlier phase of C40's climate action planning technical assistance (Gogoi et al. 2018). Before turning to the research questions and evaluation methodology, we provide a brief overview of C40, focusing in particular on Climate Action Plans (CAPs) and the thematic networks.

¹ [Climate Action Tracker](#) updates the predicted temperature increase as new NDCs are submitted.

A. Brief overview of C40 service delivery

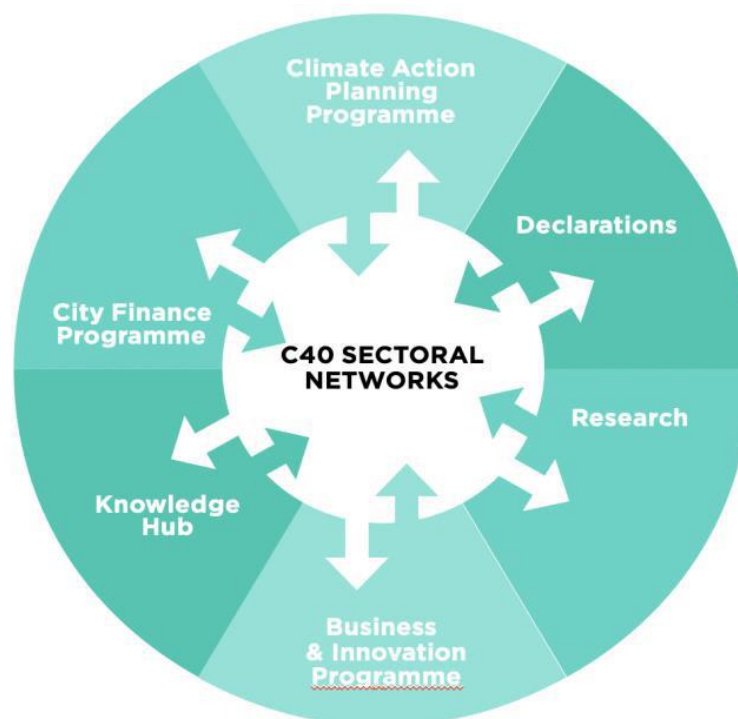
Founded in 2005 by then-mayor of London Ken Livingstone, C40 today brings together nearly 100 of the most renowned, global cities that publicly commit to leading on climate change (see Table A.1 for the list of all member cities by region). C40 membership does not entail dues, but member cities must comply with “participation standards” to retain their membership. Some of these standards are mandatory, and others are recommended. Mandatory standards include completing a GHG inventory using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) standard, completing an action plan to reduce GHGs and adapt to climate change, and participating in thematic networks, among others. Each outcome is assigned a number of points upon completion. Similarly, cities need a minimum number of points to remain in good standing. For example, cities receive points when their mayor attends the Mayors Summit and when their city hosts a network workshop. Cities that outperform their regional peers in point totals receive public recognition to provoke “friendly competition,” which is designed to propel their peers forward.²

Unlike other city-level climate network organizations, C40 members who fall short of the participation standards are temporarily classified as “inactive,” which makes them ineligible to receive a city advisor or other direct support from C40. Such cities are given a grace period to remedy their deficit and demonstrate their commitment to C40 principles. Failing subsequent progress, these cities are removed from the organization, and C40 extends an offer to an interested city in the same region whose priorities align with pursuing robust climate policies. At the time of this evaluation, the C40 network consisted of 96 cities.

Historically the sectoral, or thematic, networks have been the staple feature of C40’s offerings. Figure I.1 illustrates their centrality, highlighting the interplay between the networks and C40’s other service components, such as the climate action planning program, the various global declarations onto which mayors sign, and the business and innovation program. For example, the New Building Efficiency network supports cities in incorporating energy efficiency standards into their climate action plans, which in turn may result in discussions and workshop presentations targeting best practices in enforcing compliance with those standards. We describe C40’s climate action planning and thematic networks service delivery components in greater detail below, and throughout the report refer to other aspects of C40 services, such as the City Solutions Platform (CSP) or the Empowering Cities with Data (ECWD) program, where appropriate.

² This blog post from 2018 recognizing cities based on their 2017 performance is one such example: https://www.c40.org/blog_posts/participation-standards-2017.

Figure I.1. Linkages between thematic networks and other C40 service delivery components



Source: C40 2020b.

C40 engages cities at both technical and political levels with the majority of C40's work focused on the former. City officials from relevant departments (e.g., planning, environment, transportation, etc.) participate in the thematic networks and may be directly involved in C40-supported direct assistance. Correspondingly, C40's team includes technical staff with domain knowledge in sectors such as food, transportation, and buildings, who may be embedded in cities as a city advisor, or may be based in C40's London or New York offices. C40's network managers are the main point of direct contact for city officials with C40, and in the more popular networks may have additional support staff to assist them. The regional directors (RDs) are the lead liaisons between C40 and the mayors' offices for each region, and are in regular contact with C40's network and technical staff to identify potential matches between C40 service components and member cities' interests and needs.³ At the political level, C40's signature event is the World Mayors Summit, where mayors themselves engage in lesson-sharing, target-setting, and conversations with the private sector and civil society. Copenhagen hosted the 2019 Summit, which was attended by more than 1,700 delegates and representatives from 120 cities (C40 2019c).

1. Climate action planning

In recent years, C40 has incorporated the development of CAPs as a central objective for the organization, with the publication of a Paris Agreement-compliant CAP as one of the participation

³ The regions are Africa; Central East Asia; East, Southeast Asia, and Oceania; Europe; Latin America; North America; and South and West Asia.

standards. CAPs build on a long history of cities writing climate, environmental, and/or sustainability plans to document the programs, policies, and actions they will undertake to achieve specific objectives.

CAPs are road maps devised by cities to guide both their mitigation and adaptation climate policies. The current generation of Paris-compliant CAPs, also referred to as D2020-compliant, or 1.5°C-compliant, depart from previous vintages of plans primarily in their higher level of ambition and greater focus on science-based target-setting. CAP elements include sector-specific targets, a focus on actionable items as opposed to aspirational outcomes beyond legislative or regulatory control, tracking indicators, and monitoring timetables.

C40 has developed several supports to aid cities in developing plans. Their [Climate Action Planning Resource Centre](#) contains guides on conducting GHG emission inventories, driving adaptation and inclusive climate action, and features the Climate Action Planning Framework, which specifies the elements of a CAP which is compatible with the Paris Agreement (C40 2020c). We provide further detail on the current status of C40's climate action planning work in Chapter II.

2. Thematic networks

C40 leads 17 networks that are each organized with a sectoral focus, such as energy efficiency in privately owned buildings, mass transit, or sustainable waste management.^{4,5} Most peer-to-peer exchange occurs through networks, via webinars, workshops, study tours, and other events organized for network members. Cities often join networks because of alignment with policies and programs they are actively pursuing or anticipate pursuing. To join a network, city officials discuss their interests with their respective C40 regional director and C40 network manager, to ensure sufficient overlap between the network's priorities and the city's objectives. Cities will nominate one or more members of their technical staff with appropriate background in the sector to serve as lead representatives. These staff are expected to share key findings with their colleagues and regularly report on their participation to the city's focal point, the city official who acts as the main liaison to C40 on network-related efforts. C40 network staff request city officials to commit 3-5 hours per month to be properly involved in a network.

B. Research questions and evaluation methodology

The evaluation is structured around answering two top-level questions:

- How effective is C40 assistance in supporting cities as they develop, implement, and sustain CAPs that comply with the Paris Agreement?
- How are C40 networks supporting cities and fostering efficient knowledge transfer within and across network members to implement the necessary actions and climate policy?

Fully answering those top-level questions requires deeper examination of the multidimensionality of CAPs and networks. In particular, it is critical to consider aspects such as city-level governing capacity,

⁴ Figure 4.1 provides a list of the networks that are currently active.

⁵ C40's networks have been the subject of active academic literatures examining the devolution of climate governance from nation-state to city (e.g., Acuto 2015, Acuto and Rayner 2019, Gordon and Johnson 2018) and the role of socialization and learning in city-level climate networks (e.g., Haupt et al. 2019, Lee 2019).

coordination of efforts, alignment with evidence-based policy recommendations, constraints and bottlenecks, and the appropriateness of C40 service delivery. Further investigation is necessary to determine whether political, financial, human resource, or logistical constraints are salient obstacles to following through on CAP objectives. To provide structure in assessing these aspects, we use a maturity stage framework that focuses on the progression of activities and C40-city engagement from the planning and design stage, to execution, to monitoring progress, and lastly, to learning and knowledge transfer. Table I.1 lists these supporting research questions by maturity stage for both CAPs and thematic networks.

Table I.1. Overview of evaluation research questions

Maturity stage	Climate action plans	Thematic networks
 Planning and design	• How is city-C40 partnership on CAPs initiated? Are cities taking the lead in requesting assistance? • How does C40 increase city buy-in to develop a CAP? How is C40 assisting cities in devising a CAP? • Can CAP development be expedited? • Will CAP actions be compliant with Deadline 2020 requirements? • Are cities prioritizing action sequences in line with the 2CAP recommendations and/or priorities established in the C2I? • How detailed are the CAPs? What do they include? What do they exclude? • Are CAPs compliant with C2I targets and “Focused Acceleration” road maps?	• What role is there/should there be for non-member cities in networks? • How are networks’ objectives set and updated? • How does C40 determine whether network objectives are sufficiently ambitious?
 Execution	• What advocacy strategies are cities adopting to lobby regional and national governments? • What are the most difficult challenges cities face in executing their CAP? What remedies can C40 provide? • What are concrete ways in which CAPs have influenced city operations and non-government actors?	• What is the current status of C40’s 17 networks? What are their most visible acts of progress over 2017–2020? • What services are networks providing to members? • How are networks building local/regional capacity? How does C40 ensure the sustainability of this capacity? • How have networks responded/adapted to changing needs and capabilities? • What opportunities exist for delegating more responsibility to cities?

Maturity stage	Climate action plans	Thematic networks
 Progress monitoring	• What plans/procedures do cities have for tracking specific actions? • How will CAPs evolve if actions ultimately are deemed infeasible or fail to generate their anticipated GHG reductions? • How does C40 plan to assess or rank cities' CAP progress? • How do C40 cities' mitigation actions compare with those of non-C40 cities? What is the status of their actions?	• How have C40-wide participation standards, McKinsey's "Focused Acceleration" report, and the C2I influenced network-specific standards? • What monitoring systems exist to track city-level progress? How is this information shared with other C40 teams? How does a city's progress affect their network membership status? • How are peer-to-peer interactions taking place? How does C40 attribute cities' action adoption/implementation to participation in a network, or specific interactions?
 Learning and knowledge transfer	• How will existing knowledge on CAP development, implementation, and progress be shared with C40 and non-C40 cities? What regional initiatives exist to streamline lesson-sharing across all phases of CAP design and execution? • How will knowledge/experience be integrated into the KH? How will KH resources be promoted to cities more broadly?	• How does C40 translate insights from individual cities' network-specific experiences to benefit C40 more broadly? • How has learning from network members been disseminated to non-network C40 members and non-C40 cities? • How will existing network-based knowledge be integrated into the KH? How will the KH's role in supporting the networks/peer-to-peer-exchange be evaluated?

Notes: 2CAP = C40-Arup Partnership Climate Action Pathways; C2I = Cascade to Impact; CAP = Climate Action Plan; KH = C40 Knowledge Hub

Our research methodology leverages three distinct data sources:

- Key informant interviews (KIIs)
- CAP documents
- Publicly reported climate data submitted by cities to CDP

We provide further description below on how each of these data sources were collected and analyzed.

1. Key informant interviews

We conducted a total of 40 KIIs across a range of stakeholder groups. Most interviews were conducted with city officials from C40 cities, city officials from non-C40 cities, and with C40 staff. We describe below the focal themes of these interviews. We also interviewed staff from organizations that collaborate with C40 on city-level climate change policy and programming, and independent researchers. Through these interviews we sought external perspectives on C40's programming and to understand the experience of organizations that partner with C40, and how such partnerships translate to support for advancing city-level climate action.

Interviewed cities were selected to obtain a representative sample of C40's membership in terms of geography, socio-economic development, and current status of climate action planning activities.

When possible, C40 recommended city officials who participate in their city's climate planning work as well as network activities. Interviewees who actively participate in networks of strategic interest to CIFF, namely the Air Quality, Zero Emissions Vehicles, Food Systems, Clean Construction Forum, and Clean Energy networks, were prioritized. We interviewed city officials from both C40-member and non-C40 cities to identify notable groupwise differences. Interviews with non-C40 cities provided an opportunity to assess how non-members utilize C40-created materials, and to gauge their perceptions of possible benefits from participating in city-level climate action networks. Requests for interviews with additional cities went unfulfilled, coinciding with the worldwide rise of COVID-19 cases diverting city officials' efforts to other priorities. Table I.2 lists the final set of interviewed cities, along with icons denoting the city's publication status as a 1.5°C- or 2.0°C-compliant CAP.

Table I.2. List of cities interviewed for the evaluation and status of current CAP

C40 Interviewee Cities		Non-C40 Interviewee Cities	
Accra (Ghana)		Baltimore (USA)	
Barcelona (Spain)		Dublin (Ireland)	
Boston (USA)		Edmonton (Canada)	
Copenhagen (Denmark)		Oakland (USA)	
Jakarta (Indonesia)		Reykjavik (Iceland)	
Lagos (Nigeria)			
Los Angeles (USA)			
Melbourne (Australia)			
Milan (Italy)			
Quito (Ecuador)			
Stockholm (Sweden)			
Sydney (Australia)			
Washington, DC (USA)			

Note:  Denotes a city that has published a 1.5°C-compliant CAP.

 Denotes a city that has published a 2.0°C-compliant CAP. Cities that have published CAPs, but whose compliance with the Paris Agreement is either unverified or falls short of 2.0°C-compliance, are listed without icons.

C40 staff interviewees were drawn from a range of seniority levels. Interviewees included directors, regional directors, program directors, senior managers, technical leads, and network managers. C40 interviewees were selected who could speak to the status of climate action planning and networks from the viewpoints of city engagement, technical execution, and strategic direction.

Interviews prioritized action plan development and execution, C40's direct and indirect support for plan development, and pertinent experiences that were otherwise inaccessible to the evaluation team. We were particularly interested in interviewees reflecting on personal experiences, their perceptions, and providing both positive and negative feedback that would not necessarily be captured in publicly available formats such as published plans, supplemental documents, or webinar videos. Program documentation that C40 shared with us helped inform the interview protocols. Interviews lasted

approximately one hour and were conducted by phone or in person.⁶ Most interviews involved a single respondent, but several Global North cities made multiple interviewees available, which enabled city officials to actively engage with one another's ideas and reflections during the conversation. All interviews were conducted in English, except for our conversation with Quito. In advance of all interviews, we provided a list of guiding research questions to establish the contours of the conversation. Separate interview protocols were devised for each interviewee group. With interviewee consent, all interviews were recorded, transcribed, and coded into categories linked to the evaluation research questions. To encourage candid responses, interviewees were informed that they would not be quoted by name in any deliverable, and that interview recordings and transcripts would not be shared outside the Mathematica evaluation team.

2. Assessment of published Climate Action Plans

To formalize insights gained from the KIIs, we devised an assessment framework to analyze the content of published CAPs for nine cities, listed in Table I.3, that were selected by convenience sampling.⁷ Our assessment's purpose is to summarize plan contents, both what is present and what is absent, to highlight features that are common across cities' plans, and to draw attention to best practices that may serve as a model for cities currently developing their own plans.

Table I.3. Key documents used in CAP assessment, by city

City	Key CAP document(s)	Year published	KII interviewee
Barcelona	Climate Plan 2018–2030	2018	✓
Boston	City of Boston Climate Action Plan 2019 Update	2019	✓
Dublin	Dublin City Council Climate Change Action Plan 2019–2024	2019	✓
eThekweni (Durban)	Durban Climate Change Strategy	2014	
London	London Environment Strategy	2018	
Los Angeles	L.A.'s Green New Deal: Sustainable City pLAn 2019	2019	✓
Stockholm	Strategy for a Fossil-Fuel Free Stockholm by 2040	2016	✓
	Climate Adaptation in Stockholm	2017	
Sydney	Environmental Action 2016–2021 Strategy and Action Plan	2017	✓
Washington, DC	Sustainable DC 2.0 Plan	2019	✓
	Clean Energy DC	2018	
	Climate Ready DC	2016	

Note: Additional documents that were reviewed during the assessment are cited in references.

CAP = Climate Action Plan; KII = key informant interview.

Our assessment approach uses indicators that synthesize recommendations from existing climate action-focused frameworks (C40 2019e, 2020c; McKinsey and C40 2017), tracking tools (C40 2019d), academic research on best practices in climate and regional plans (Berke and Godschalk 2009; Bassett and Shandas 2010; Deetjen et al. 2018), and the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) criteria (OECD 2019). Indicators are

⁶ Jakarta was the sole exception and provided written survey responses by email.

⁷ We reviewed Durban's (eThekweni's) 2014 plan with the expectation of comparing it with the city's 2019 CAP to identify noticeable changes. However, we could not obtain the 2019 plan in time to include it in the analysis.

grouped into the six categories listed in Table I.4 alongside their key themes. The complete list of indicators is organized by category in Table A.2.

Table I.4. Indicator categories used in assessing climate action plans

Indicator category	Key themes
City vision and collaboration	• Alignment with Paris Agreement targets • Prioritization of actions in line with D2020 • Stakeholder engagement • Equity and inclusion • Responsiveness to city context
Powers and responsibilities	• City powers analysis • Resource allocation
Mitigation actions	• Sector-specific efforts to reduce emissions from buildings, transportation, etc.
Adaptation actions	• Efforts to increase resilience to climate hazards
Monitoring and data collection	• Plans for the collection, monitoring, and use of data to inform actions

Our indicator assessment is based on the availability of information in a CAP, and the level of detail of that information.⁸ We interpret cities who provide considerable detail on indicator specifics as more likely to follow through in that particular area and rank them at a higher level. For example, mitigation actions that mention specific policies and programs, reduction targets, monitoring indicators, reporting time frames, and lead entities, would suggest a stronger commitment to action than vague statements that lack quantified values.

3. Analysis of publicly reported climate data

Each year, cities may volunteer to report climate data to global platforms such as [CDP](#) that consolidate information on cities' climate policies and performance. We capitalize on this publicly available data to examine the quantity and magnitude of climate mitigation actions that cities report. Using publicly reported CDP data for 2018 and 2019, our analysis is guided by the following objectives. First, we examine which C40 cities are publicly reporting climate actions. Second, we assess the magnitude of cities' GHG mitigation plans relative to their current emissions, to understand whether reported actions align with the medium-term target of halving emissions by 2030.⁹ Lastly, the CDP data enables us to compare the number of actions reported and the estimated mitigation shares of C40 against non-C40 cities, to evaluate whether C40 cities are in fact advancing more ambitious climate policy. We assess outcomes at both the level of individual cities, and through the six illustrative city-types adopted in McKinsey and C40 (2017). The "McKinsey Typology" assembles city peer groups according to relevant city characteristics, such as average income, population density, current carbon intensity levels, and extent of city powers.

We acknowledge that the majority of C40 cities have yet to complete a Paris-compliant CAP, and that currently available CDP data is an imperfect guide to the actions they will be considering and finalizing

⁸ We are not able to evaluate the accuracy or completeness of the information and assume that any objective statements included in a CAP are factually correct.

⁹ To construct an estimated emissions reductions share, we aggregate reported emissions and estimated emission reductions for each reporting year at the city-level. Cities may report annual emissions by scope (e.g., scope 1, scope 2, and/or scope 3) and/or by sector (e.g., waste, transportation, stationary energy, etc.). If a city disaggregates emissions values by both sector and scope, we use total emissions summed from the sectoral subtotals.

this year. As a result, data on file should be considered to proxy for the level of climate action ambition that cities had before publishing their CAP. Although imperfect, these values serve as an invaluable benchmark against which CDP submissions for 2020 and 2021 should be compared. In particular, subsequent CDP submissions will provide support in distinguishing the contribution that C40's climate action planning activities have made in ratcheting-up cities' efforts.

4. Synthesis of approaches

The multiple approaches encompassed by our methodology support an examination of C40's network and climate action planning activities from various angles. We developed a CAP assessment framework to provide a structured way to engage with the content that would be expected in a plan. This methodological strand generates evidence on what cities have stated they will do, how they expect to do it, and how those expectations are communicated to the public. There is an important backstory that cities do not document in their plans, such as their internal decision-making processes, the challenges they foresee in operationalizing plan actions, and what additional support will be needed to ensure they stay on track, that would be helpful to cities that have not yet devised a CAP.¹⁰ Our key informant interviews address those themes, and through their open-ended format create the space for interviewees to corroborate key ideas in the CAPs and to share their personal experiences, successes, challenges, and concerns that are often undocumented, but which could strengthen service design and delivery. Since the majority of C40 cities have not yet finalized a Paris-compliant CAP, cities' CDP data submissions to date are unlikely to reflect the level of ambition that will be articulated in their eventual CAPs. Regardless, our quantitative analysis offers insight into cities' present and anticipated climate actions, and examines the status of cities' current efforts relative to the goal of achieving carbon neutrality. Throughout the evaluation, we have used insights derived from one research method to inform data collection and analysis in another. For example, our review of CAP documents enabled us to ask more targeted questions of city officials from cities with published plans, while our CDP analysis afforded us the chance to test for comparability between a city's CAP against their actions reported to CDP.

C. Organization of report

The remainder of the report is organized as follows. Chapter II describes how C40 assists cities in climate action planning across the four maturity stages and presents key findings from our interviews with city officials and C40 staff. The chapter addresses research questions related to plan development, the prioritization of climate actions, how action progress will be monitored, and channels for lesson-sharing. In Chapter III, we present our findings from a review of nine cities' CAPs to understand the type of actions and level of detail with which they are reported. We developed an indicator-based assessment framework to analyze their content and highlight where CAP descriptions are exemplary and could serve as best practices for other cities to emulate. In Chapter IV, we report the key findings of our quantitative analysis of publicly reported submissions to the CDP data platform. We examine the magnitude of mitigation actions that C40 and non-C40 cities are reporting and compare performance between these two groups. Chapter V focuses on C40's thematic networks, their current status, and their role in supporting city-level climate action. We offer a set of recommendations in Chapter VI that

¹⁰ We note that C40 uses the CAP Framework (C40 2020c) to assess cities' CAPs for their implementability and their basis in evidence, but challenges that are identified during the framework review process may not be reflected in the CAP document itself.

are based on the KIIs, review of published CAPs, and CDP data analysis, and for each propose a stakeholder group we think is best positioned to lead. Chapter VII offers some concluding thoughts on key opportunities and challenges that lie ahead for operationalizing climate action.

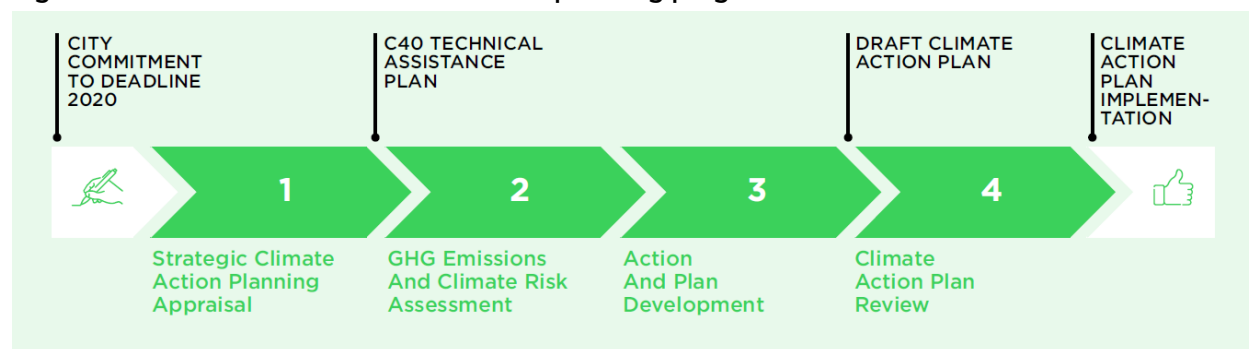


II. Key findings from climate action planning activities

Of C40's 96 member cities, 13 have publicly released 1.5°C CAPs and are working through the initial stages of implementing those actions. The remainder are at varying stages of planning and designing their plans, which will be completed by Q2 2021. Many of those initial 13 cities were members of the Deadline 2020 pilot group that C40 organized to test the feasibility of producing Paris-compatible plans. Those cities participated in workshops and peer-to-peer exchanges through which they compared notes and had access to C40's technical experts to assist with modeling emissions pathways, prioritizing actions, setting targets, and developing stakeholder consultation processes. Their experiences revealed the types of assistance that the remainder of C40 cities would plausibly need to start the plan development process themselves.

C40 has institutionalized the support it will provide to members to develop a Paris-compliant CAP in a climate action planning program, summarized in Figure II.1. The program, which supports cities who have committed to lead on climate action (C40 2018a), begins with a review of a city's historical and planned climate action portfolio and focuses on identifying how C40 assistance would be most valuable. Stages 2 and 3 comprise a technical assistance (TA) package through which C40's technical staff work with city officials to review historical GHG emissions and forecast emissions trajectories based on sets of climate actions, diagnose key climate risks, identify appropriate climate actions, and establish action priorities. Through donor support, C40 is currently delivering this TA program to most of the network's member cities in Africa, Asia, and Latin America. The last stage of the planning program is an independent review of a city's plan against the contents of the CAP Framework (C40 2020c).

Figure II.1. Overview of C40's climate action planning program



Source: C40 2018a

Whereas Chapter III examines the text of plans published to date, to understand which actions they include and how they are packaged, this chapter aims to describe the background processes that lead to a published CAP and advancing CAP actions. We draw on all the KIIs we conducted to characterize how C40 and cities interact, to diagnose formidable constraints to cities progressing with their CAPs, and to document interviewees' experiences and perceptions.



A. Planning and design stage

In this section, we discuss key findings related to all activities that contribute to the eventual publication of a CAP. In particular, we focus on describing specific channels through which C40 supports member cities, the tools they have developed to facilitate climate action identification, and how cities are prioritizing actions for implementation.

1. Composition of cities by CAP publication status

The group of cities approached by C40 to pilot the creation of Paris-compliant CAPs drew primarily from Europe and North America, with Durban (eThekweni) a standout exception. C40 focused on inviting Steering Committee cities who “in principle should be the leaders among leaders” to the CAP pilot study with the aim of quickly producing a first batch of CAPs as a demonstration effect. Selected cities were disproportionately selected from the Global North with CIFF providing financial support for seven cities (UK BEIS 2018). An unanticipated downside was that “[C40] didn’t learn enough lessons for delivering the program in the Global South,” where cities face different challenges of rapid population growth, extreme heat exposure, and weaker fiscal capacity.

For approximately half of all C40 cities, particularly in the Global South, this climate plan will be the first one they produce; Global North cities will presumably advance faster given their longer history of producing climate plans. Many of C40’s Global North members have produced climate and sustainability plans for one or more decades. Their earlier start not only gives them experience in developing the governance structures to develop and implement plans, it has generated a pre-existing pipeline of climate actions to continue pursuing through their Paris-compliant plans. One C40 interviewee stated that cities with experience producing plans “are not starting from scratch; they are building on an existing evidence-base, they are building on a set of engaged stakeholders, and each time, they get the luxury of sort of ratcheting up ambition and increasing the sort of robustness of those plans from over the last 10 years.” No city official in any of our interviews expressed doubt or reluctance about the value of developing a 1.5°C-compatible climate action plan. Cities are already persuaded, but they will vary in their resource requirements to bring a plan to fruition.

2. C40’s engagement with cities in supporting CAP development

C40’s involvement in the CAP development process varies significantly across cities. Some interviewees, particularly Global North cities with climate action planning experience, report not receiving or anticipate not receiving direct support to publish a Paris-compatible CAP outside of their existing participation in thematic networks. These cities referenced key C40 documents, such as the CAP Framework (C40 2020c), as particularly helpful guides in ensuring their ultimate plan satisfies the criteria to be considered Paris-compatible. Other cities have received grants from C40 to fund external consultants to carry out well-defined analyses, such as estimating health co-benefits from improved air quality. The third category comprises cities in Africa, Asia, and Latin America that will participate in the full TA program described earlier.

CAPs are city-led; cities exercise complete discretion over the strategy and actions they take, and C40 accordingly sees its role as supporting and encouraging them toward greater ambition when possible. C40 emphasizes that effective climate action planning positions cities in the driver’s seat, and that CAPs should not be documents they unilaterally develop and hand over to cities. Given that cities



"We want them to own it, and we can recommend and make suggestions and show examples, but it's really for them to decide what's most appropriate given their contacts, their relationships, their sensitivities, and their moral priorities, to decide what's the best process to engage."

—C40 interviewee

direct the development of their plans, some CAPs will undoubtedly be out of alignment with Deadline 2020 guidance, the Cascade to Impact (C2I) targets that C40 uses to report progress to CIFF, or the "Focused Acceleration" mitigation strategy recommendations in McKinsey and C40 (2017) according to city type. The actions and priorities set by cities will reflect local needs and capacities, shaped by C40's efforts to increase ambitiousness levels when appropriate. Regardless, city officials voiced that the set of D2020 materials has been helpful in multiple phases of plan development. One official stated that her city "wouldn't really know if [it] were in fact achieving a Deadline 2020 climate action plan without that [CAP] framework."

C40's city advisors have played a crucial role in facilitating the behind-the-scenes efforts to advance CAP production and is a direct assistance model that could benefit under-resourced Global North cities. City advisors are C40 staff embedded in the local city government with the express mandate of facilitating climate policy progress. Global South cities are eligible to participate in the city advisor program, but not all candidate cities have one.¹¹ Their proximity to the mayor's office and government departments engaged in climate policy-setting offers them unrivaled access to real-time, on-the-ground information that can guide C40 service delivery. Among the 19 activities C40 carries out that were included in the 2018 City Satisfaction Survey, cities ranked "getting direct support from C40 staff, e.g., regional director/city advisor" with the highest satisfaction and as the most important. The city advisor model operates on the assumption that providing this embedded resource will enable cities to set up the necessary systems, coordinate across city departments, and in the process build-up a city's internal capabilities so that the CAP apparatus eventually can be sustained without direct C40 assistance. One C40 interviewee noted, "The cities that have advanced the most in this climate action planning process were the ones with the city advisor, versus [cities where] we didn't have any local staff." Because the donor-funded city advisor program targets Global South cities, under-resourced Global North cities whose progress has been slow do not qualify.

The proposed actions cities initially submit to C40 for review often err more on the side of being insufficiently ambitious than overly ambitious and infeasible. C40's technical review of cities' action proposals begins with an updated review of the city's powers that differentiates the actions a city can legally undertake from those actions for which it has no authority. For example, public transit policies and investments are often made by regional or state actors, which means that cities in many instances cannot unilaterally decide to subsidize fares or expand service routes. When existing powers to take the action are lacking, C40 staff propose alternatives that are legally permissible. Conditional on being compatible with the city's powers, technical leads assess an action against the city's resources (i.e., staffing and financing capacity) and what peer cities have been able to achieve. C40 staff state that cities are not so much submitting unrealistically demanding plans, as they are proposing plans with underwhelming targets. Upon reviewing the plans, C40 staff offer feedback to cities and may reference peer cities with higher ambition levels to encourage a ratcheting-up of targets. To make these determinations, C40 staff rely on their own and their colleagues' expert judgment.

¹¹ The city advisor contract for some cities, like Mexico City, has already ended, while other cities, especially those in the Central East Asia and South and West Asia regions, do not have an advisor in place.

3. Production of analytical tools to support TA delivery

C40 has built in-house, interactive, decision support tools that personalize recommendations based on a city's actual circumstances. The Pathways tool forecasts business as usual (BAU) emissions levels in the absence of further city action, which informs the level of ambition cities must enact for D2020-compliance. In this modeling phase, users observe the effects of strategies they determine and can plan for scenarios across a multitude of potential reduction pathways. For example, a city planner might assume that investments in renewable energy gradually increase the zero-carbon share of electricity to 50 percent by 2030, which informs other efforts they pursue to achieve an emissions reduction target. Upon constructing a 1.5°C-compliant pathway, users transition to action prioritization using the Action Selection and Prioritization (ASAP) tool. Through ASAP, users shortlist priority actions drawn from a bank of 150 potential actions. Although GHG reductions are the central focus in both of these tools, ASAP can incorporate additional criteria, such as green job creation and health co-benefits, as decision-relevant criteria.

The Pathways tool, informed by city-specific limits on mayoral powers, is used by C40 in the TA workshops to support cross-agency consensus-building on GHG reduction strategies. The tool helps decision makers throughout the city work together to plan for scenarios across different strategy approaches and recognize the level of action needed to adhere to D2020 timelines. By incorporating the current status of city powers into the strategy scoping process, the option space is limited by default to those domains over which a city has powers, or so called “unconditional” powers that cities can exercise on their own. In the Pathways tool, users can also include “conditional” actions that rely on another actor, such as a regional government or a utility, to commit the action. By foregrounding mayoral powers in the planning stage, C40 narrows cities’ attention to those areas where they hold political and legal authority and can most plausibly exercise action.

4. Pace of CAP development

Plan development is a lengthy process, and there appear to be few, benign opportunities to expedite the process. With typical start-end periods spanning 12–24 months, CAPs are not rapidly drafted. Both city officials and C40 staff doubt there are many ways the process can be fast-tracked. One city official explained, “By the nature of the work, you can only accomplish so much in this amount of time and things are [in] sequence, so I can't imagine going faster.” One C40 interviewee stated that any attempt to accelerate plan production that did not dramatically alter the plan’s substance would at best reduce the production time by one or two months. A dramatic acceleration in plan production would involve outsourcing the work to external consultants, or C40 staff, and would compromise “the capacity building, the focus on governance, the focus on ownership, the focus on consensus-building, on deliberation, [and] on discussions” enabled under the current timeline.

Hastening plan production would likely undermine the popular support needed from stakeholders to ensure long-term climate policy success. An official from one C40 city that recently completed its D2020-compliant CAP believes that “a key part of having the extensive external engagement is getting the buy-in. And what I hear from other parties is that maybe that's a prerequisite for people accepting the plan afterwards.” One C40 interviewee shared that there is a “tension between going too fast, scaring a lot of folks, [and] creating unnecessary resistance. But then, at the same time, it [is] a very lengthy process to get everyone on board. And so, in the desire for immediate results, maybe some stakeholders get disincentivized or they feel like they're shunted out of the way.”

5. Prioritization of climate actions

The mitigation strategies described in “Focused Acceleration” (McKinsey and C40 2017) are strategies, not actions, and they offer limited guidance for which actions cities should pursue in their CAPs. The mitigation recommendations in that report provide general guidance on the major emissions sources that are associated with cities of a given archetype (e.g., a densely populated, high-income city), but they do not specify the set of actions required to advance the strategy's objective. One C40 interviewee exemplified the distinction between strategies and actions, using the example of kerosene being used as a cooking fuel. Shifting away from kerosene and toward electricity as an energy source for cooking is the strategy, and it can be achieved through actions such as awareness, subsidizing electricity connections, imposing taxes on kerosene, banning kerosene, running publicity campaigns, or any other combination of actions. Cities that work with their own, accurate GHG inventory, can formulate a presumptively more appropriate set of recommendations than the guidance offered in McKinsey and C40 (2017) in isolation. Since all, or practically all, C40 cities will have completed a GHG inventory leading into the CAP development, city officials are armed with locally relevant data on emissions sources and remaining data gaps.

Priority actions for this generation of CAPs must focus on immediate wins achievable by 2025 and 2030. The C40 TA program further encourages this short-term focus, recognizing the immense amount of technical, political, and economic change that will plausibly undermine any fine-grained action planning through 2050 that is carried out today. A short-term focus enables cities to develop successes, gain momentum toward more complex actions, and shore up public support for actions whose effects will take longer to materialize and are likely to entail significant disruption to everyday life.

“Whatever C40 does around implementation will focus on a few actions. A client’s action plan will look at 15, 20, 30 actions. C40 can only really provide targeted support on a few of those. The city needs to be empowered and capacitated and supported to deliver on the rest of the actions.”

—C40 interviewee

C40’s action strategy recommendations are not currently informed by projected costs. Even though the 1.5°C target imposes a net zero carbon goal, multiple approaches can achieve that goal with dramatically different price tags. For example, the existing building stock could be maintained as is without energy efficiency retrofits so long as ample renewable energy (RE) capacity is added to the grid. Alternatively, overall building efficiency can be improved to reduce the amount of new RE that has to feed into the grid. When a city has powers over actions that can achieve the same outcome, the decision-making process should at least partly be governed by cost considerations. Costs do not enter into climate action planning until after strategies have been identified using the Pathways tool. When cities shift into the action identification and prioritization stage, later into engagement with the CAP program, C40 and city officials then take action costs into consideration for a subset of priority actions. One C40 interviewee explained the decision to wait until cities are further along, saying “[Costs are] so contextual that I think any analysis we did would be pretty limited in its application.” Having access to costing projections earlier on, potentially even from other cities who enacted similar actions, could help ensure that pursued strategies incorporate cost-effectiveness objectives.



B. Execution stage

After publishing their plans, cities will transition to implementing their stated climate actions, some of which may be continuations of existing programs and policies, and others

that will be new endeavors. Whether cities are able to execute their plans on the timetable they have indicated will depend on the resources they deploy, whether efforts are aligned with other law-making bodies, the magnitude of implementation constraints they face, and the degree to which they can identify and pursue solutions that overcome those constraints.

1. Timing and severity of implementation constraints

The D2020-compliant CAPs that recently have been completed can offer only limited evidence on key implementation constraints; robust insights on plan implementation, particularly in Global South cities with more limited experience implementing climate action, will require more time. Even though Global North cities may have strong histories of writing and acting on environmental plans, the D2020-compliant plans are fundamentally distinct in their scope and demands. Earlier generations of climate plans sufficed, with government buildings attaining Leadership in Energy and Environmental Design (LEED) certification and promoting renewables, not full decarbonization of the entire economy. Some implementation challenges can be foreseen with clarity, because they resemble existing problems. Others will be recognizable only at later stages of execution. For example, an interviewee shared the challenge of promoting zero carbon building energy codes in a country without no zero carbon buildings. The audaciousness of the D2020 targets will inevitably face challenges that will become more salient once all low-cost mitigation options are exhausted. For example, reducing building energy consumption by 10 percent is straightforward and achievable. Once a building's energy has been reduced by 90 percent, the remaining 10 percentage point reduction will be dramatically more costly and technically demanding. Accordingly, the set of near-term actions that cities propose in their CAPs appear feasible from the perspective of their technical and operational requirements, but implementation constraints in all sectors will become more binding with progress as fewer mitigation opportunities remain and marginal abatement costs increase.

2. C40's approach for supporting climate action implementation

C40 intends to narrow their direct support for a small number of actions where they have the strongest comparative advantage. Moving forward, C40 plans to work with member cities to identify a handful of high-priority areas that are of strategic importance to achieving CAP objectives and that would benefit from C40's help. One interviewee succinctly captured this focus: "Better one action to be 100 percent done than 10 actions each 10 percent done."

"The city advisors are going to become essential in the implementation of climate action plans. [...] The implementation of the plan is going to have a lot of activities, specific activities in different areas. And [they] are the ones who understand how to connect those activities to the budget, to project preparation, to implementation, to networks...how to connect whatever the networks are doing with implementation."

—C40 interviewee

The city advisors will continue to be indispensable as CAPs proceed to implementation, as a bridge to link city departments to one another and to C40, and to raise awareness about new challenges and opportunities.

City advisors serve as a key link between the city and C40 and foster information-sharing in both directions. In virtue of being embedded within the city, they enjoy a privileged position of being able to patch together departments working on related but separate threads. As an example, C40's work on clean construction has obvious touch points with housing initiatives, waste reduction, and construction site air quality. City advisors possessing an expansive

understanding of department operations and circumstances can facilitate connections that push

departments toward structural alignment when interests do overlap. Advisors are connected to city politics in a way that grants them real-time insight into political challenges and opportunities. This positioning gives C40 a way to quickly preempt project risks when challenges arise, and act on newly surfaced political developments. Because advisors work closely with the various departments and political levels, they are able to pitch concepts to decision makers in a way that resonates with their priorities and concerns. The city advisor is especially beneficial in cities with limited internal capacity. For some cities, their presence may effectively double a city's resources for advancing climate action.

3. Limitations of city powers and the role of collaborating with higher levels of government

Cities anticipate a range of implementation hurdles for actions that are laid out in their plans, and several common themes emerged as substantial obstacles. The CAP planning process itself underscored for many cities that high-return actions are often beyond their remit. Such cities will have to focus on "vertical integration" by lobbying higher levels of government who can pull the levers of enacting more ambitious standards, requirements, and targets. Regional and federal agencies are likely to be responsible for the most capital-intensive actions required for decarbonization, such as widespread RE deployment and mass transit expansion, but even those less costly actions that remain have a high price tag and will require extensive resources from the city purse and a variety of financing sources. Such projects include constructing cycling lanes, introducing zero emission zones, retrofitting municipal buildings, and building adaptation infrastructure.

Cities' efforts to mitigate emissions, which C40 will continue to support, will be most transformative when in concert with their regional and national counterparts. Several examples show how actions that originate at the city level can lead to policy movements at the regional or national level. The South Africa Buildings Programme launched in 2018 is one example: the push for several major South African cities to in parallel adopt zero-carbon building energy codes may provide enough momentum for the federal government to enact similar policies with national reach. When multiple star cities are already pursuing these actions, the political cost of emulation at the federal level is dampened. Likewise, the zero carbon buildings initiative with Chinese cities has spurred the national government's interest in collaborating with C40 to pursue further research at the ministerial level. In addition to its own City Diplomacy team, which is tasked with a similar mandate, C40 partners with organizations, such as the Coalition for Urban Transitions (CUT), that work on strengthening linkages between city and national actors to pursue and harmonize ambitious climate policy. Further efforts will be necessary to accelerate flagship programs on electric bus procurement and enacting zero carbon building standards to achieve national-level scaling-up. These initiatives will often involve non-C40 members. For example, the [Zero Emission Bus Rapid-Deployment Accelerator \(ZEBRA\)](#), through which C40 collaborates with the International Council on Clean Transportation (ICCT), presents an opportunity to form larger coalitions that transcend C40 membership to deploy electric bus fleets throughout Latin America. When initiatives like ZEBRA create umbrella alliances with non-C40 cities, a broader network of actors applies pressure for national action.

4. Addressing access to finance constraints

It is unsurprising that most interviewees cited access to finance as a key constraint to rapid implementation. Cities will not always be able to self-finance actions, and the project window for which treasury departments can budget is frequently limited to one or two years (potentially up to four years in Nordic cities). Cities anticipate cobbling together a portfolio of financing sources, such as ODA,

multilateral development banks (MDBs), and private banks, and by issuing green bonds. Projects with stable, forecastable revenue streams, like the farebox for electric bus purchases, are likely to find willing investors. Other investments, especially in adaptation infrastructure to defend against sea level rise, will likely require support from the national treasury.

Governance features that are specific to cities will further complicate project finance. For one, without a sovereign guarantee permitting municipal debt accumulation, some cities are ineligible to receive direct lending. Political timelines also play a key role, as mayors frequently want projects that bear fruit before the end of their term. The project financing turnaround time for MDBs like the Asian Development Bank and the Inter-American Development Bank, which would be prime candidates for providing climate finance, is likely incompatible with mayoral time frames. For capital-intensive projects whose full completion exceeds a mayor's term, pilot programs or piecemeal implementation, such as constructing one segment of a citywide cycling lane network, can showcase successes within a short window while building capacity that can support future up-scaling.

C40 runs several initiatives for cities that aim to remove barriers to finance, but these initiatives are likely to require a rapid scaling-up to accommodate new demand generated through the CAP

program. C40 has two key mechanisms to support cities in securing project finance. The C40 [Cities Finance Facility \(CFF\)](#) strengthens cities' capacity to develop investor-ready project documents. C40's [Financing Stable Cities Initiative \(FSCI\)](#) comprises various pillars, but interviewees most commonly referenced the Finance Academies, which are intensive workshops that bring together city Chief Financial Officers (CFOs), city department heads (e.g., heads of public works departments), and technical experts to identify how city finance can be mobilized to implement climate actions. Since 2015, FSCI has organized five Finance Academies attended by officials from 30 cities. The CFF thus far has focused on capital-intensive investment proposals for bus and rooftop solar procurement, and has been utilized for fewer than 20 projects.¹² Since the first wave of D2020 CAPs prioritized Global North cities who are ineligible for CFF support, the CFF mechanism has not yet been fully validated for supporting the complete range of climate actions that will require private finance. For example, cities will issue tenders for electric vehicle (EV) fleets and construction of greenfield waste management sites, which have not yet been supported through the CFF and may require feasibility studies or cost-planning exercises for which the CFF has not yet gained expertise. Even if new climate actions require the same type of financing access assistance as historical actions, the completion of all cities' CAPs by the end of 2020 will generate a surge of demand for financing support that is substantially larger than the current scale of CFF and FSCI activities.

5. Innovative government activities influenced by climate actions

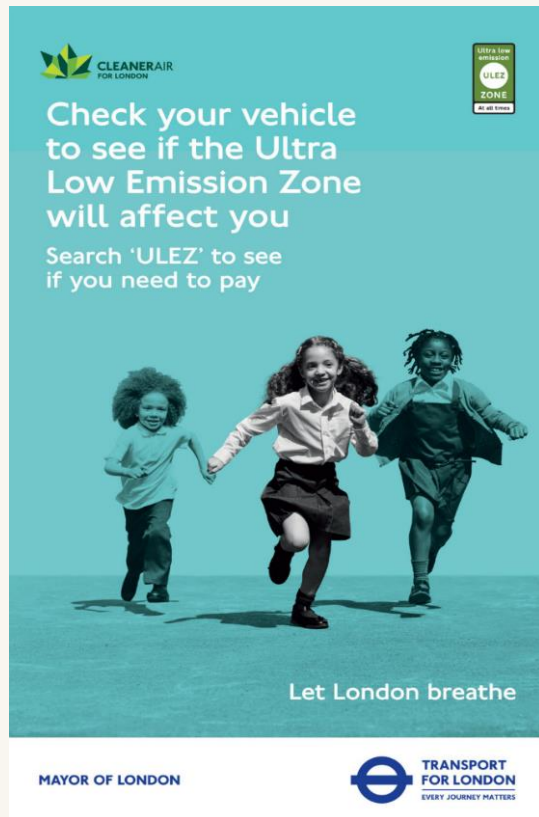
Cities such as Los Angeles, Oslo, and Stockholm have introduced carbon budgets into their city operations that assign emissions limits across departments. Although these programs are not necessarily punitive for non-compliance, they signal that agencies must couple financial prudence in their operations with environmental prudence. As an example, a carbon budgeting approach can help justify the price premium of EVs when a department expands its vehicle fleet.

Human-centered design principles must be applied throughout implementation to sustain buy-in, fend off threats, and prevent the rollback of climate progress. The actions that cities will pursue

¹² This statement is based on the projects listed on the CFF website as of April 2020.

should be well-grounded in technical and scientific models for the GHG reduction or adaptation benefits they will deliver, but interest groups and lobbies will rally against reforms that harm them even when the climate dividends are large. Human-centered, sustained messaging campaigns may be one effective means to incapacitate such resistance, with Transport for London's poster campaign one effective (see Figure II.2). One C40 interviewee shared that awareness-raising efforts "should not be an afterthought, but a very integral part of the program we're proposing. I think that's one lesson-learned for us." More effort is required in messaging, coalition-building, and supporting allies to ensure that climate momentum is sustained even when political winds change direction.

Figure II.2. Example poster from Transport for London's ultra-low emission zone awareness raising campaign



In 2019, Transport for London (TfL) conducted an awareness-raising campaign to inform Londoners of the health benefits of establishing an Ultra Low Emission Zone (ULEZ) in central London. To travel in the zone, a motorist must drive a vehicle that satisfies the emission standards, or pay a daily charge. Posters displayed smiling children playing, alongside the "Let London Breathe" tagline. ULEZs will be expanded to the North and South Circulars, and C40 anticipates that the awareness-raising campaign and advertisement of the health benefits will preempt future threats to these zones from companies and individuals whose existing vehicles would incur daily charges.

Source: <https://making-pictures.com/news/transport-for-london/>



C. Progress monitoring stage

Achieving carbon neutrality by mid-century will require cities to regularly monitor their emissions and to engage in course-correction when their progress is lagging. In this section, we address research questions related to the procedures that cities are or anticipate using to monitor their progress, as well as key obstacles that currently hamper progress monitoring.

1. Cities' challenges in data collection and progress monitoring practices

C40 staff, cities, and external organizations recognize that data collection and monitoring are essential and that cities are struggling to fully engage with data regardless of their level of

development. One thematic network manager stated, “Irrespective of [cities’] capacity and their resources, most cities, the majority of cities, even [climate-leading cities], have a shared challenge when it comes to collecting [and using] data.” Without defensible data, cities will struggle to present a watertight business case for advancing actions, especially those actions whose targets are set relative to a baseline level. Data collection and analysis gaps spurred the creation of programs, such as Empowering Cities with Data (ECWD), whose grant program has been designed to enable targeted data collection and facilitate more efficient data-sharing arrangements across relevant stakeholders.

Some cities are attempting to track an unmanageable number of indicators and do not yet have clarity on where they should prioritize and narrow. Many CAPs feature an overwhelming number of actions, such as the 242 in Barcelona’s plan (Barcelona City Council 2018), 219 in Dublin’s (Dublin City Council and Codema 2019), and the 445 in LA’s Green New Deal (City of Los Angeles 2019). Cities may feel compelled to track all of those actions and develop indicators to communicate progress more broadly. One interviewee described the consuming process of having to first identify indicators, and then to secure funding to collect them. A non-C40 city official recalled the process of following-up on the status of the more than 150 actions in her city’s previous plan: “It took six months of work to be tracking down people who are leading those activities, and getting narratives and metrics and funds spent and all of that. So, it was a huge lift just to do that analysis.” Another city described its sustainability office’s tracking tool as a “massive spreadsheet” that has been difficult to manage even with a staff of eight.

2. Ways in which C40 uses monitoring data shared by cities

C40 reports back to cities on their climate performance, through peer and target comparisons, for a subset of headline indicators. In the KH, cities have private-access pages that feature a dashboard with their overall participation scoring and how many mandatory standards they have met. Across the sectors (e.g., sustainable transport, clean energy, waste, etc.), dot plots display their performance relative to their own 2020, 2030, and 2050 targets, and relative to their McKinsey typology peers (McKinsey and C40 2017). The pages also feature recommended reading materials from the KH for each sector whose indicators are displayed. On public pages, C40 has built a metric-focused and a city-focused interactive dashboard using CDP data to compare cities on a handful of indicators, such as waste diversion rates and travel distance via mass transit.¹³

C40 does not currently plan to rank or score cities’ CAPs. There also are no plans to create a “two-tier” system comparing “high quality” and “low quality” CAPs based on the Essential and Go Further guidelines (C40 2020c). Earlier reviews of individual city plans, such as Stockholm’s (Ramboll 2018), were conducted to refine the framework and clarify content. Regarding a CAP’s “quality,” one C40 employee shared, “We don’t tell them who are the better cities, but we tell them, ‘Well, this is the region average, this is where you are, and you can be more active if you want.’” C40’s current focus is in supporting cities to at least satisfy the framework’s “essential” requirements, and to push them further when possible. As cities progress in their CAP actions, C40 is likely to continue using positive peer pressure as an encouragement device by spotlighting leading cities.

¹³ The metric-focused dashboard is available at <https://bit.ly/36dqwxC> and the city-focused dashboard is available at <https://bit.ly/2TlKjWh>.

3. Cumulative mitigation progress and external factors

Several cities who regularly report their emissions and claim to be on track or nearly on track to meet their 2020/2025 mitigation targets have greatly benefited from tailwinds beyond their control.

Several Global North cities' CAPs report sizable GHG reductions in recent years, which at a high level suggest solid progress. When these reductions are decomposed by contribution, the dominant factor tends to be lower carbon intensity in the electricity sector, which is not caused by city policy but broader shifts in energy markets arising from shale gas and shale oil finds. As well, cities whose recent winters have been comparatively warm have consumed less fuel oil, natural gas, and electricity for heating, contributing to a relative reduction in emissions not due to any underlying proactive actions. Cities that overlook these facts will derive a false sense of accomplishment that obscures the challenge they face in personally driving decarbonization.

4. Importance of routine GHG monitoring

Continued community-scale GHG monitoring will be essential for monitoring progress in emissions reduction and revising actions when reductions are underperforming. C40 staff caution against cities believing that completing a GPC-compliant inventory is an initial step that needs to be conducted only at the start of the planning process. Instead, regular inventorying provides a status check on whether the pace of reductions is in line with the Deadline 2020 trajectory, and when reinforcing policies should be considered to accelerate that pace. Future revisions to CAP actions should be made based on emissions data at the time of revision, not only at the time the initial CAP was produced.

The absence of regular GHG monitoring will hamper cities' ability to learn whether they are on pace to achieve mitigation targets and differentiate between effective and ineffective programs. One non-C40 city admitted that it "[hasn't] done an inventory since 2014 and so, we don't actually really know where emissions are going." As time passes, this limitation will leave cities blind to the pace of acceleration they would need to adhere to their current emission targets. As a specific example, a Johannesburg-based rooftop solar water heater program was rolled out to more than 100,000 households. Four years later, there is still no information about the number of heaters still functioning, or how many were sold for scrap metal. Data on this program's effectiveness would have yielded useful insights for judging whether this policy should be expanded or replicated elsewhere.



D. Knowledge transfer stage

Knowledge-sharing is central to C40's ethos, and insights from all stages of CAP activities, from design through monitoring, will be shared through various channels. Here, we address research questions on the mechanisms C40 will use to share knowledge, both among C40 cities and outside with non-C40 cities.

1. Climate action planning and development of knowledge products

As cities plan, implement, and monitor their CAPs, a wealth of knowledge on best practices is being generated. Internally, city advisors hold monthly calls to share their "experiences, frustrations, disappointments, successes...to facilitate that exchange of knowledge," which keeps them apprised of developments and possible solutions to challenges they face. Other forums have similar objectives, but a different makeup, such as a WhatsApp group for city focal points and city advisors in the Africa region to discuss CAP-related topics. Experiences are logged through case studies, of use to both the city itself and other C40 members. Both the Climate Leadership in Cities (CLIC) Programme Logframe

(UK BEIS 2019a) and key performance indicators (KPIs) tracked by funders stipulate that case studies and knowledge products documenting important components of the CAP program be generated and disseminated.

2. C40 Knowledge Hub and city officials' engagement with knowledge products

The C40 Knowledge Hub will be a key, publicly available destination for maintaining knowledge products on climate action planning. Unveiled in October 2019, the KH is a quickly growing repository of case studies, policy briefs, implementation guides, opinion pieces, and miscellaneous resources available to both C40 and non-C40 cities. The KH replaces the C40 Exchange, which was a platform only for C40 members. C40's communications team oversees publicity and dissemination and would be the responsible party for any concerted efforts to share resources with non-C40 cities. For the most part, interviewees from non-C40 cities had engaged with C40 resources at some point in time, and often cited specific documents. However, they were largely unaware of the existence of the KH or its public access nature, because the previous knowledge platform, the C40 Exchange, was a closed tool restricted to C40 members.

Although many C40 city official interviewees are aware of the KH, few report having deeply engaged with the material and perceive a variety of constraints to fully utilizing the knowledge captured in KH content.

In particular, interviewees from Global South cities expressed less enthusiasm for engaging with KH materials and cited obstacles such as limited Internet connectivity and language barriers. Although some documents have been translated into a handful of non-English languages, KH site navigation and search functions remain exclusively in English. City officials who understand written English may still find it difficult to read technical reports in English. An additional barrier is the perception that city officials have about the applicability of KH materials, like case studies, which are produced by cities with dramatically different resource capacities and operating circumstances. As one C40 staff person shared, city officials also face "context" barriers. For example, a case study based on a program that leveraged high quality, granular data that was delivered by a large team of highly technical staff may be written off by some city officials as inapplicable to their city's circumstances instead of engaging with the material to determine which lessons might still be transferable. Even when materials are accessible and appropriate, interviewees reported that reading KH materials may not be perceived as important work for their job. Several officials indicated they feel scrutiny from supervisors regarding time spent on C40-related activities, and that reading "blog posts" and resources not immediately tied to their job is less justifiable than attending webinars or speaking with C40 staff.

"I think you do need that human-to-human contact, that face-to-face. It doesn't substitute...It's the one thing that works."

—Non-C40 city official

No matter how expansive the KH becomes, city officials are likely to prefer person-to-person contact to work through, advise, and receive support from one another.

One of the key benefits of C40 membership is the personal aspect of being part of a group. Therefore, officials said that they would likely benefit from the KH resources but would still want to access information the KH cannot capture. Some interviewees stated that they likely would be able to access desired information faster by directly reaching out to fellow network members, the network manager, or the regional director.



III. Key findings from assessing climate action plans

Although interviews with city officials and C40 staff provided valuable context on the motivations, processes, and challenges in advancing a climate action plan, research questions regarding the details and content of CAPs are best answered by reviewing published CAPs themselves. In this chapter, we present key findings from a review of nine cities' CAPs. Our findings are structured by an assessment framework that synthesizes reporting indicators from earlier frameworks, tracking tools, academic research, and reports.¹⁴ The selected indicators are categorized under five themes:

- City vision and collaboration
- Powers and responsibilities
- Mitigation actions
- Adaptation actions
- Monitoring and data collection

These categories, respectively, assess the city's goals and level of engagement and collaboration with affected stakeholders; the allocation of powers, resources, and responsibilities to implement climate actions; specific mitigation and adaptation actions and policies; and the comprehensiveness of proposed monitoring and data collection programs.¹⁵

Having developed the assessment framework, a reviewer from the evaluation team read each CAP and identified the relevant content corresponding to each indicator. Text passages were transferred to a document review spreadsheet in which we captured specific details, such as indicator targets, timetables, technologies, benefits, and processes, along with any noteworthy quotations. We noted accordingly when relevant information on an indicator was not available in a CAP, or if the CAP referred to supplemental documents.

After having read all CAPs and distilled their content in the review spreadsheet, we then developed an indicator-specific performance appraisal. Across all indicators, we assessed the detail and scope of relevant content provided in each city's CAP and related documents and employed a color-coded scheme to depict their relative performance. At a high level, indicators coded in green shades are described in a plan, taking a value of "minimal," "satisfactory," or "exemplary," while indicators that reviewers did not find described in relevant plan documents are colored in gray. For indicators described within a plan, we assess relative performance according to the comprehensiveness and detail with which they are captured. We interpret plans with richer details on policies, programs, actors, targets, and timetables as more robust and established than plans that lack quantified outcomes or thorough explanations. Accordingly, indicators are ranked more highly (e.g., "exemplary") when

¹⁴ Chapter I.B. offers a comprehensive description of our CAP assessment methodology.

¹⁵ Table A.2. shows the complete list of indicators, organized by category.

relevant information is detailed. Although this chapter draws primarily from the CAPs themselves, key findings are also informed by our KIIs where applicable. We code as “Lacks powers” those indicators falling outside city powers, such as mass transit development for many cities, for which the plan does not also describe how the city will act or lobby other governing bodies.¹⁶

As noted in Chapter I, we preface our findings with several caveats. First, the degree of detail in the CAP is not necessarily representative of a city’s progress, as cities may limit the information included in the CAP to make the document concise and accessible to lay readers. Second, indicators that are scored as “Addressed Elsewhere” or “Not Addressed” should not necessarily be interpreted as an omission. Although we focused primarily on a city’s main mitigation document, many cities had supplemental plans that may contain information relevant to the indicators but for which an exhaustive review exceeded the evaluation’s scope. Lastly, language barriers presented a challenge to accessing all CAP-related documents, since supplemental documents are sometime only available in the local language. For instance, several documents referenced in Ramboll’s review of the Stockholm CAP are published only in Swedish (Ramboll 2018).



A. Planning and design stage

1. City vision and collaboration indicators

The city vision and collaboration indicators, listed in Table III.1, reflect a CAP’s ambitiousness, and how cities plan to prioritize, collaborate, and engage with stakeholders to achieve their emissions reduction targets. To be considered exemplary, CAPs should declare an overall aim of achieving carbon neutrality by 2050 (“City vision”) and include commitments and engagement from key stakeholders (“Engaging stakeholders”). The plan should communicate the criteria used in prioritizing actions based on highest potential emissions reductions, greatest possible impact, and/or estimated risk reduction (“Prioritizing actions”). Communication, education, and advocacy efforts should involve the larger community (“Communication, education, advocacy”). The CAP should be responsive to a city’s unique circumstances and consider climate, geography, socioeconomics, demographics, and other features (“Tailored to city context”). Plans should apply an equity lens to mitigation and adaptation planning and advance the well-being of vulnerable populations (“Equity”).

¹⁶ Importantly, some cities, namely Stockholm, Dublin, and Sydney, note that particular actions or entire sectors are not under the jurisdiction of the municipality. In those cases, we still shade the indicators according to the green scale, if the city is 1) leading by example and taking actions to address the indicators within the municipality; and 2) describes how the city will lobby other government actors and agencies to pursue change. Failing to fulfill those criteria would result in a grayscale value.

Table III.1. Plan performance according to city vision and collaboration indicators

	Barcelona	Boston	DC	Dublin	Durban	LA	London	Stockholm	Sydney
City vision	5	5	5	4	3	5	5	5	4
Prioritizing actions	3	5	5	4	4	4	4	5	3
Communication, education, advocacy	4	5	5	5	3	4	5	4	1
Engaging stakeholders	5	5	5	5	3	5	5	4	5
Tailoring to city context	5	4	5	4	4	5	5	1	1
Equity	4	4	5	4	4	5	5	1	4

Note: Values reflect the evaluation team's assessment of information available in each city's key CAP documents.

Legend:	0	1	2	3	4	5
	Not addressed	Addressed elsewhere	Lacks powers	Minimal	Satisfactory	Exemplary

Although most cities set targets to achieve zero emissions by 2050, accompanied by interim targets for 2025–2030, plans rarely detail how consumption-based emissions will be reduced. Dublin and Sydney currently list emissions targets only through 2030, though Sydney's 2050 targets are currently under development (City of Sydney 2020). Cities set emissions reduction targets based on territorial accounting methods that prioritize reporting of Scope 1 and Scope 2 emissions from activities inside city boundaries. Scope 3 emissions, most noticeably from waste, are sometimes mentioned and represent emissions generated outside the city boundary that are induced by activity inside the boundary. For example, aviation emissions for flights departing or landing in an airport located inside a city's boundary are counted as Scope 3 emissions. Unlike scope-based inventorying methods, consumption-based emissions (CBE) are accounted for at the point of consumption, not production, using an individual's consumption profile. Consider the example of a television manufactured in a Seoul factory, but bought new by a resident of Rio de Janeiro. A CBE approach would apportion the emissions generated from the TV's production to the buyer in Brazil, while a scope-based approach would apportion the majority of emissions to Seoul. Plans rarely described CBE management strategies or policies, though some cities stated intentions to develop one. For example, Stockholm "seeks to reduce consumption-based emissions through information and mandatory impositions" (Stockholm stad 2016, p. 15), but any actions would occur outside of its CAP strategy. Boston includes a similar statement (City of Boston 2019, p. 78). Other cities, such as Dublin, do not refer to CBE at all. The CAP Framework includes CBE as a "go further" target, and several city officials we interviewed stated that the public is increasingly demanding information about their CBE footprints (C40 2020c).

Cities do not always elaborate which criteria they used for prioritizing mitigation or adaptation actions. Barcelona and Sydney, for example, do not include explicit statements about how or whether city leaders decided to prioritize some actions over others. Cities that do state their prioritization criteria use a range of metrics, most commonly an action's net emission reduction potential. Boston, for example, focuses on new construction of zero net carbon buildings and retrofitting their existing building stock, because "buildings account for approximately 71 percent of [the city's] community carbon emissions, and represent the greatest opportunity for emissions reductions" (City of Boston 2019, p. 33). Stockholm prioritizes actions in areas where the city has powers to act with the greatest emission reduction potential and for which investments are anticipated to stimulate economic growth

(Stockholm stad 2016, p. 7). With respect to the prioritization of adaptation actions, we consider Washington, DC, to be a best practice example, because its plan identified and ranked the areas of greatest risk based on the location of critical infrastructure, availability of community resources, and presence of other exposed assets (Government of the District of Columbia 2016, p. 4).

With the exception of Durban, all plans describe robust and responsive stakeholder engagement processes. Cities describe developing partnerships with other agencies, such as the Boston Public Health Department and Department of Neighborhood Development, to ensure that transportation investments contribute to health and equity outcomes (City of Boston 2019, p. 60). Barcelona created a Climate Emergency Commission that included community members, representatives from disadvantaged communities, and policy and science experts (Barcelona City Council 2018, p. 18). London's draft strategy was reviewed via online discussion threads, surveys, emails, and interview polls. "Talk London" and "London Datastore" are supplemental documents that display responses and polling results from the community feedback measures that fed into the final plan's content.

Business is noticeably missing in CAPs' description of consulted stakeholders. Some cities have invited the private sector to early-stage CAP workshops, and others have postponed engagement or pursued arms-length consultation processes. Reflecting on C40's experience so far, one staff person relayed a colleague's statement that "business engagements in the planning stage would have made the plans better." Involving the private sector early can preempt latter flare-ups that threaten to derail action, such as the resistance that New York City Mayor Bill de Blasio has faced from contractors in response to his support for the NYC Energy Conservation Code. Early private sector involvement may also decrease the likelihood of a failed procurement process or implementation of ineffectual policy by avoiding mistakes and decisions that were based on imperfect technical knowledge.

Nearly all of the reviewed CAPs apply an equity lens to climate action planning, and consider the social, environmental, health, and economic benefits of climate action on vulnerable populations. Barcelona and Washington, DC, highlight their equity focus in dedicated chapters "Taking Care of Everyone" and "An Equitable Transformation," respectively. Barcelona's plan also aligns each set of targets with the Sustainable Development Goals (Barcelona City Council 2018; Government of the District of Columbia 2019). Still, many of these targets remain broad. Barcelona, for example, includes a target to "provide grants and subsidies for housing energy improvements and prioritize work on the homes of families in vulnerable situations and at risk of social exclusion (annually)," but it does not estimate the size of grants or state how many houses will be improved (Barcelona City Council 2019, p. 65). Similarly, Boston identifies "green jobs" as a co-benefit of stronger energy efficiency and renewable energy standards in buildings. However, their plan neither quantifies the number of green jobs nor indicates whether green job growth will be measured or monitored (City of Boston 2019, p. 53).

2. Powers and resources indicators

The powers and resources indicators assess a city's resources and capacity to affect change, and consists of the two indicators displayed in Table III.2. To be rated favorably, a plan should include a powers analysis ("Powers analysis") that specifies the sectors and subsectors under the city's jurisdiction, versus those under the control of other governing bodies, agencies, and the private sector. In some cases, the city may need to lobby or advocate for actions that fall outside of its jurisdiction. The plan should name the lead agency for each action and the method of collaboration. CAPs should also ensure that there are sufficient human and financial resources to deliver the plan in the short term and,

ideally, include a plan to build capacity and secure funding for long-term actions (“Human and financial resources”).

Table III.2. Plan performance according to powers and resources indicators

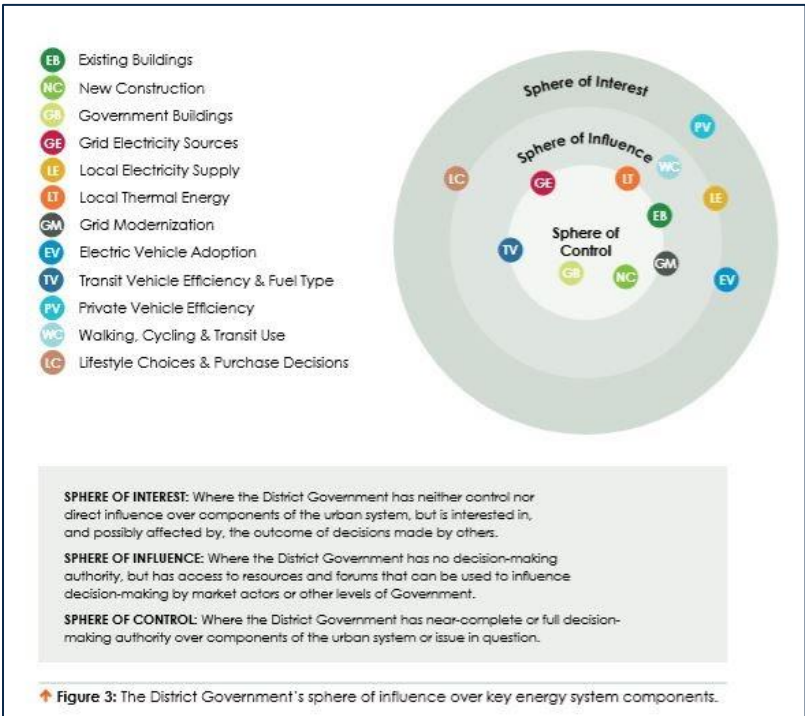
	Barcelona	Boston	DC	Dublin	Durban	LA	London	Stockholm	Sydney
Powers analysis	4	4	5	5	4	4	5	5	5
Human and financial resources	4	3	4	5	4	4	4	5	2

Note: Values reflect the evaluation team’s assessment of information available in each city’s key CAP documents.

Legend:	0	1	2	3	4	5
	Not addressed	Addressed elsewhere	Lacks powers	Minimal	Satisfactory	Exemplary

Most city plans include diagrams or discussions of the sectors and subsectors that are under a city’s jurisdiction. Dublin and Sydney make explicit that action from higher authorities is a prerequisite to achieving their targeted level of decarbonization (Dublin City Council and Codema 2019; City of Sydney 2017c). Similarly, Washington, DC, includes a graphic showing its sector-level spheres of influence and control (Figure III.1). Areas of interest indicate where the city must partner to achieve results (Government of the District of Columbia 2018, p. 7). For such areas, the plan should ideally also indicate who will lead the action and how collaboration will occur. We believe there is considerable room for improvement for plans to provide more detail about the partnerships they must pursue when city powers are limited.

Figure III.1. Depiction of mayoral powers by energy system component in Washington, DC



Source: Government of the District of Columbia 2018.

The highest-emitting sectors, usually buildings and transportation, are frequently outside the city government's jurisdiction. The Dublin City Council, for example, exercises power over only 5 percent of the city's emissions, and has focused its CAP on domains under local authority control, including public lighting and the city's social housing units. Similarly, cities like Los Angeles discuss the ways in which they will "Lead by Example" in CAP chapters that focus exclusively on their actions to cut emissions from government operations and assets (City of Los Angeles 2019). Interviewees also emphasized the importance of "walking the talk" to attain public support for plans whose actions encompass the entire city.

Overall, we regarded Stockholm as a best practice example for the powers analysis indicator.

Although Stockholm has limited powers, the CAP outlines how the city will "lead by example" and pursue aggressive mitigation actions to become free of fossil fuels by 2030. Each action has a designated task lead, and responsible committees are charged with ratifying, implementing, and overseeing follow-through (Stockholms stad 2016, p. 45). Further, the plan states that milestone targets for 2020 are included in the Stockholm Environment Programme 2016–2019 Strategy Plan, and as a result, they will become embedded in the integrated system for steering and follow-up. The CAP also states that these actions alone are insufficient and petitions other governing bodies and agencies to do their part: "For this reason, the long-term strategy includes a number of investigative assignments, the aim of which is ultimately to influence Swedish and European legislation" (Stockholms stad 2016, p. 7).

CAPs generally include minimal detail regarding budgeted or planned financial resources; human resources are often described with no more detail than naming a committee's or commission's members.

We highlight Dublin and Stockholm as best practice examples in elaborating the financial status of individual actions. Dublin's plan explicitly indicates which actions have secured funding and which are awaiting budget allocations (Dublin City Council and Codema 2019, p. 68). Stockholm's plan declares that municipal budgets through 2018 set aside funds for climate-related measures, suggests longer-term budget priorities, and provides guidance for allocating funds to high-priority areas (Stockholms stad 2016, p. 15). Stockholm's Budget 2018–2020 report presents line item budgets for each of the city's governing committees and agencies (Stockholms stad 2019). Other cities offered general funding descriptions, such as "identify funding opportunities for the implementation of the key priorities of the [Durban Climate Change Strategy]," (eThekweni 2014, p. 35) or "give special consideration in 2019 funding round to Zero Emission Buildings" (City of Boston 2019, p. 39). Most plans highlight a commission, team, or working group dedicated to implementation and/or oversight of the plan. Barcelona, for example, has established three working groups, a climate office, and an internal training plan for staff directly involved in climate action (Barcelona City Council 2018, p. 141). Similarly, Washington, DC, has established a core Sustainable DC team with four full-time staff (Government of the District of Columbia 2019, p. 20).



"What's not in [our city's] plan, what you can't see is that each one of those initiatives has a lead department assigned to it. And we, before we published the plan, we sat down with the general managers of each department and reviewed with them what we were planning to put in the plan, that their department was responsible for leading. And through those conversations, often the general managers had additional things they wanted us to add. And so, it was through that consultation and back and forth, that we came up with those lists, and I think most general managers see it as an opportunity to have their programming reflected in the plan."

– C40 member city official



B. Execution stage

1. Mitigation action indicators

The mitigation action indicators specify the content that should be included in a CAP and span the typical mitigation opportunities available to cities, including expansion of renewables, increasing energy efficiency, promoting low-emission mobility, and improving waste management practices (Table III.3). Rather than recount performance across all indicators, we focus our discussion on the Cascade to Impact's highest priority indicators for 2019, which includes compliance with World Health Organization (WHO) air quality standards, construction of zero carbon buildings, achieving zero waste to disposal, and the promotion of healthy and low carbon diets (C40 2019d).

Table III.3. Plan performance according to mitigation action indicators

	Barcelona	Boston	DC	Dublin	Durban	LA	London	Stockholm	Sydney
Renewables	5	5	5	3	3	5	5	5	5
District energy systems	0	4	4	4	0	0	4	5	4
Smart grid management	0	3	3	0	0	5	4	0	0
Efficiency standards for new buildings	3	5	4	4	3	4	4	5	5
Building retrofits	5	5	4	4	3	4	4	3	3
Updates to energy efficient appliances	4	4	5	3	4	5	5	4	4
Lighting upgrades	3	3	4	3	3	4	4	3	3
Building automation and controls	3	3	3	4	3	4	4	0	4
Transit-oriented development	3	5	3	3	3	5	1	5	1
Deterrents to private vehicles	4	5	4	3	3	5	1	5	3
Mode shift	4	5	4	3	3	5	1	3	4
Electric vehicles	4	5	5	3	3	5	5	4	4
Commercial freight optimization	0	0	1	3	3	4	4	3	3
Waste management	5	1	5	4	4	4	4	2	4
Utilities improvements	4	1	4	3	4	5	4	0	5
Low carbon diet	4	0	3	3	3	3	0	0	0

Note: Values reflect the evaluation team's assessment of information available in each city's key CAP documents.

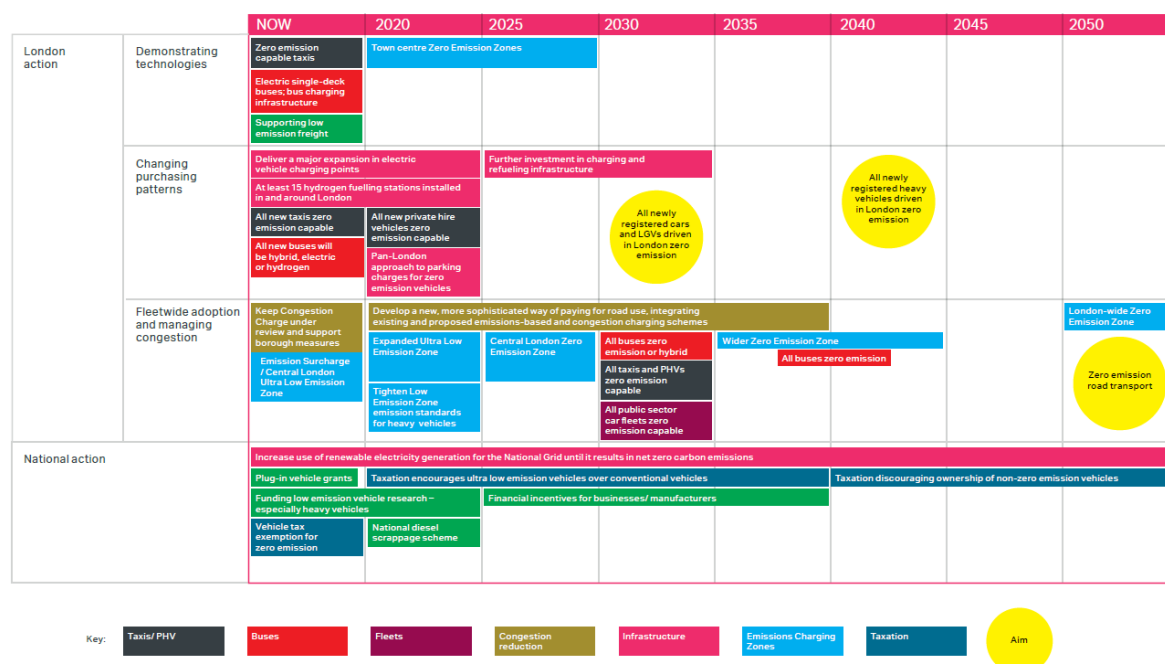
Legend:	0	1	2	3	4	5
	Not addressed	Addressed elsewhere	Lacks powers	Minimal	Satisfactory	Exemplary

Nearly all cities have actions devoted to expanding renewable energy, implementing high energy efficiency standards for new buildings, retrofitting old buildings, and updating energy efficient appliances. Across all four indicators, we note that some give quantified targets, with interim and long-term goals, while other cities give less detail. Variations in performance across cities largely reflect differences in the amount of detail the CAP included. London, for example, specifies targets (e.g., 15 percent of demand met by *renewable and district energy* by 2030, the number of PV installations by 2030 and 2050) and a timetable, and distinguishes between actions the Greater London Authority can undertake (e.g., the [Decentralized Energy Enabling Project](#)) and those for which the UK government must act (e.g., applying similar access rights and business rates to district heating networks as to other statutory utilities [Greater London Authority 2018a, p. 263]). We ranked Boston's plan for *energy efficiency standards* in new construction highly for including policy-level estimates for GHG reductions, and for the city's advocacy to revise the Massachusetts Stretch Energy Code, which enables municipalities to set energy efficiency and building performance standards that exceed the state's building code (City of Boston 2019, p. 35-37). In regard to building retrofits, Barcelona's plan sets a target share of the building stock to be renovated (20 percent of residential buildings built more than 40 years ago), indicates the number of "productive roofs" to be installed on public buildings (100), and estimates the mitigation potential of these actions (7 percent reduction) (Barcelona City Council 2018, p. 77). We considered Washington's plan exemplary for its details on promoting *energy efficient appliances*. The district outlines specific heating and cooling technology types and includes the specifications for standards that will apply to buildings by 2021 (District of Columbia 2018, p. 67). In contrast, Durban identifies specific targets, but the actions it will take toward these targets are vague and lack detail on which energy efficiency measures will be implemented. For example, its plan states that "businesses [will] adopt a range of energy efficiency technologies with 90 percent of lighting, heating, ventilation, and cooling (HVAC) and water heating equipment within facilities becoming energy efficient by 2030" (eThekweni 2014, p. 25). Sydney's actions, too, are less concrete, with targets such as "develop and deliver an energy focused retrofit program for apartments" (City of Sydney 2017a, p. 27).

We observed more variation regarding transit-related mitigation actions; although some cities rank quite highly on these indicators, others are weak or missing entirely. Boston's plan for *transit-oriented development* was strong, because the city intends to advocate for regional planning policies, such as the ongoing Rail Vision process to improve the existing commuter rail system led by the Massachusetts Department of Transportation (City of Boston 2019, p. 57). This type of regional approach is missing from several other city plans. For example, Barcelona's plan states the city will "adapt the necessary current urban planning regulations so they help to achieve the climate change mitigation and adaptation goals and targets (2020)," but do not state specific aims (Barcelona City Council 2018, p. 89). Regarding *deterrents for private vehicles*, Boston is a best practice city, because leaders described how they plan to work with city and state transportation associations and developers to implement a "points-based system that will allow developers to choose from a menu of transportation demand management options...[that] aim to reduce the vehicle miles traveled" (City of Boston 2019, p. 62). These options include updates and expanded parking freezes and other programs. Leaders also estimate expected reductions in emissions, vehicle miles traveled, and the resulting increase in public transit commuting as a result of efforts to deter solo driving. As another positive example, Los Angeles makes strong efforts in support of a *mode shift*. They state an overall goal to "increase the percentage of all trips made by walking, biking, micro-mobility/matched rides or transit to at least 35 percent by 2025; 50 percent by 2035; and maintain at least 50 percent by 2050." This goal is followed with specific

actions including the creation of four new routes to areas of the city that were not previously served by the county bus, as well as expanded services to ensure that wait times do not go beyond 15 minutes during weekdays (City of Los Angeles 2019, p. 72). London ranked highly on the EV indicator based on its detailed “road map to zero emission road transport” (Figure III.2). The road map uses five-year blocks to detail how multiple policy instruments, including a review of existing congestion pricing, taxation of non-EVs, and expansion of zero emission zones, can be adopted to achieve zero emissions in London’s road transport sector by 2050. For each action area, the plan specifies who is responsible, London or the United Kingdom, and features timetables specific to each vehicle class (Greater London Authority 2018a, p. 115). Dublin and Durban both ranked poorly for these four indicators, given that their plans lack specificity regarding aims and actionable steps.

Figure III.2. London’s “road map to zero emission road transport”



Source: Greater London Authority 2018a, 115.

Barcelona is the only city that presents a satisfactory set of actions related to a low-carbon diet. The majority of city plans either include vague references or omit the issue entirely. Barcelona’s actions include: “Develop short food circuits with various initiatives and agents to boost local, ecological agriculture, and logistics to facilitate these circuits” and “Promote and boost training and activities designed to introduce knowledge of vegetarianism in various spheres” (Barcelona City Council 2018, pp. 127–128). Still, this plan was not given exemplary status, because the actions identify neither quantifiable targets nor expected emissions reductions. Although other plans, such as Los Angeles’ Green New Deal, do reference food systems transitions, the emphasis is on non-climate objectives, such as hunger eradication and strengthening food sovereignty and security. For example, the chapter titled “Food Systems: Ensuring access to healthy food in a changing climate” includes targets such as “increase the number of urban agriculture sites in LA by at least 25 percent by 2025; and 50 percent by 2035” (City of Los Angeles 2019, p. 106). Some of the actions may reduce the carbon footprint of food production, such as “establish[ing] new zoning categories for innovative food production,” but the

location of food production is ultimately a less important factor governing food-based GHG emissions than food type (City of Los Angeles 2019, p. 111).¹⁷

2. Adaptation action indicators

The adaptation action indicators specify the content that should be included in a CAP. Table III.4 summarizes the performance of all reviewed CAPs against our adaptation indicators. Again, we focus our discussion on the Cascade to Impact's highest priority indicators, which include the development and installation of cooling materials, green infrastructure, coastal protection barriers, Sustainable Urban Drainage systems (SuDS), and flood risk maps and models.

Table III.4. Plan performance according to adaptation action indicators

	Barcelona	Boston	DC	Dublin	Durban	LA	London	Stockholm	Sydney
Coastal city adaptations	4	3	4	4	4	1	4	0	5
Drainage systems	4	0	3	4	3	0	5	0	2
Flood risk maps and models	3	3	5	5	3	1	5	1	4
Green infrastructure and green spaces	4	4	4	3	3	5	5	3	1
Resilient transportation	4	3	3	3	3	4	5	0	4
Resilient buildings	4	4	3	4	3	5	5	3	4
Climate hazard assessment	5	4	5	5	4	1	5	4	4
Climate impact assessment	5	1	4	5	4	1	5	3	4

Note: Values reflect the evaluation team's assessment of information available in each city's key CAP documents.

Legend:	0	1	2	3	4	5
	Not addressed	Addressed elsewhere	Lacks powers	Minimal	Satisfactory	Exemplary

Adaptation targets tend to have less specificity than mitigation targets; actions are often unquantified and lack specific indicators. We found that descriptions of adaptation actions commonly include non-specific verbs like "support," "improve," "develop," "study," and "propose," suggesting these actions tend to still be in a planning stage. As a result, and as is evidenced in Table III.4, we rated the corresponding actions in lighter shades of green. There are a few reasons as to why this may be the case. First, many of these adaptation actions fall beyond the city's powers. As detailed below, constructing sustainable drainage systems and coastal barriers often must be implemented in conjunction with other agencies or actors, and this need for cross-agency collaboration may be a reason that CAP actions lack specificity. Second, although the CAP Planning Framework indicates that mitigation and adaptation planning should be done in an integrated way to "maximize efficiencies and minimize investment risk" (C40 2020c), we note that several cities develop separate adaptation and mitigation plans. Los Angeles, for example, has both a "Resilient Los Angeles Strategy," as well as a

¹⁷ See Sigal Samuel's recent Vox article, "How to reduce your food's carbon footprint, in 2 charts" for additional information: <https://www.vox.com/future-perfect/2020/2/20/21144017/local-food-carbon-footprint-climate-environment>.

"Local Hazard Mitigation Plan," which are the key references for adaptation indicators scored as "Addressed Elsewhere." Additionally, some of the mitigation plans are more current than the adaptation ones, which may explain a discrepancy in the level of ambition and detail. Washington's mitigation plan was published in 2018, for example, while its climate resiliency plan was published in 2016. Third, the lack of a rigorous climate hazard and climate impact assessment makes it difficult for a city to specify and quantify adaptation targets. These assessments are designed to help cities identify relevant climate hazards and assess their probability, intensity, and potential threat to the population, facilities, and systems. Stockholm has yet to conduct a climate impact assessment but intends to do so. As a result, Stockholm's column is shaded almost entirely in light green or grey tones, as the city lacks the necessary evidence base and resulting action specificity that is present in other plans (Stockholms stad 2017, p. 3).

Plans showed variation in the adaptation actions related to developments on the coastline and drainage systems. Although some cities gave detailed targets, with interim and long-term goals, others included less specificity. We highlight Sydney and London's plans, for *coastal city adaptations* and *drainage systems*, respectively. Although these actions fall outside the city's purview, both cities describe a plan to engage with other actors to develop appropriate responses. Sydney's plan advocates for a "revision of engineering and building standards to increase building resiliency," as well as "a consistent [New South Wales] state planning framework to address sea level rise and storm surge" (City of Sydney 2017a, p. 11). London's plan describes how the mayor will work with infrastructure providers and landowners to increase drainage capacity. It also quantifies the share of land to be transitioned from conventional sewers to SuDS (Greater London Authority 2018a, p. 366).

Some cities include detailed flood risk maps, models, and plans to develop green spaces; others reference these topics but lack specific plans and/or targets. Both Dublin and London have detailed *flood risk maps and models* (Dublin City Council and Codema 2016; Greater London Authority 2018a, p. 338). London's plan is especially noteworthy, because it estimates the number of people and houses at risk of flooding under current conditions and under a sea-level rise scenario of 0.9 meters (Greater London Authority 2018a, p. 336). In terms of *green space*, Los Angeles includes particularly strong targets, such as an "increase[d] tree canopy in areas of greatest need by at least 50 percent by 2028," which will contribute to reducing the city's urban heat island effect by 1.7°F and 3°F by 2025 and 2035, respectively (City of Los Angeles 2019, p. 118). Similarly, London's aim is to be the "world's first National Park City, where more than half of its area is green, where the natural environment is protected, and where the network of green infrastructure is managed to benefit all Londoners" (Greater London Authority 2018a, p. 157). In contrast, Dublin's less specific aim is to "assess the feasibility of green walls" (Dublin City Council and Codema, p. 95).

Plans tended to specify stronger actions for improving the climate resilience of building infrastructure than they did for transport infrastructure. Los Angeles, for example, requires that all new roofs be made into cool roofs by 2020, with an additional 13,000 cool roofs installed by 2021 (City of Los Angeles 2019, p. 122). London's plan "requires developers to follow the cooling hierarchy," which minimizes higher-energy mechanical cooling techniques and maximizes passive cooling via energy efficient design, green roofs and walls, fenestration, and other mechanisms (Greater London Authority 2018a, p. 379). By contrast, Washington, DC, aims to "improve transportation and utility infrastructure in order to maintain viability during periods of extreme heat, severe weather, and flooding" (Government of the District of Columbia 2016, p. 8). Similarly, Boston's plan states that the city will "support flood protection and carbon reduction measures for at-risk [Massachusetts Bay

Transportation Authority] stations" (City of Boston 2019, p. 58). Neither Washington's nor Boston's plans specify the improvements that will be implemented or their expected benefits.



C. Progress monitoring stage

1. Monitoring and data collection indicators

The monitoring and data collection theme encompasses indicators for the availability and quality of information on a CAP's targets, GHG inventorying and scenario-modeling, and overall data management strategy. Table III.5 summarizes CAP performance against this theme's indicators. We looked for ambitious targets that were disaggregated into smaller, actionable steps, each with key performance indicators and milestones ("Measurable targets"). Steps should be situated within an implementation timetable that outlines expected progress by phases. The plan should be monitored against these targets, and progress should be reported regularly and publicly. Plans should commit to scheduled updates of the emissions inventory and risk reduction impacts, the results of which should inform plan revisions ("Monitoring plan"). The plan should also feature a recent GHG inventory, BAU predictions, and an emissions trajectory based on CAP actions and potential reductions across all priority sectors ("GHG emissions inventory," "GHG emissions trajectory"). BAU forecasts describe model inputs and assumptions used in building the model. The city should report emissions annually and publicly and use monitoring data to course-correct or accelerate timelines as needed ("GHG emissions monitoring"). If actions will be insufficient to achieve carbon neutrality by 2050, the plan should describe how offsets, carbon sinks, and negative emission technologies will be used ("GHG residual emissions"). The CAP should also include efforts to improve air quality data collection and analysis, and to establish the health impacts of air pollution and clean air benefits ("Air quality monitoring"). Lastly, we inspected CAPs for documentation of a climate data management strategy that aligns with any citywide data initiatives and encompasses data collection, management, and oversight practices ("Data management strategy").

Table III.5. Plan performance according to monitoring and data collection indicators

	Barcelona	Boston	DC	Dublin	Durban	LA	London	Stockholm	Sydney
Measurable targets	5	5	5	4	3	5	5	4	4
Monitoring plan	5	5	4	5	3	5	5	5	5
GHG residual emissions	3	4	0	0	0	4	5	5	4
GHG emissions inventory	5	5	5	5	4	5	5	5	5
GHG emissions trajectory	5	4	5	4	0	4	5	4	4
GHG emissions monitoring	5	4	4	5	0	4	5	5	4
Air quality monitoring	2	3	3	4	1	5	5	1	3
Data management strategy	4	3	5	4	0	4	5	3	0

Note: Values reflect the evaluation team's assessment of information available in each city's key CAP documents.

Legend:	0	1	2	3	4	5
	Not addressed	Addressed elsewhere	Lacks powers	Minimal	Satisfactory	Exemplary

Nearly all plans feature strong monitoring plans with measurable targets. We considered London’s plan a best practice example because of its all-encompassing annual progress reporting strategy. A supplemental report titled “One Year On” summarizes progress made thus far. The report contains a chapter for each strategy area (e.g., climate change mitigation and energy, air quality, etc.) and details the programs, policies, and lobbying and partnership efforts made by the city in pursuit of its climate goals. Importantly, this report details specific projects, numbers, and partners. The supplemental implementation plan also provides a delivery timetable and additional information on how actions will be monitored and reported. For example, London’s aim to have the world’s best air quality will be measured by the “number of legal exceedances per year” and “area covered by air quality focus areas.” The plan also identifies the data sets, data owners, and frequency with which data will be published, illustrated in Figure III.3 for the city’s zero waste target. London’s plan describes how indicators will be developed across various sectors, and how data will inform updates to their mitigation and adaptation strategies. Unlike other cities that present historical and future emissions only in aggregate, London’s plan includes source-level breakdowns (Greater London Authority 2018b, p. 25).

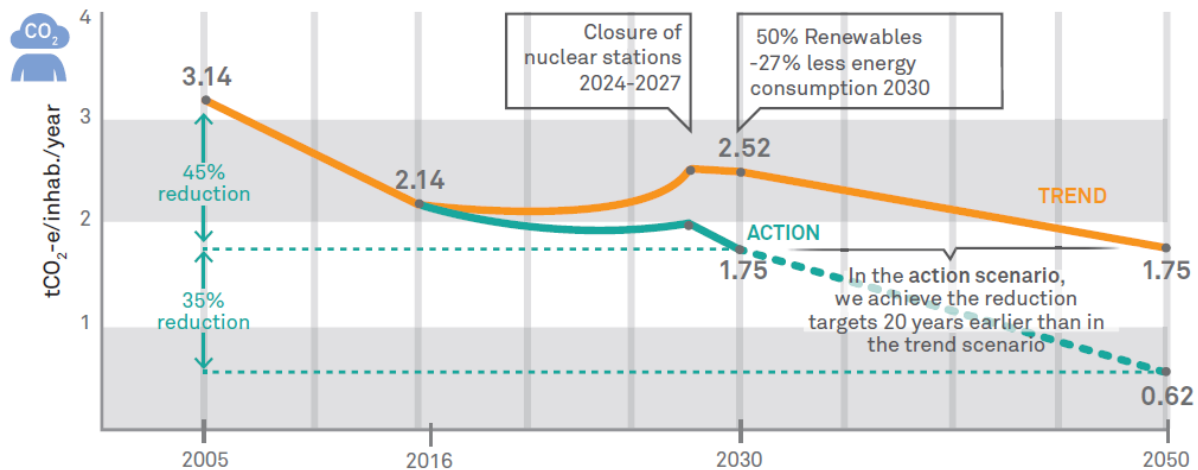
Figure III.3. Example of zero waste indicators in London’s implementation plan

Target	Measure reported on	Dataset/s to be used	Dataset owner	Publication of data frequency
London will be a zero waste city. By 2026 no biodegradable or recyclable waste will be sent to landfill, and by 2030 65% of London’s municipal waste will be recycled	Household waste recycling performance	Local authority data returns	DEFRA	Annually (last published in 2017)
	Non-household waste recycling performance	Data provided by waste industry	GLA	Annually from 2019

Source: Greater London Authority 2018b

Nearly all plans include emissions trajectories and forecast GHG reductions at the city-level and sector-level, but they rarely estimate reductions by climate action. Barcelona offers a best practice example through its intuitive illustration comparing the results of an “action scenario” under which the full set of proposed actions are achieved, against a “trend scenario” calibrated from per capita emissions behavior between 2005 and 2016. Figure III.4 depicts the action scenario achieving an 80 percent reduction in 2005-level emissions by 2050. The action scenario also achieves in 2030 the same level of per capita emissions that the BAU scenario reaches in 2050. Barcelona’s plan also estimates emissions reductions by sector (Barcelona City Council 2018, p. 26, p. 55). No plan consistently features GHG reduction/avoidance estimates at the level of individual actions, likely because much of the action-level modeling work will be conducted in the implementation phase. This finding is consistent with interviewees’ statements that cities will continue estimating community-scale emissions. The large number of climate actions cities anticipate undertaking would be more feasible to monitor when aggregated by sector, rather than carried out individually.

Figure III.4. Comparison of Barcelona's per capita emissions under action and trend scenarios



Source: Barcelona City Council 2018

Some cities have estimated their residual emissions but anticipate identifying specific carbon sinks and offsets in the future. Los Angeles, for example, predicts that technology and policy limitations will result in 8.5 percent of current emissions still being generated in 2050, largely from sea and air travel, and industry (City of Los Angeles 2019, p. 13). Offsetting residual emissions through means other than deforestation initiatives will require new technologies and carbon negative projects, but specifics are not yet available, as this area will presumably mature in coming years. Stockholm estimates that 0.4 tons of CO₂ per capita will remain as residual emissions by 2040 and plans to invest in carbon sinks that have yet to be determined. City planners also discuss the importance of a coordinated regional response to address Scope 3 emissions to minimize cross-border leakage (Stockholms stad 2016, p. 15). Dublin, Durban, and Washington, DC, are examples of cities that do not address residual emissions at all. Although aiming for carbon neutrality, they are uncertain about achieving it by 2050.

"In our strategy we'll have an estimate of what our residual emissions will look like...and how we want to deal with that, [but] I think...we're looking for guidance to help us."

—C40 member city official

With the exception of Durban, all cities include strong plans to monitor emissions. Stockholm, for example, makes explicit how emissions are calculated; it details the sources that are accounted for (including rail traffic and shipping within the city's boundaries), identifies how calculations are conducted (i.e., a consumption-based method that leverages life-cycle assessment results), and accounts for population growth that will expand the city to 1 million residents by 2020 (Stockholms stad 2016, p.18). The plan also calls for analyzing and re-calculating emissions every four years, and outlines targets through 2039 to ensure that short-term efforts keep the city on track with long-term goals (Stockholms stad 2016, p. 45). Committees and boards of participating companies are given responsibility for ratifying, implementing, and following up on measures to ensure that targets are reached in a cost-effective manner. Additionally, there is an acceleration strategy if short-term efforts do not meet their targets. The City Executive Board may call upon committees to take further action if needed (Stockholms stad 2016, p. 45).

With the exception of London and Los Angeles, air quality monitoring plans are less robust than GHG monitoring plans. London has an exceptionally advanced monitoring network that includes street-by-street monitoring to map air pollution with high temporal resolution. The monitoring system will report on a variety of pollutants, including nitrogen dioxide, ozone, nitric oxide, and others. An Air Quality Action Plan will be implemented for all areas that exceed air quality objectives and European Union (EU) limits, to reduce local pollution sources (Greater London Authority 2018a, pp. 40–70). London’s implementation plan details expected emissions reductions that should result from actions taken to improve air quality (Greater London Authority 2018b, p. 10). The city will measure its efforts against these targets (Figure III.5).

Figure III.5. Anticipated emissions reductions resulting from actions to improve London’s air quality

Emission reductions compared to a 2013 baseline	
2020	NO _x 40% reduction, PM ₁₀ 16% reduction, PM _{2.5} 28% reduction
2025	NO _x 55% reduction, PM ₁₀ 23% reduction, PM _{2.5} 37% reduction
2030	NO _x 65% reduction, PM ₁₀ 28% reduction, PM _{2.5} 43% reduction (WHO guidelines)
2050	NO _x 82% reduction, PM ₁₀ 38% reduction, PM _{2.5} 52% reduction

Source: Greater London Authority 2018b, p. 10

Los Angeles is also taking steps to monitor air quality and quantifies the air quality co-benefits expected from the CAP. The city is engaged in several efforts to deploy and expand monitoring networks, including the use of a GPS-enabled smart inhaler program and fence-line monitoring at refineries and oil and gas extraction sites, and has partnered with the South Coast Air Quality Management District to forecast the particulate matter and ozone pollution effects of various climate policies (City of Los Angeles 2019, p. 17). Meeting these air quality goals by 2025 would avoid an estimated \$5.8 billion in annual health care costs (City of Los Angeles 2019, p. 89). By contrast, Sydney’s air quality monitoring plan is less detailed. Although air quality is cited as a growing concern due to predicted increases in transportation emissions from population growth, the proposed responses are unspecific in language. Sydney’s plan seeks to “identify opportunities to help reduce local air pollution” by 2021 (City of Sydney 2017c, p. 70), and “advocate for air quality monitoring to be conducted within our local area” (City of Sydney 2017a, p. 53). At the federal level, Australia’s Environment Ministers are working “to establish a National Clean Air Agreement to improve air quality and address the impacts on human health and the environment” (City of Sydney 2017a, p. 47), but Sydney’s plan does not fully detail how the city will engage with and support such efforts.

Some cities describe their data management processes and highlight the importance of good data, while others do not explicate these aims as clearly. London serves as a best practice example for a few reasons. First, its plan includes explicit efforts to improve data monitoring and reporting by sector. For example, it aims to “establish a mandatory national data reporting system for municipal waste that is straightforward to use and understand. There is currently no requirement to report business waste, and there is very limited or robust data available. This means that the extent of waste being produced by businesses, and the level of recycling, are based on estimates” (Greater London Authority 2018a, p. 206). Second is a plan to use data to identify knowledge gaps and inform action priorities: “There is

currently no systematic collection of data to show how well the city is adapting to the impacts of severe weather and longer-term climate change, and whether the efforts intended to reduce risk and increase resilience are working. Such data collection, which could largely be drawn from existing data sets, would help London adapt to climate change and become more resilient. It would capture evidence of good and poor performance, identify adaptation priorities, and highlight knowledge gaps" (Greater London Authority 2018a, p. 354). Although this area is ripe for improvement, we appreciate the fact that there is an examination of the city's shortcomings and a discussion of the need and means to improve their processes. Third, when databases are referenced, as they are throughout the plan, there is a note about the quality of the data and an indication of improvements that may be needed. Other cities, including Durban and Sydney, lack specific data management aims and processes.



IV. Key findings from analyzing CDP climate data

Cities' success in operationalizing their CAPs and achieving emissions reductions will be an ongoing process that requires regular monitoring to verify they are on pace to achieve key milestones and to course-correct when performance lags. C40 and non-C40 cities submit data on their GHG inventories and climate actions to reporting platforms like CDP, to support such monitoring. In this chapter, we analyze CDP data with three objectives in mind: to examine the prevalence of climate action reporting, to assess the magnitude of actions that cities have reported, and to compare groupwise performance between C40 and non-C40 cities. This analysis is strictly descriptive and not intended to make any claim about the effect of C40 membership on the outcomes of interest. Ex ante, we posit that C40 cities would be committing to more aggressive emission reduction targets than non-C40 cities, and use the data to test this claim. In addition to reviewing performance for C40 as a group and for individual cities, we also present groupwise comparisons using the city typology developed in McKinsey and C40 (2017). The typology consists of six categories that are based on a city's level of economic development, density, population, climate, and other related factors.

We draw on 2018 and 2019 data publicly reported to CDP and use the most recent values a city has made available. Some cities have opted to keep their CDP submissions private, which prevents us from determining the breadth or magnitude of actions that all C40 cities have committed to or are planning.¹⁸ A percentage of the private reporters undoubtedly provided information on climate actions, mitigation estimates, or GHG inventories, but as such would go unreported in our analysis.

A. Overview of climate data reporting status

In both 2018 and 2019, the majority of C40 member cities reported some level of climate action and a GHG inventory. These outcomes are consistent with the mandatory C40 participation standard that member cities "report annually on progress through a C40 recognized platform," which does not stipulate public reporting. Still, more than a quarter of the network's membership did not publicly report either outcome, as seen in Columns 1 and 5 in Table IV.1. Relative to the group of non-C40 cities, C40 members are more likely to report an action or an inventory, and when reporting an action are more likely to have included an estimated number of tons of CO₂e reduced or avoided. Cities that report a climate action and do not include a mitigation estimate often provided only a description of the climate action, or indicated that the action may be implemented in the future and that abatement forecasts had not been conducted. Among non-C40 cities, there is a dramatic uptick in reporting in 2019, likely spurred by climate emergency declarations and the youth movement that mobilized cities into greater outward action. The share of C40 cities that reported any climate action, provided an abatement estimate, or reported a GHG inventory, also increased from 2018 to 2019, but at a smaller number of percentage points than non-C40 cities.

¹⁸ C40 member cities that privately reported to CDP in 2018 were Abidjan, Amsterdam, Berlin, Dubai, Guangzhou, Hanoi, Istanbul, Los Angeles, Madrid, Milan, Moscow, New Orleans, Pretoria–Tshwane, Qingdao, Salvador, Shenzhen, and Wuhan. In 2019, Guangzhou, Hanoi, Ho Chi Minh, Nanjing, Qingdao, and Wuhan submitted private CDP reports.

Table IV.1. Overview of CDP reporting by C40 status

Year	Reported any climate action*		Reported emission reduction estimate for any action		Reported any GHG inventory†	
	# C40 cities (%)	# Non-C40 cities (%)	# C40 cities (%)	# Non-C40 cities (%)	# C40 cities (%)	# Non-C40 cities (%)
	(1)	(2)	(3)	(4)	(5)	(6)
2018	47 (51%)	178 (22%)	29 (31%)	71 (9%)	51 (55%)	169 (21%)
2019	66 (71%)	449 (55%)	46 (49%)	248 (31%)	60 (65%)	361 (45%)
2018 or 2019	69 (74%)	475 (59%)	48 (52%)	258 (32%)	66 (71%)	402 (50%)

Source: Authors' calculations using CDP 2018 and CDP 2019a.

* A city is counted as reporting any climate action if it provides any mitigation action information (an action sector, action title, action description, implementation status, estimated emissions reduction target, or an action time scale) in its CDP submission for that year.

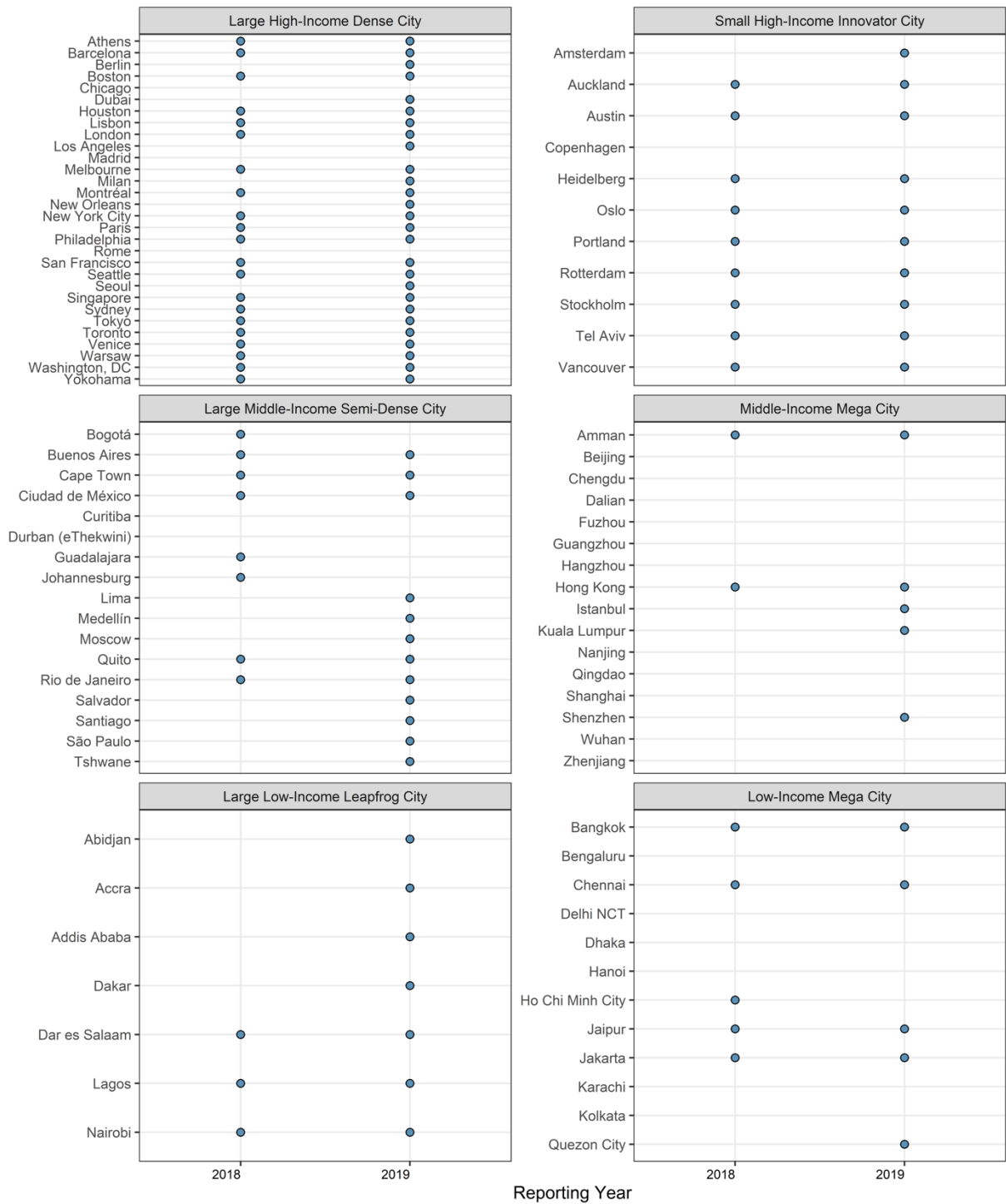
† A city is counted as reporting a GHG inventory if it reports any emissions values in its CDP submission for that year. For non-C40 cities, percentages are computed relative to the 805 non-C40 cities that publicly disclosed to CDP in 2018 or 2019. Percentage values reported for C40 cities are with respect to the 93 C40 member cities whose McKinsey Typology type was shared by C40.

B. Examination of C40 cities' mitigation action data

The majority of C40 cities report at least one mitigation action in their CDP submissions, but their performance and regularity are uneven across the McKinsey city typology groups. High-income cities, represented in both the Large Dense City and Innovator City categories, are the most likely to report any type of climate action and consistently report publicly in both years, as seen in Figure IV.1.¹⁹ In contrast, the middle- and low-income megacities are the least likely to report actions. The low reporting rates for these categories are primarily driven by Chinese cities who largely submitted private reports, as well as the absence of any data from many of the South Asian members. A key development in 2019 is the large increase (16 cities) in low-income and middle-income cities reporting climate actions that had not reported them in the previous year, potentially inspired by both the climate emergency and compliance with C40's participation standards. For the number of climate actions a city reports, a similar pattern emerges across McKinsey city types as shown in Figure IV.2. High-income cities report a relatively large number of climate actions each, as they tend to have the highest per capita emissions, and only a small number of high-income cities reported actions in neither 2018 nor 2019. Middle-income cities on average report fewer actions than high-income cities, and low-income cities on average even fewer. Although all Large Low-Income Leapfrog cities reported a mitigation action (Figure IV.1), most reported no more than two actions apiece.

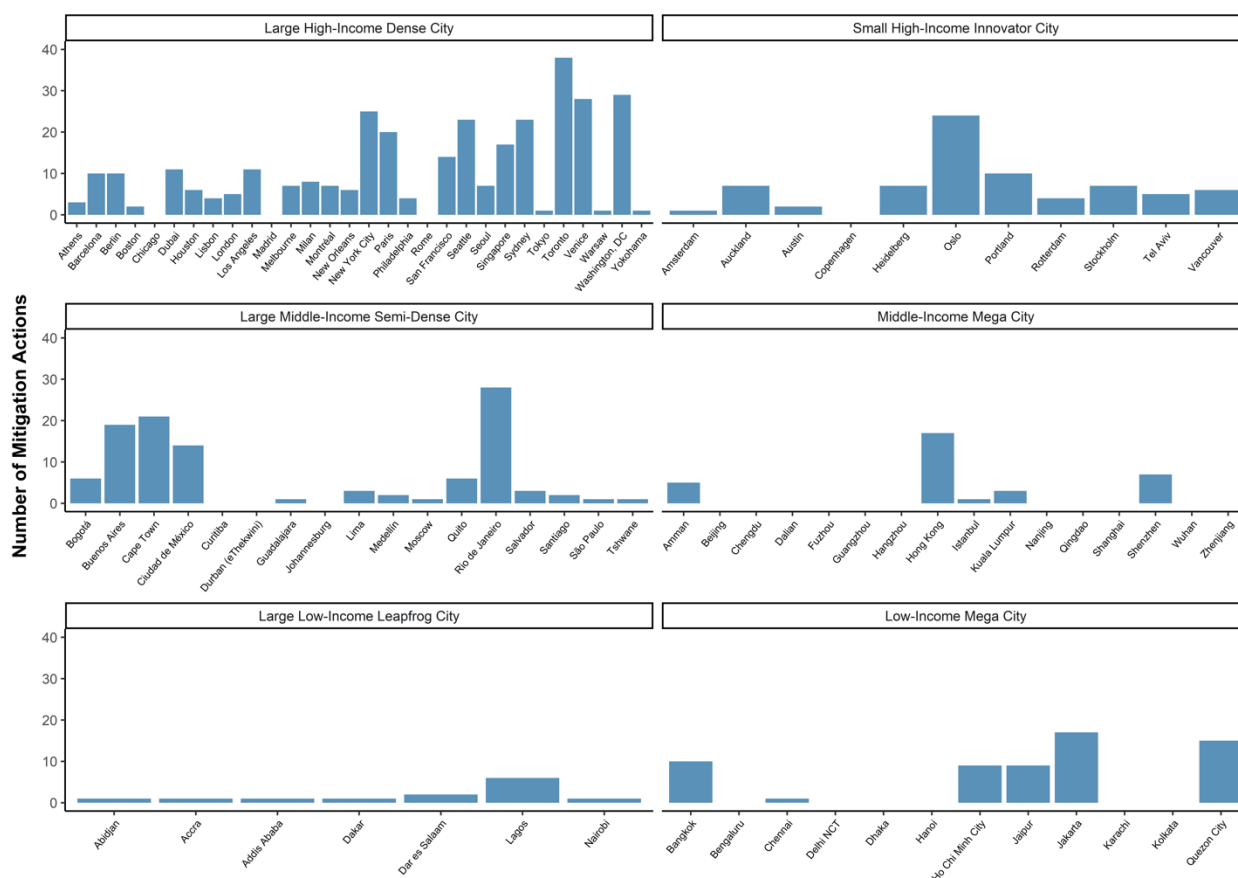
¹⁹ For cities reporting in both 2018 and 2019, 2019 data on climate actions may reuse values submitted in the 2018 reporting period wholesale. Such a scenario would not represent an actual update. Because we cannot rule out that 2018 reuse simply reflects no change in a city's climate goals between consecutive years, we count both 2018 and 2019 submissions as valid and distinct.

Figure IV.1. City-level climate action reporting status, by city type



Source: Authors' calculations using CDP 2018 and CDP 2019a.

Figure IV.2. Number of mitigation actions a city reported, by city type



Source: Authors' calculations using CDP 2018 and CDP 2019a.

Note: For cities that publicly reported climate actions in both 2018 and 2019, this figure includes the year that contained more distinct climate actions.

Cities reporting their climate actions report an average of roughly nine actions each, and many report only one or two; cities appear to be under-reporting their true climate actions in CDP submissions. Toronto reports the greatest number of actions at nearly 40, and relatively few cities describe more than 20 actions.²⁰ In contrast, several of the recently published D2020-compliant CAPs include more than 100 actions each, such as Barcelona's (Barcelona City Council 2018) and Los Angeles' (City of Los Angeles 2019), who in CDP report about 10 actions each. A likely explanation stems from the CDP questionnaire requesting that cities report their "most impactful mitigation actions" and differences among cities on which "impact" cutoff to use when reporting. Because the CDP reporting system imposes no limits on the number of actions a city can include, we believe the cities themselves are under-reporting their activities and progress. As a result, CDP data would be an imperfect reflection of all the actions that cities have committed or are considering, which would render CDP data less valid for researchers, donors, and governments who want globally accurate data on the total mitigation potential cities are pursuing. Another possible explanation for the mismatch between action counts

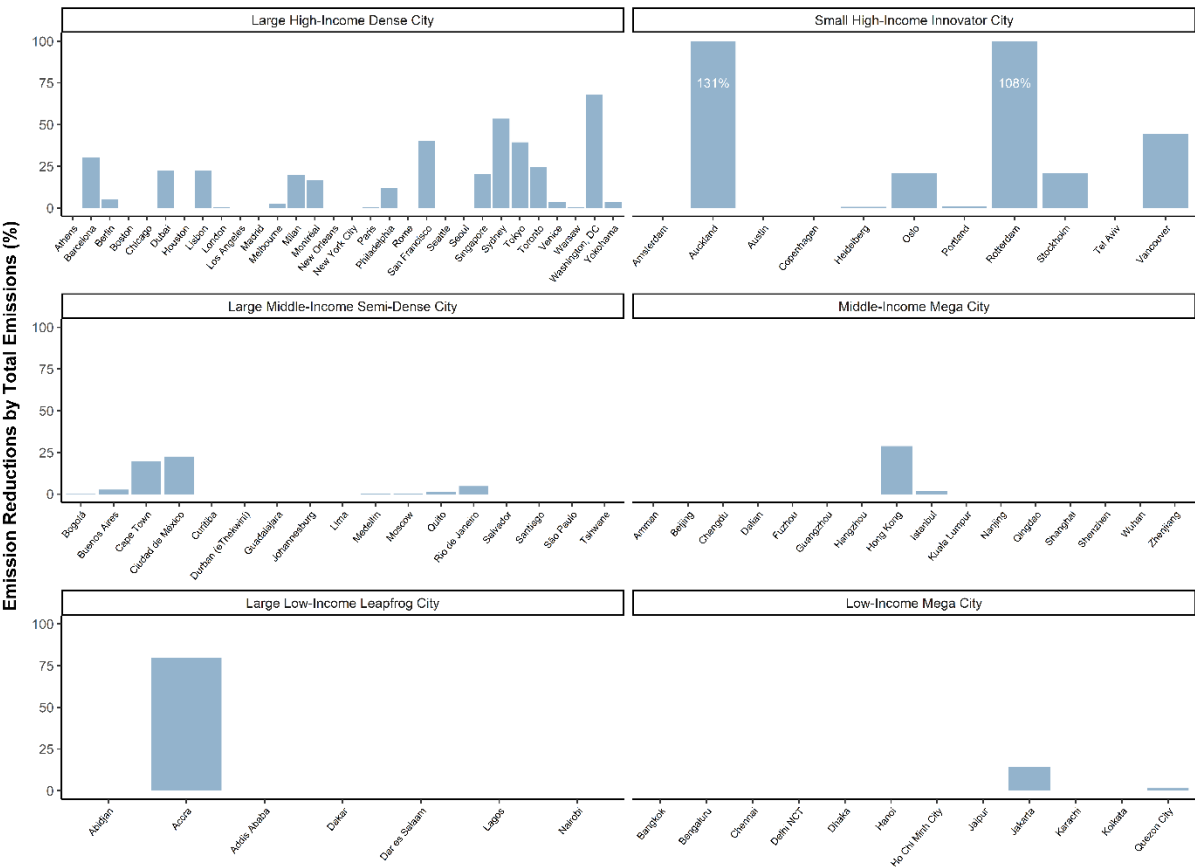
²⁰ CDP does not impose limits on the number of actions a city can include in its submission. Counts of total actions therefore are not an artifact of the CDP reporting system.

reported in CDP and provided in CAPs is that cities are bundling multiple actions into individual entries, such as inputting all buildings-related efforts as a single action. Both explanations would make it challenging to track progress on cities' actions. Unreported actions cannot be tracked, and if distinct actions are bundled, they cannot be individually monitored over time. Bundled actions would need to be bundled the exact same way over time to support meaningful monitoring of whether the actions have delivered their intended emission reductions. Otherwise, changes over time could simply be driven by compositional differences. Regardless of the cause, the disparity between CAP action counts and CDP counts suggests there is room for improvement in reporting updated annual statuses of cities' climate actions.

We estimate the share of current GHG emissions that would be mitigated if cities fully implemented their reported climate actions. In addition to reporting the sector, status, and description of their climate actions, cities can provide an estimate for the abatement size of each action in metric tons of CO₂e. Unfortunately, only a slight majority of C40 cities (52 percent, as seen in Table IV.1) report such estimates for at least one action. For cities that reported an abatement estimate for any climate action, we sum up the projected abatement totals for each city to calculate the share of current emissions that would be mitigated under full adherence with those actions.²¹ For example, a city that reports a community-scale inventory of 9.0 million tons (MT) CO₂e and lists actions totaling 3.0 MT CO₂e would be reporting an estimated emission reduction share of 33 percent. On this measure, high-income cities report higher emission reduction shares relative to low- and medium-income cities, and are more likely to include mitigation estimates for at least one action (Figure IV.3), which is a necessary input to calculate an emission reduction share. High-income cities on average report the highest mitigation shares, but the majority of them add up to no more than 25 percent of their current emissions; more than one dozen such cities report totals below 5 percent. Only a few cities, including Accra, Auckland, Rotterdam, and Washington, DC, report actions whose fulfillment would reduce current emissions by at least 50 percent. If all climate actions that C40 cities report to CDP were fully realized, current emissions for each city would on average drop by 21 percent.

²¹ This calculation is conditional on including an abatement estimate. Cities that report neither a climate action nor an abatement estimate are considered missing values and excluded from subsequent analyses.

Figure IV.3. City-level emissions reduction shares, by city type

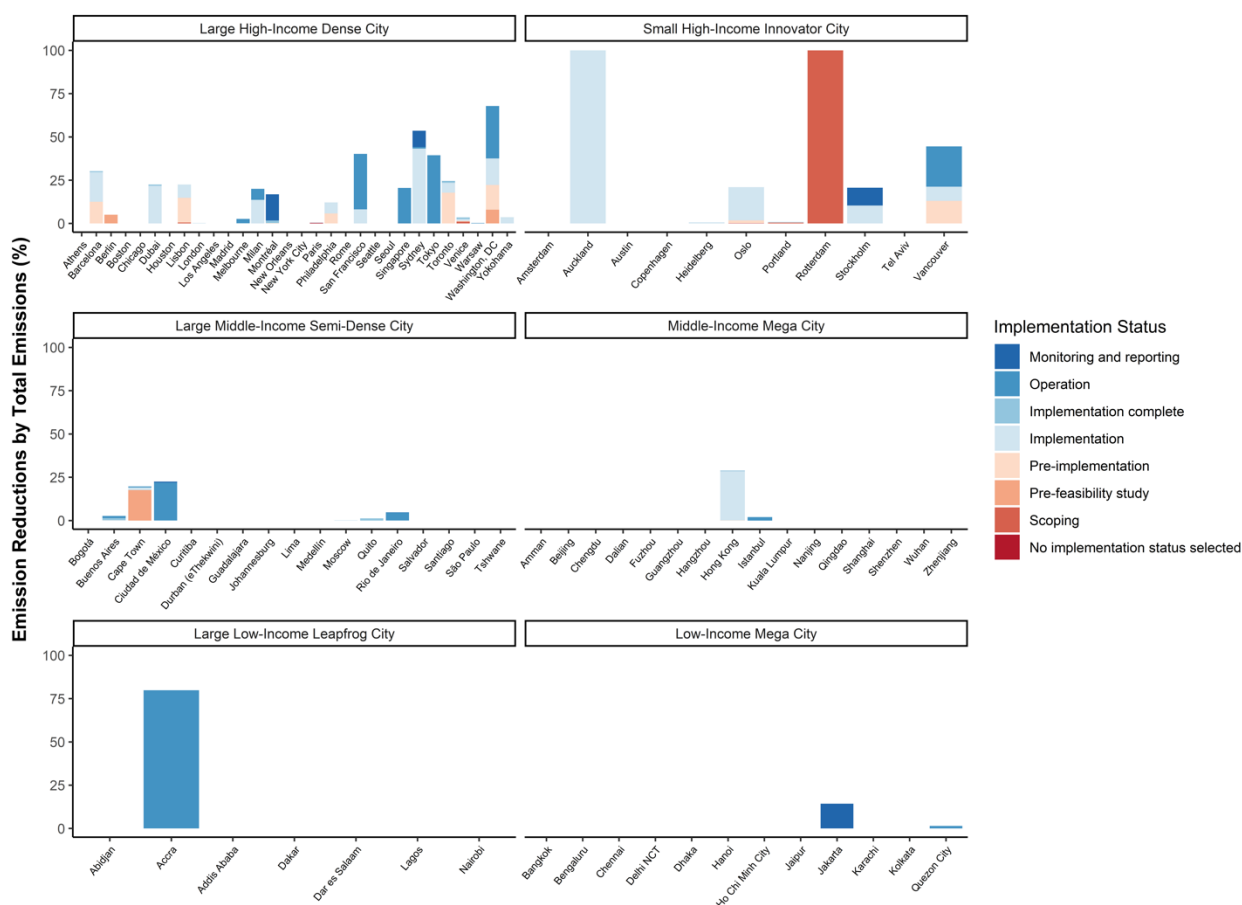


Source: Authors' calculations using CDP 2018 and CDP 2019a.

Note: For the few cases in which a city does not report an emissions inventory in the same year as the most recent action reporting year, we use emissions values for the other reporting year when available.

The majority of reported climate actions are currently in some stage of implementation; CDP reports therefore provide limited insight into the pipeline of mitigation actions that remain at the scoping through pre-implementation stages. For each mitigation action submitted to CDP, a city can specify the action's implementation status. The status options are shown in the legend of Figure IV.4, with 'scoping' the most preliminary and 'monitoring and reporting' denoting climate actions mature enough to enable data collection and analysis of results. While there is some variation in the status of actions that C40 cities have reported, with some cities reporting a combination of actions on either side of formal implementation, approximately 82 percent of the emissions reductions (tons of CO₂e) from reported actions are at the "implementation" or better status. As a result, CDP submissions more closely reflect the mitigation efforts that cities have already made, than what they plan to do. Given the significant emission reduction efforts that cities have ahead of them, we would have anticipated a much larger share of total mitigation coming from actions reported at the scoping, pre-feasibility study, and pre-implementation phases.

Figure IV.4. City-level implementation status of climate actions, by city type



Source: Authors' calculations using CDP 2018 and CDP 2019a.

Note: For the few cases in which a city does not report an emissions inventory in the same year as the most recent action reporting year, we use emissions values for the other reporting year when available.

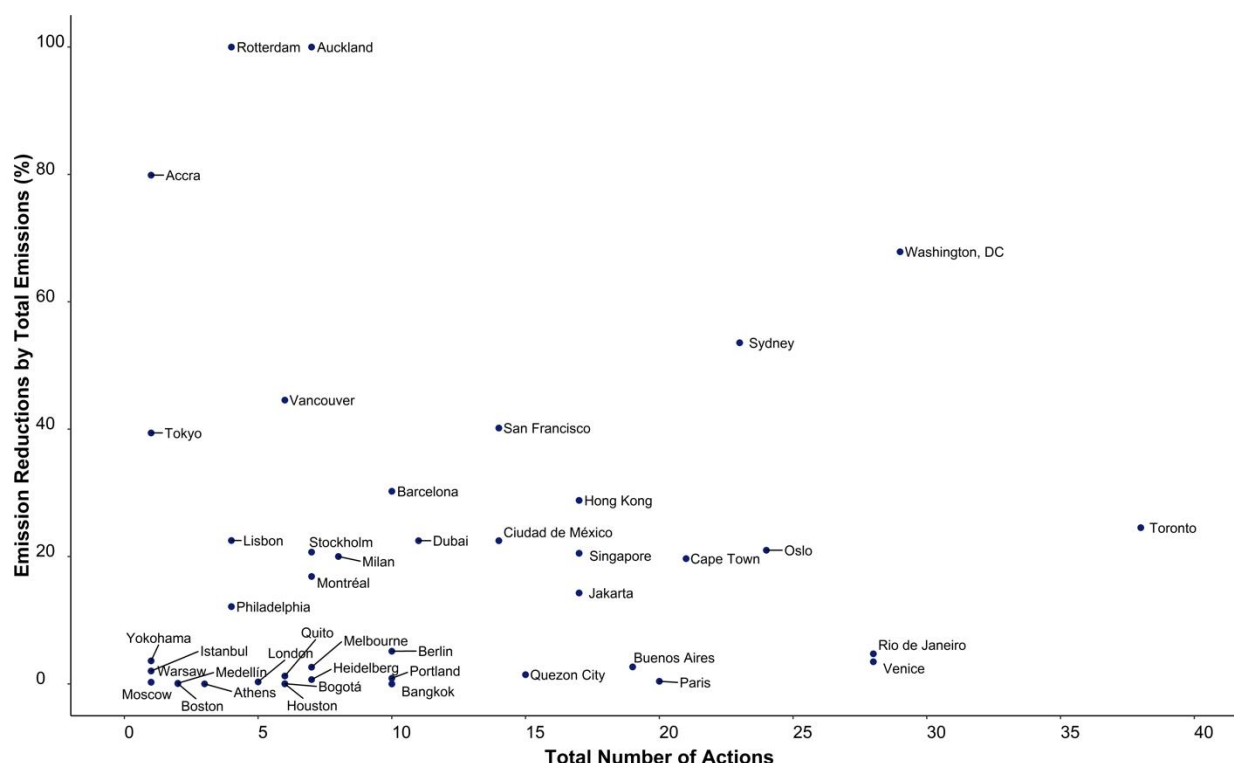
The number of actions cities report bears a limited relationship to their emissions reduction share.

Earlier C40 research (e.g., C40 and Arup 2015a, 2015b) has used the number of climate actions that cities carry out as a proxy for their climate policy ambitiousness, such that more actions translate to more aggressive mitigation efforts. We find the relationship to be more tenuous, at least for the data submitted to CDP.²² Although we would not expect all cities to lie on a diagonal line, we observe both cities reporting many actions that do not add up to a large reduction share, and cities reporting fewer than 10 actions, which would reduce emissions by more than 80 percent. One possible explanation is that the number of reported climate actions is less informative about climate policy than earlier assumed. As described earlier, cities may also be packaging an individual "action" in different ways. For example, a city promoting mass transit ridership might subsidize fare cards, roll out print and radio advertising campaigns, and increase service frequency. Because a climate action does not have a precise definition, one city might define the three tactics above as three distinct actions, while another city may count them as one—namely, "promoting mass transit ridership." Another possible explanation rests in how cities engage with CDP reporting. Although the CDP questionnaire invites

²² This figure includes only C40 cities reporting nonzero emissions reduction values.

cities to report their highest impact actions, Figure IV.2 demonstrates that the number of actions tends to be small. If cities in actuality are undertaking 100 distinct actions, then both the action counts and the mitigation estimates of Figure IV.5 would be underestimated.

Figure IV.5. Comparison of the share of emission reduction and number of reported climate actions for C40 cities



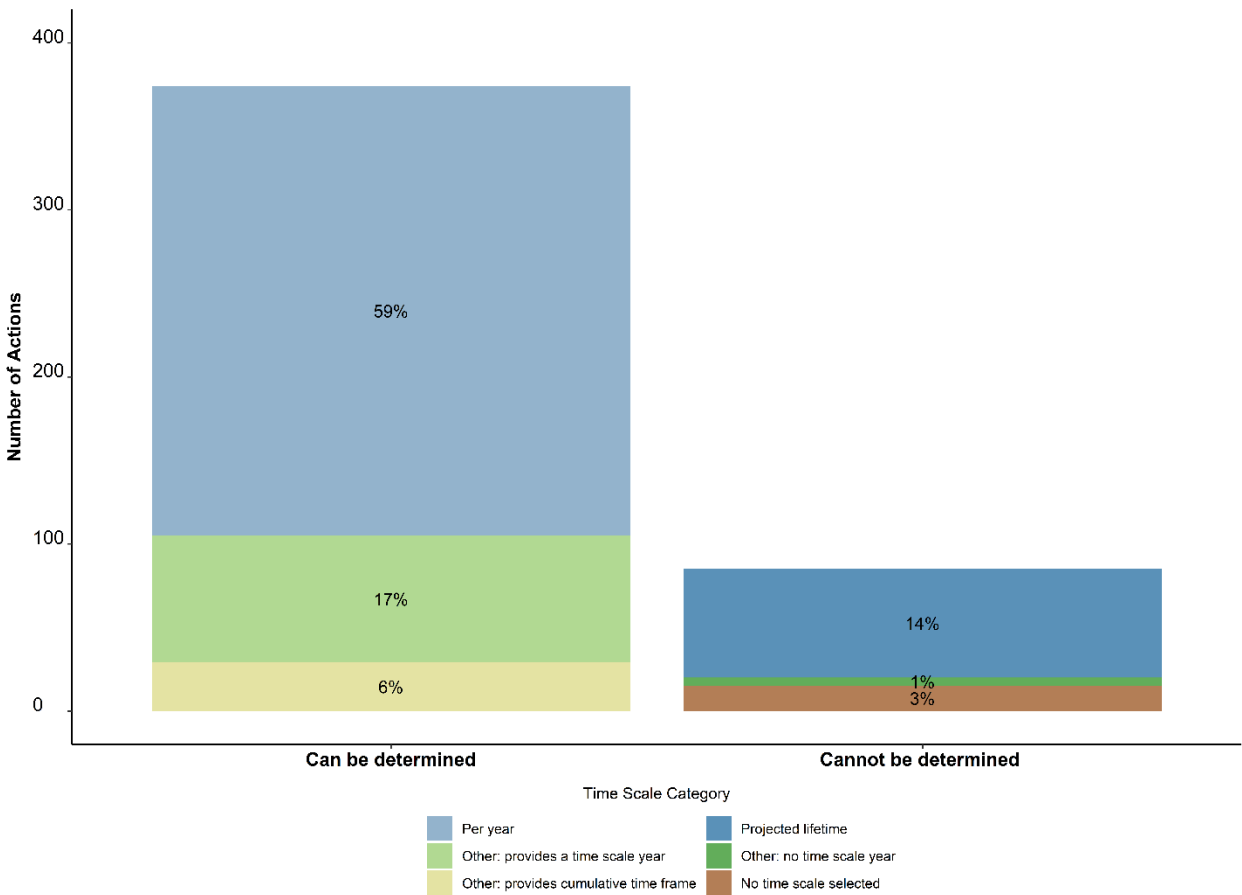
Source: Authors' calculations using CDP 2018 and CDP 2019a.

Note: Values for each city are calculated using the most recent, public CDP submission in which a city reports a climate action. C40 cities that did not report an emissions reduction estimate for any action are not included. Auckland and Rotterdam report reductions in excess of 100 percent of current emissions, which we topcode as 100 percent for visual clarity. When a city does not report an emissions inventory in the same year as the most recent action reporting year, we use emissions values for the other reporting year, if available.

Meaningful analysis of climate action across cities requires data to be reported in standardized units, such as thousands of tons of CO₂e annually, but 20 percent of the actions reported by C40 cities do not specify a time frame over which reductions will accrue. Climate actions reported to CDP include a time component, because mitigation estimates may be described as cumulative sums, such as X tons of CO₂e over the life of a project, or as an annual flow for actions whose effects will be permanent from the perspective of avoided emissions. If the start and end dates of a project are provided, then the annual average emissions reduction can be determined. When dates are not provided, there is no way to standardize those cumulative totals to annual values. For example, a city may state that the project will avoid 620,000 tons CO₂e, but the implications are different if the project duration is three years as opposed to 30 years. The majority of climate actions (59 percent) are specified in terms of annual reductions, and an additional 23 percent can be converted to annual values because of sufficient time scale information, as displayed in Figure IV.6. However, nearly 20 percent of climate actions cannot. If these actions are disproportionately large, they would account for more than 20 percent of total

emissions reductions, and their exclusion from any global analysis would suggest that cities are doing much less than they actually are. Without providing additional information on the time scales for which reduction estimates are reported, such data creates additional challenges for organizations and individuals who want accurate information on cities’ mitigation status and forecasts.

Figure IV.6. Time scale used by cities in reporting their emissions reduction actions



Source: Authors’ calculations using CDP 2018 and CDP 2019a.
Note: Values are calculated using both 2018 and 2019 public CDP submissions that include estimated emission reduction targets.

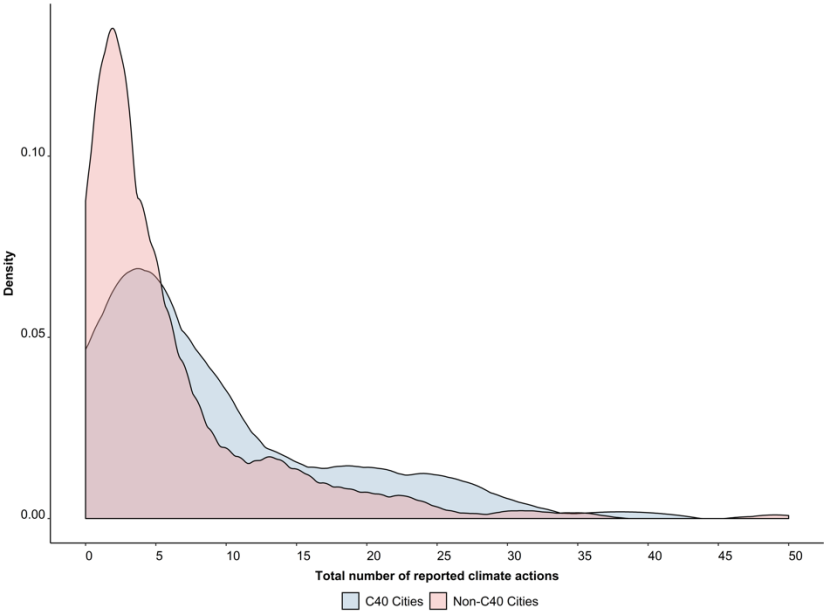
C. Comparison of C40 and non-C40 city mitigation ambition

When viewed as groups, the overwhelming majority of both C40 and non-C40 cities report fewer than a dozen climate actions apiece. Across C40 members and non-C40 cities, Table IV.1 compares the share of cities reporting any climate action and indicates that C40 cities are more likely to report at least one mitigation action. Do C40 cities report comparatively more climate actions, or more ambitious climate actions in terms of their emission reduction shares? Figure IV.7 shows that on average, C40 cities do describe more climate actions in their CDP submissions.²³ The large peak in the

²³ Figure IV.6 and IV.7 are kernel density plots that depict the distribution of values and are similar to histograms.

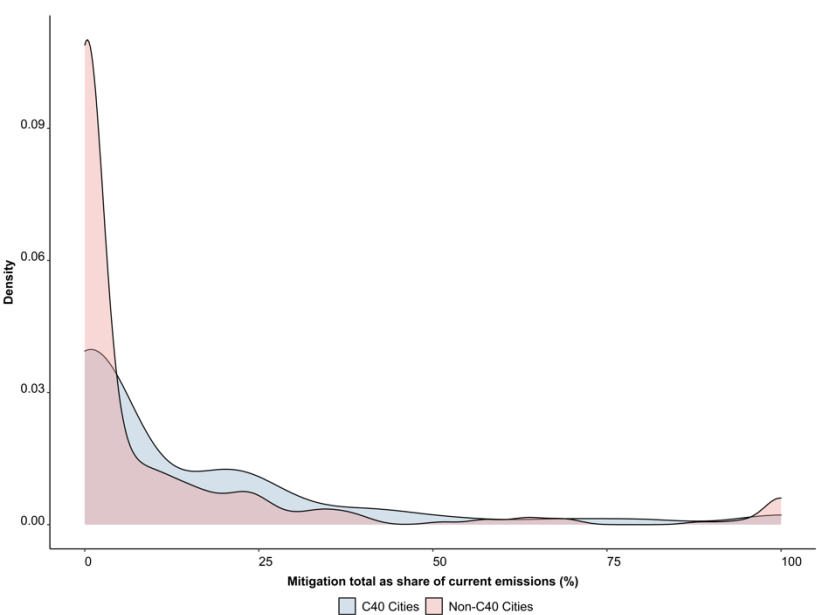
pink distribution of non-C40 cities signifies that a larger share of all non-C40 cities report fewer than five actions than is the case for C40 cities whose peak is more muted. The blue curve lies above the pink curve for nearly all values above seven actions, meaning that a greater percentage of C40 cities report at each of those values than non-C40 cities do. When examining the size of climate actions in terms of the emission reduction share, a similar pattern holds as seen in Figure IV.8. The pink curve's peak at small values means that a larger percentage of non-C40 cities report small reduction totals, and for the range from 5 percent to 90 percent on the x-axis, the blue curve's position above the pink curve means that C40 cities are on average pursuing larger mitigation totals. However, a larger share of non-C40 cities than C40 cities have listed climate actions that would achieve carbon neutrality, as seen by the relative height of the pink curve at a mitigation share value of 100. Still, cities with such ambitions are few in number as observed by their overall height relative to the height of curves at smaller mitigation share values. In short, among cities that have publicly reported to CDP, C40 cities are reporting both more climate actions and listing more actions that account for a larger share of current emissions than do non-C40 cities.

Figure IV.7. Distribution of cities' total number of reported climate actions, by C40 membership status



Data: CDP 2018, CDP 2019a
Note: Values for each city are calculated using their most recent, public CDP submission.

Figure IV.8. Distribution of cities' reported emission reduction shares, by C40 membership status



Data: CDP 2018, CDP 2019a
Note: Values for each city are calculated using their most recent, public CDP submission.

D. Potential limitations in using CDP data

The 2018–2019 CDP data supports cross-sectional comparisons of city-level mitigation actions, but results are likely to be a proxy rather than a comprehensive guide of city-level actions. Results could be impacted by systematic inconsistencies in climate action reporting across years, time scales, and definitions for what constitutes an action. The CDP questionnaire provides cities the opportunity to report on their “most impactful mitigation actions” (CDP 2019a), but cities are likely to exercise their own discretion as to what qualifies as “impactful.” Omission of actions, even those that are only at a scoping phase and not yet under implementation, will present an underestimate for the true level of climate action that cities are undertaking. Cities should disaggregate actions into separate records, but some have reported a comprehensive plan as a single action (e.g., Auckland’s reporting of public transportation action in 2019). Furthermore, when standardizing estimated emission reductions, we compare estimates with current emission values, which will overestimate the mitigation potential for Global South economies whose emissions will continue growing in coming years. Finally, our actions data is sourced from the “Mitigation Actions” section of the CDP questionnaire, which is a small component of a comprehensive survey. The level of detail required to complete the extensive survey (with 14 sections) implies that the data gathering process may be vulnerable to survey fatigue or inconsistent reporting across years. This claim is corroborated by several city officials who in interviews shared a perception that CDP reporting is burdensome and delivers ambiguous benefit to them. There is obvious value in cities annually submitting comprehensive and public reports of their climate data, even covering mitigation actions that are in preliminary stages of consideration. We believe that coordination across the various organizations and donors who use this data could drive the creation of additional tools and guidance that might further simplify data collection and reporting processes.



V. Key findings from analyzing C40's thematic networks

Whereas the preceding three chapters addressed various dimensions of climate action planning and the climate actions that cities are undertaking, we now turn to examining C40's thematic networks. In this chapter, we focus on characterizing the current status of the networks and how they self-organize, describing their relationship to other C40 service delivery components, and examining how they assess their contribution in facilitating city climate actions. The findings herein are derived from key informant interviews with city officials and C40 staff, and from various internal and public C40 documents on network activities. Although our selection of interviewees prioritized officials and C40 staff involved in networks of strategic interest to ClIFF, our interview questions also sought input on the totality of C40's networks.²⁴ Consequently, we believe that the findings described below apply more generally to the remaining networks.



A. Planning and design stage

The sectoral networks, which span domains from renewable energy, to managing urban flooding, to circular economy design, bring together cities with common interests in driving climate actions forward for that sector. In this section, we address research questions related to the development and revision of networks' objectives, the effect of ambitious target-setting on network activities, and the level of involvement that non-C40 cities have in network functioning.

1. Establishing network objectives and developing work plans

City participants define a network's strategy and objectives; network managers solicit input on cities' priorities and develop activities around them. Network managers use their annual workshops to reflect on cities' experiences and remaining challenges, and to fine-tune network activities and priorities to be more responsive to cities' needs. For newly formed networks, the kickoff workshop is the initial forum for cities to articulate their interests and the types of activities they want the network to organize. One manager uses action planning sheets during each workshop to gauge cities' interests in who they wish to be connected to and what topics they want the network to address, and to describe the cities' main ambitions for the following year. Another manager stated, "We use their experiences, what they're working on at the moment, their challenges, their barriers, what they would like to advance, using this information to feed into the network objectives and the strategy...constantly adapting and changing to

"I think each network should have its own work plan, as well, and that should be co-developed with the cities [that] are involved with that network and agreed, and then, everyone has got a bit of skin in the game ...to contribute to the network and achieve whatever they decide is the important thing for that year, two years, three years..."

—City official

²⁴ ClIFF's priority networks for the purpose of this evaluation are Air Quality, Clean Construction Forum, Clean Energy, Food Systems, and Zero Emission Vehicles.

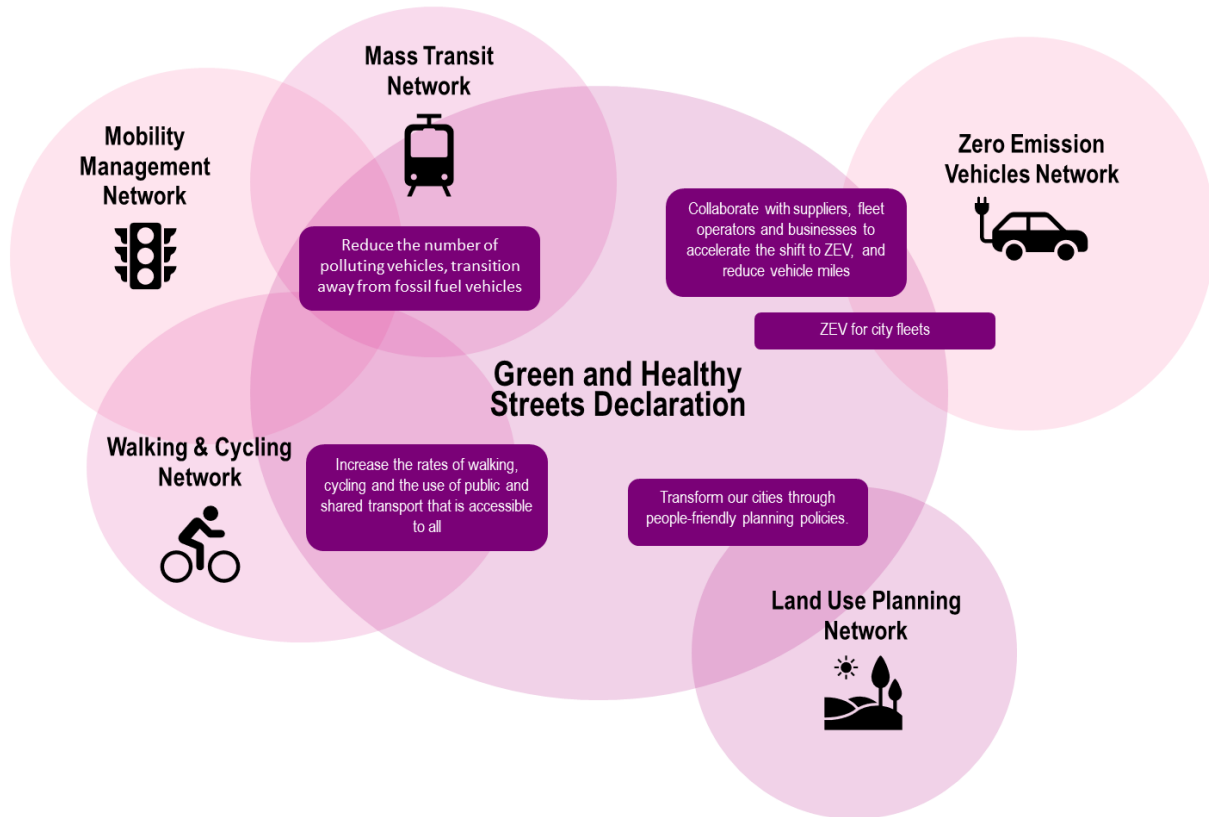
make sure that everything that I'm offering in terms of the opportunities and the activities are in direct response to their needs."

Cities that are signatories to the relevant declaration and/or are among the group of donors' priority cities are given more weight when network activities and objectives are developed. C40 has developed multiple "declarations," which are public commitments signed by mayors who pledge that their city will meet the declaration's targets. For example, the Advancing Towards Zero Waste Declaration features targets for reducing municipal solid waste generation and disposal by 2030. Networks are considered "an effective delivery mechanism" to encourage and support cities in working toward declaration targets, but being a signatory of the most relevant declaration is not a requirement for network membership. Similarly, a city can sign a declaration even if it is not currently a member of that declaration's most relevant network. However, C40 interviewees stated that having signed the relevant declaration increases the chances that a city's recommendations or requests for specific network activities will be fulfilled, as is also the case for cities that donors have specified as priorities in their support for direct assistance, such as TA programs. Network staff also prioritize the interests of cities that are more active and more likely to participate in activities, which meshes with C40's objective to allocate network resources where they will be most productive. One C40 interviewee shared, "We just don't want them to engage...just to wear the C40 badge and say, 'we participated in C40,'" and stated that she allocates more of her time to working with those member cities who have actively participated and translated network resources into policy change.

Network objectives draw directly from C40 declaration targets; this approach ensures that D2020-compliant actions guide networks' actions. Among the network managers we spoke to, declarations were always mentioned as the key input driving the work planning. Efforts are made expressly to align network priorities with declaration commitments, as illustrated in Figure V.1. As an example, the scope of the Green and Healthy Streets Declaration overlaps with at least five distinct Transportation and Urban Planning networks whose work plans coincide with portions of the declaration text, shown in the purple boxes. Declaration signers commit to accelerating the shift to ZEV, across the city and especially in city fleet purchases, which are objectives shared by the ZEV Network.²⁵ Declaration goals also touch upon reducing dependence on vehicles powered by fossil fuels, increasing the modal share of non-vehicular transport, and transforming land use planning to facilitate these preceding objectives. Other declarations are more tailored to a single network, like the Good Food Cities Declaration and the Food Systems Network. In general, because declaration target-setting is established by conforming to Paris Agreement goals, declarations themselves are sufficiently ambitious instruments. By extension, networks' goals are ambitious given their cues from declarations.

²⁵ The ZEV network has four focus areas: making the case for transitioning to EVs, planning for EV charging infrastructure, increasing incentives for EV uptake, and promoting fleet electrification (C40 2020d).

Figure V.1. Illustration of the Green and Healthy Streets Declaration's intersections with multiple thematic networks



Note: Authors' creation based on declaration and network documentation. The authors have paraphrased declaration content where necessary.

2. Dynamism of network organization and objectives

C40 networks prize responsiveness to new research advances, which can potentially lead to friction when emergent science-based evidence upends existing knowledge. In one instance, a group of C40 cities had dedicated six months to drafting text for a new declaration. Just before submitting a draft to C40 leadership for review, a well-respected researcher had published a paper casting doubt on the current understanding of the field. The researcher suggested that in this domain, more drastic action than previously assumed was necessary to achieve compliance with the Paris Agreement. Guided by the paper's recommendations, C40 leadership overwrote the draft's targets with more aggressive goals and timetables, effectively undermining the work carried out by the drafting cities. Although the cities recognized the importance of raising ambition levels, city officials were frustrated by the experience. Alternative ways of managing this situation may have been preferable, such as retaining the drafters' recommendations to gradually phase in more aggressive targets; this approach would still have contributed to science-based policymaking but without eroding social capital.

Networks are dynamic and may be shuttered or overhauled to reflect evolving expectations or funding priorities; member cities wish they were more involved in the decision making. C40 does not publicly maintain a list of networks that have closed down, however, interviewees did refer to activities

and participation in networks, such as Green Growth, that no longer exist.²⁶ Other networks have been modified to reflect higher ambition, such as the ZEV network superseding the Low Emission Vehicles network, which in turn supplanted the EV network in 2014 (Urquhart 2014). Given the duration of C40's existence, developments like these are to be expected and reflect strengthened expectations, new priorities or opportunities, and technology maturation, such as growth in EV penetration. Still, some city interviewees expressed dissatisfaction with networks, programs, or initiatives they had participated in being suddenly terminated without consultation or transparency. For example, a city official shared the following experience:

"...and then [C40] ended the [Climate Positive] program. And so, now there's absolutely no recognition for that project, which is really disappointing, and they didn't talk to us about it before it was done. So, what's missing there is the transparency around decision making on priorities. Why did they decide to end that and put the resources into something else? Which is what happened, it's not clear, and it's not been explained, no matter how many times we've asked."

3. Involvement of non-C40 cities

Non-C40 cities participate in network events on an ad hoc basis, and opportunities for their involvement vary widely across networks. Network activities are designed to benefit network members, but opportunities sometimes arise to invite other cities. As one example, invites to a planned US workshop addressing ZEVs may be extended to several California cities that lead in EV adoption and charger installations. Such opportunities appear to largely be one-off interactions, and the networks we spoke with did not detail plans to sustain partnership with non-member cities. As C40 prioritizes targeting resources to the subset of network members that are most likely to make significant mitigation efforts, the case for employing resources to support non-C40 cities will grow less compelling unless those efforts can stimulate regional momentum, like the ZEBRA project, with the potential to incorporate non-C40 cities.²⁷ Another avenue for engaging non-C40 cities occurs via collaborating organizations and sister networks, which operate on a case-by-case basis. For example, the Food Systems Network collaborates with the Milan Urban Food Policy Pact whose annual gatherings draw on all Pact signatories, only some of whom are C40 members. Such non-C40 avenues present additional opportunities through which C40 lesson-sharing and partnerships could more broadly be exercised.



B. Execution stage

Having established how the networks self-organize and update their objectives, we now examine networks' operations. This section addresses questions related to the current status of network membership, outcomes achieved from network participation, and challenges that cities cited as barriers to more engaged participation.

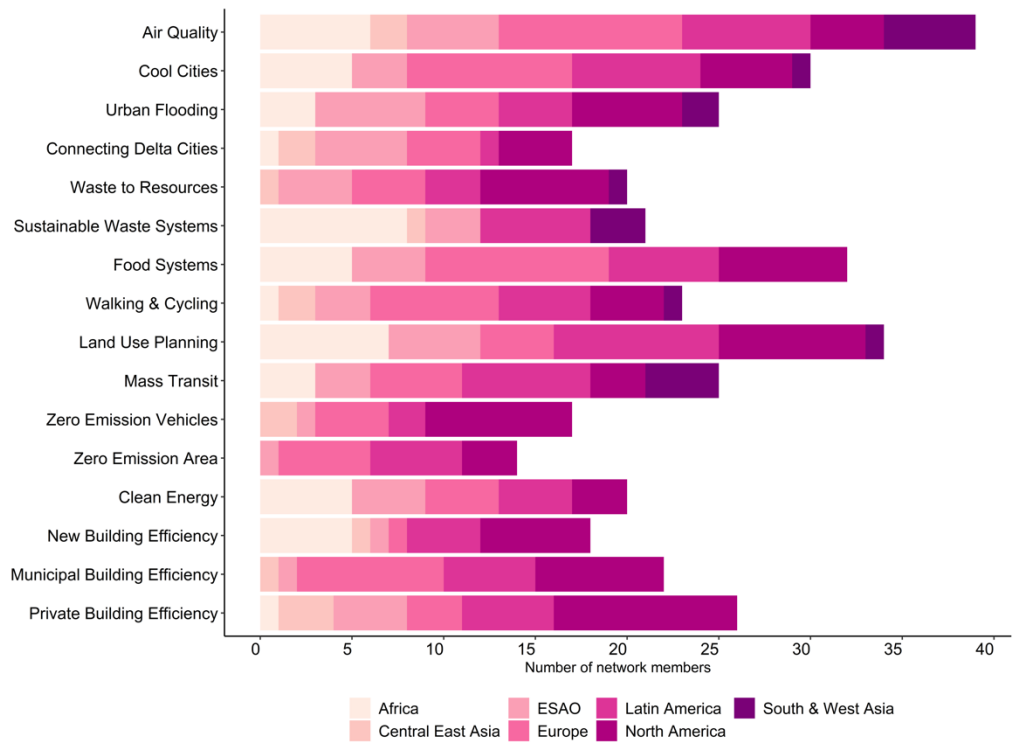
²⁶ Table 6 in Attström et. al. (2016) lists all the networks active at the time of their data collection, and references networks like District Energy, Measurement and Reporting, and Sustainable Infrastructure Finance that have either been wound down or folded into other networks. Differences between the 2016 list and the current list of networks would be a lower bound for all network changes occurring over the span of C40's operations.

²⁷ ZEBRA is an association of transit agencies that collaborate to share knowledge about zero emission buses.

1. Current status of network membership and composition

C40 currently operates 17 sector-focused networks, each with a membership of actively participating cities varying between 14 and 39 and a mean membership size of 24 cities. Some of the networks have been in operation for more than a decade, while others like Air Quality (2018) and the Clean Construction Forum (2019) are recent additions. Networks are organized under umbrella initiatives such as "Energy and Buildings" and "Transportation and Urban Planning" that pair related networks and may share common staff and reporting procedures. As seen in Figure V.2, the Air Quality network is the most populated network and draws member cities from each C40 region, consistent with the far-reaching impacts of air pollution at all levels of economic development. Not all networks have members from each C40 region. Regions that are most likely to have no representatives in a network include Africa (e.g., Waste to Resources), Central East Asia (e.g., Cool Cities), and South and West Asia (e.g., Zero Emission Vehicles, Zero Emission Area, etc.). Cities in these regions tend to participate in fewer networks, as discussed below, and some of the sectoral objectives, such as expanding ZEVs, may not align with policy priorities.

Figure V.2. Network membership size by region



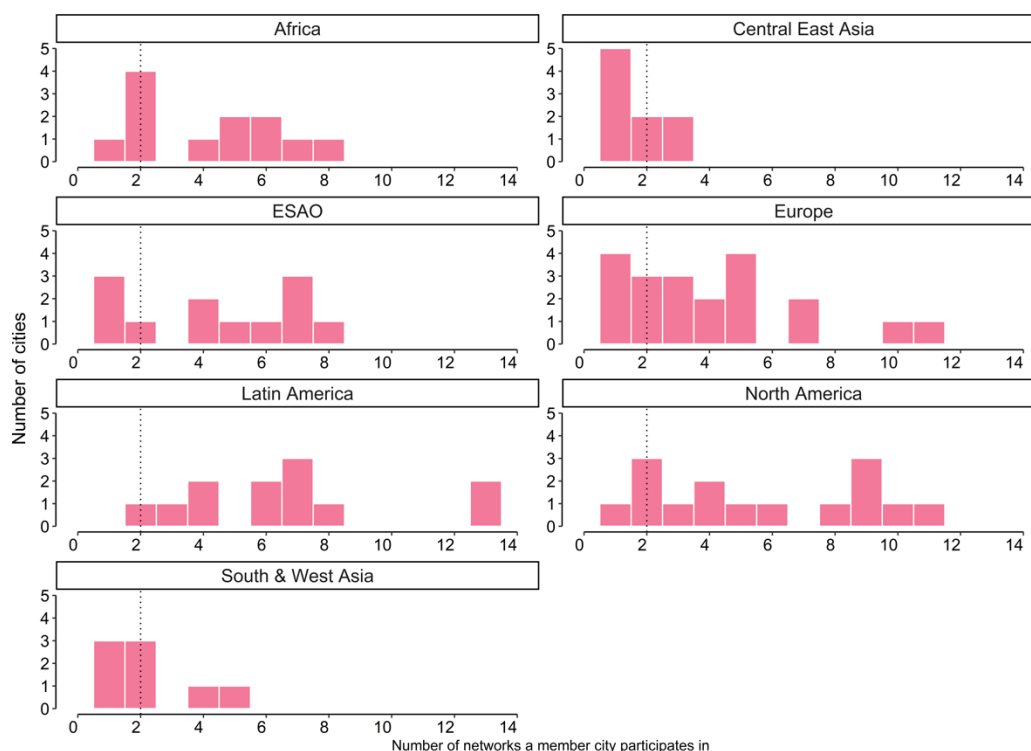
Source: Authors' calculations using Q1 2020 network status information shared by C40.

Note: No data was available for membership in the Clean Construction Forum. The Mobility Management network has been renamed as the Zero Emission Area network.

ESAO = East, Southeast Asia, and Oceania

City engagement is mixed, with some members actively participating in all activities, while other cities make more casual use of network offerings. At a high level, differences in network participation are pronounced at the regional level.²⁸ Figure V.3 displays frequency counts for the number of cities (y-axis), by the number of networks in which they actively participate. The dashed line denotes the level at which cities would just be in compliance with the Participation Standard of involvement in two networks. In most regions, there is at least one city participating in only a single network. Low participation levels, in terms of number of cities, are most common in Central East Asia and Europe. On the other extreme, a handful of cities participate in close to a dozen networks apiece, and are exclusively in Latin America, Europe, and North America. C40 cities participate in an average of four networks each, and the median value is three networks.

Figure V.3. Frequency counts of the number of networks cities participate in, by C40 region



Source: Authors' calculations using Q1 2020 network status information shared by C40.

Note: Dashed line denotes that cities should participate in at least two networks to comply with the Participation Standards. No data was available for membership in the Clean Construction Forum.

ESAO = East, Southeast Asia, and Oceania

Network size is a challenge, with several networks' member lists in excess of an optimal count.

Network membership is driven by cities' interests, and C40 currently exercises no public target for how many cities should belong to any network. One C40 staff member referred to a "sweet spot" size—greater than a handful, as too few members would limit information-sharing options, but less than 20, because a large group would prevent members from building familiarity with one another. Larger

²⁸ The evaluation team did not have access to documents with granular breakdowns for how each city utilizes a network's activities. C40's monitoring documents state that a city's network membership status "is according to the best judgment of the network manager and may include strategic considerations."

networks tend to give rise to a feeling of anonymity. They are also less conducive to fostering the type of trust that arises in more intimate settings with repeated interactions, where participants feel comfortable sharing challenges and failures. As described in Section V.C, the introduction of network standards will self-regulate this concern when networks expand beyond their ideal ceiling. If too many cities continue to pile into such networks, network standards can be further raised until an optimal group size is reached.

2. Network services and successes

Networks continue to provide many of the same services they did in previous years. Networks run annual workshops, host webinars, organize study tours and trainings, and set up deep dive phone calls specific to their thematic content. Central to all these activities are the “network managers,” who are C40 staff whose primary responsibility is coordinating the aforementioned network functions, identifying opportunities for connecting cities who could engage in peer learning, and maintaining



“Any time I go for a C40 program, it’s like I’m leaving my family in [my city] to go and meet another family where the event is taking place. So they have been very wonderful. They have been very good.”

—City official

regular contact with member cities. Interviews revealed that city officials consider the network managers to be accessible and responsive, and maintain communication with managers through email, phone calls, and WhatsApp. Even though the contact information of all network participants is made available to network members, managers still play an indispensable role as knowledge broker and connector. Consider the example of City X, which is interested in learning how to institute some new action. City X is aware of the relevant successes in cities Y and Z but still leans on the manager to provide inside

information only available to the “hub” of the network. As one manager shared, “They know London has done that, but they still come to me and say, ‘Who else has done it? Is London the best one? Who is the best city that has done it?’ They want a kind of a real-time update on that specific topic and then to be connected to the best city out there.” Managers would then initiate the conversation between the two cities. To stay apprised of such dialogues and any ensuing policy developments, managers review the intercity email threads, or reach out to the initiating city to get an update on whether the conversation produced any tangible outcomes.

Membership with other city climate networks is common, but C40’s services are distinctive and have limited overlap with other efforts. Member cities often participate in anywhere from one to three

additional climate- or city-focused networks. The Global Covenant of Mayors (GCOM), Carbon Neutral Cities Alliance (CNCA), Urban Sustainability Directors Network (USDN), United Cities and Local Governments (UCLG), ICLEI, and regional networks like Climate Mayors and EUROCITIES were the most frequently referenced. Furthermore, the membership composition of these networks is often dramatically different, as with GCOM and ICLEI in which a plethora of cities with populations under 100,000 participate. Were C40’s network activities to end, cities would presumably seek additional support from these other networks and coalitions that tend to have fewer full-time staff and personalized attention, or can facilitate connections to direct assistance like the D2020 TA program. City officials would incur larger search costs in sourcing relevant information and would not be able to connect as easily with their direct counterparts in cities that have pursued or are pursuing similar activities, and are consequently working through similar challenges. As a result, it is likely that without C40, cities would be slower in making climate action progress and/or committing to less ambitious targets. Other networks either focus on capacity-building at the technical staff level or convening

mayors, while C40 does both. C40's work makes a strong case that progress requires inroads at the political and the technical level, and as such assumes a role that is not occupied by other organizations with global membership.

C40 maintains a running list of "results" arising from peer-to-peer exchanges through the network activities; examples range from transformative to minor. C40 shared with us a "City to City Sharing through C40 Networks" document that showcases network-specific successes that can be directly linked to their activities (C40 2020b). Buenos Aires' 2018 zoning code reform is one example likely to have big implications for curbing emissions growth through promoting densification and infill. The city's Director of Planning participated in multiple C40-organized activities in 2017 and 2018, and the city pursued in-depth exchanges with Mexico City, São Paulo, and Barcelona to refine technical aspects of the reform. Other successes are less dramatic, such as Athens' installation of three public water fountains that the city adapted from London's bottle-refill scheme. A common message shared by both city officials and C40 interviewees related to the "safe space" nature of the networks. By cultivating a closed environment of repeated interactions, network members develop trust with one another that fosters candor about mistakes their cities have made and errors to avoid duplicating. Consequently, networks' "results" are a combination of both transfers of best practice knowledge, which are visible, and the unseen avoidance of repeating mistakes made by other members.



"The most important thing you can hear from another city is what went horribly wrong. This isn't a space where they're worried ... what they're going to say has been taken out of context, or there's some private sector supplier trying to sell to them. These are their peers who know the challenges they face. They can talk openly about the political process and the challenges they have."

—C40 interviewee

3. Challenges in achieving deeper participation

Language and time zone differences remain obstacles to full participation. English is the dominant language for network activities that will unavoidably limit participation for some. Network managers described ways they minimize language differences from being a barrier for participating in workshops, such as by providing translated materials beforehand and ensuring that real-time translation is available. For webinars and deep-dive calls, the respective city advisor may also attend the call and convey the key points. Time zone differences are also a factor affecting participation levels, with many virtual events (e.g., webinars, calls) timed to accommodate North American and European schedules. C40 has run echo calls/presentations at dramatically different times to make some of their programming compatible to cities in other regions, but they do not require that presenters/moderators be willing to present twice. Although these presentations are recorded and available for any official to watch afterward, interviewees prefer a live format that enables them to actively engage with the presenter during the Q&A.

4. Delegation of network management responsibilities

There are no obvious opportunities for delegating additional network responsibilities to member cities without compromising network effectiveness. As many networks are led by a single manager, any potential devolution of network management would require cities take on some of the network manager's roles. For the key roles that managers play, both establishing and nurturing connections between cities, and identifying how cities' needs can be best served through other C40 service components, we see no immediately viable role for introducing a city official into these responsibilities;

city employees whose priority is their own city simply could not fulfill such a role. Furthermore, C40 interviewees with prior work experience in city government stated that they would not have been granted the authority or time to carry out tasks coordinated by network managers. For most officials, C40 engagement is additional to their existing full-time responsibilities, which leaves little to no bandwidth for undertaking greater responsibilities within networks, such as coordinating events that would not be primarily for their own city's benefit. From a financial perspective, network operating costs are presumably small, especially because network managers routinely split their time across other projects and partnerships across which salaries should also be distributed. We therefore see neither a strong strategic nor financial case to support expanding city officials' roles in managing networks.



C. Progress monitoring stage

C40 has invested resources and developed tools to track how network services have contributed to propelling cities' climate actions. This section addresses the type of tools that C40 uses and how they attribute policy changes to C40's services. We start with a brief description of the network-level participation standards that C40 is currently rolling out.

1. Introduction of network standards

C40's Participation Standards are in the early phase of being adapted and incorporated into each network; members must demonstrate progress. The Participation Standards apply to C40 membership in general, and until recently, there had been no equivalent governing the requirements for being a member of an individual network. C40 is in the early stages of rolling out network-specific standards that would specify minimum requirements cities must satisfy to maintain their membership in that network. One technical staff person stated, "These standards you have now might have worked

"We need to demonstrate how you've used what you've gotten from C40 and show us what's happened as a result of that. It's not saying if you haven't implemented your congestion charge by 2030, we're kicking you out of C40. It's if you're not able to take forward climate action and demonstrate how you're doing that by learning from us, taking our resources, then it doesn't make sense for you to be in C40."

—C40 interviewee

well five years ago, not now [when] we're in the most critical phase to face climate change. Now cities need to act." The Air Quality network is pioneering the standards-setting process, and it is too early to assess what the likely long-term effects of this shift will be aside from focusing C40 resources to those cities whose objectives are most closely aligned with the network's objectives. The principles behind the network standards will reinforce that network offerings must ultimately translate into tangible outcomes and progress toward enacting effective policies and practices. These have been incorporated into C40's draft Leadership Standards. Staff who we interviewed who were most likely to be affected by these

changes, by virtue of their roles as network managers or technical leads, appear to welcome this development. One manager shared, "We're raising expectations, raising ambition, better managing, better supporting our cities, and better allocating resources in the future, because at the moment, the current C40-wide Participation Standards do not fully align with the specific network standards."

2. C40's tracking tools and service delivery coordination

Network managers are actively engaged in monitoring city-to-city communication and, through informal conversations with cities, are able to maintain an accurate sense of cities' circumstances. As network managers are often copied on bilateral contact, they have an accurate sense of which cities are communicating on specific topics. Peer-to-peer contact through WhatsApp and by phone makes tracking for managers more difficult, but it is encouraged by C40 staff if those are the preferred ways that cities wish to stay in contact with one another. Managers actively facilitate the forging of new connections. "We try to ask, because in each workshop ... we do we have these action planning sheets where we say: What do you want to talk [about]? Who would you like to talk to? What is your main ambition for one year? And when we do the next workshop, we take that back and we reflect on it, and that's when we can potentially learn about this organic discussion that have (sic) happened and a way to then track them." City officials stated that network managers are responsive to their requests for information and connection and reported only a single incident of a former network manager who was negligent in supporting the network's cities.



"I called the cities that I knew [were] working on something, and I knew they had interactions, and I say, 'Look, David, can you confirm that this action is actually happening because you talked to city X?' If I get a yes, for me this proves that the networks are successful. If I get a no, well, we could have done better. So qualitatively, I think the network should capture which of the actions that are being done in the cities are actually influenced by C40 networks, and I think this can be done through the professional relationship, not with impersonal forms, just filling in surveys."

—C40 interviewee

Networks employ several tracking tools that capture progress at varying levels of frequency, granularity, and formality. Some of the approaches are routinized and thoroughly documented through tools such as the Key Performance Indicator (KPI) Progression Table and the SectorSheets. Consider an example case of the KPI Progression Table tracking progress for the Energy & Buildings Initiative (E&B), which encompasses networks like Clean Energy and Private Building Efficiency. The table is used to track the status of actions pursued by cities participating in E&B networks and is updated semiannually by their respective network and program (e.g., the C40 Cities South Africa Buildings Programme) staff.²⁹ Examples of actions, which may be projects, policies, or programs, include "introduce a system for recording municipal building energy consumption data" and "develop power purchase agreements to site rooftop solar on 1 million square feet of municipally-owned buildings." Actions are marked with their status at baseline when the action first entered C40's purview, along with the status ("progression") as of the most recent update. Figure V.4 displays the four levels of progression used in this monitoring technique. Comparison of the two "progression" values indicates the extent to which the city has advanced in that action since the baseline. C40 captures notable updates in case studies that elaborate how TA or precursor cities' experiences laid the foundation. For example, Washington, DC, received TA to analyze building performance data that later culminated in the 2018 passage of the Building Energy Performance Standards. These standards will gradually roll out energy reduction requirements throughout the city's building stock (C40 and Nordic

²⁹ In the example KPI Progression Table that C40 shared with the evaluation team, 30 participant cities were tracked on 1 to 3 actions, and averaged 1.5 actions each.

Sustainability 2018). Other cities are actively studying Washington's and New York City's respective policies to inform their own building energy policy design.

Figure V.4. Progression values used in C40's action progress tracking framework

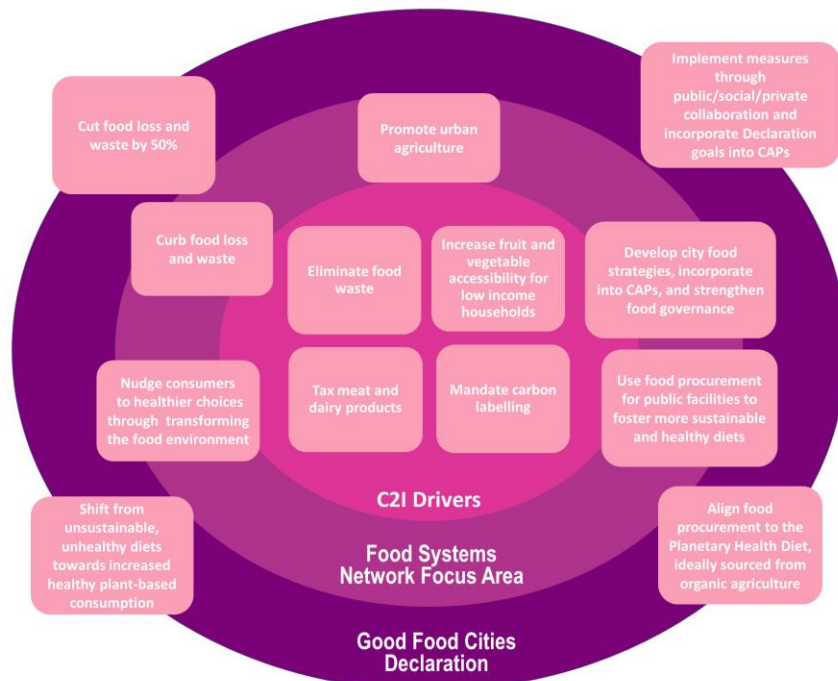


Note: Adapted from C40 (2019b).

The SectorSheet is a more comprehensive tracking tool and facilitates internal coordination. Like the KPI Progression Table, the SectorSheet catalogs the status of key actions by actively participating cities in a sector (e.g., buildings). However, it also diagnoses the known barriers to implementation, how the networks can alleviate those barriers, and which other C40 resources or services might be relevant. More comprehensive information is collected on the cities involved in Cascade to Impact (C2I) reporting, a tool that CIFF and C40 co-developed to track C40 programming and city progress, with detailed quarterly updates on progress, challenges, and mitigating actions. Similarly, cities that have signed declarations have their progress in achieving declaration commitments recorded, albeit with less frequency than C2I-targeted cities. The SectorSheet flags opportunities for integrating service delivery across the range of C40 components.

Progress tracking is complicated by the lack of perfect alignment between network focus areas, C2I indicators, and declaration commitments. As a result, C40 must maintain distinct progress tracking procedures against multiple references whose indicators may not yet be fully specified. Not surprisingly given their priorities, network focus areas, C2I indicators, and declaration commitments prioritize somewhat different indicators, focus on different timeframes, and capture different content. Network focus areas may address process outcomes, such as submitting legislation to a committee for review, while C2I and declaration commitments consist of ultimate outcomes, such as the average share of daily calories from meat and dairy products. Declarations address goals to achieve by 2030, 2040, or 2050, whereas network outcomes and C2I indicators focus on immediately measurable results. The three components also vary in the content they capture. Declaration commitments exist at a strategic level with signatories having substantial latitude in how they achieve commitment goals, while the C2I drivers are indicators. Network focus areas describe workstreams that if fulfilled would achieve declaration commitments, and whose effectiveness would be validated by monitoring relevant C2I indicators. Consider the case of the Food Systems Network, whose focus areas are placed in the middle ring of Figure V.5, and whose corresponding Good Food Cities Declaration and C2I drivers respectively appear in the outer and inner rings. Some objectives have obvious alignment across the three vehicles, such as the reduction of food waste. Declaration objectives could potentially encompass a wide range of tactics that are adjacent to the specific methods envisioned by the C2I drivers. For example, consumers may shift to healthier, more sustainable dietary choices because of advertising campaigns and the increased availability of high-quality, plant-based foods. In short, taxing meat and dairy products is only one of many actions that can deliver outcomes envisioned by both the declaration and the network's focus areas.

Figure V.5. Connections between Cascade to Impact, network focus, and declaration commitments in food systems policy



Note: Authors' creation based on Cascade to Impact, declaration, and network documentation. The authors have paraphrased document text where necessary.

Current tracking methods used in monitoring network progress are a significant improvement from earlier approaches like the Network Quarterly Reports (NQRs) that primarily tabulated outputs.

NQRs compiled data on cities' interactions with the networks, measured as their participation in workshops, webinars, city-to-city interactions, and any other touch points. C40 calculated year-on-year differences and devised explanations for any resulting trends. Although this approach would identify the disengaged cities with whom follow-up discussions could be held to address outstanding barriers to participation, the interaction metrics provide few insights into the value-add that network involvement gives cities, or the contribution made by networks when barriers to cities' actions were lifted. C40 credits CIFF with having advanced their thinking toward more robust measurement systems that are better suited to capture network effectiveness. Through these systems, C40 maintains current information on cities' progress that can facilitate coordinating both cross-city connections and intra-C40 service delivery.

We did not find evidence of major information bottlenecks that prevent network managers from communicating cities' needs and challenges to other C40 service delivery components. When cities verbalize constraints with data management or with developing project finance documents, linkages can be made to the appropriate parties, such as Empowering Cities with Data or the Cities Finance Facility. Interviewed cities did not indicate that networks were unsuccessful or reluctant in connecting them to the appropriate resources.

3. Requesting data and information from cities

As with CAP-related data requests made of cities, networks also create information-sharing demands that could benefit from more coordination and streamlining. C40 staff recognize that data collection requests impose a burden on city officials but note that such data is often necessary for C40 to understand city progress and remaining impediments, and to communicate its impact to funders. CDP data reporting was the most commonly cited concern by city officials, who expend significant energy in answering a questionnaire that expands with each reporting year. C40 staff mentioned that questions may be added because analysis of the previous year's responses revealed that cities were not understanding question text and were submitting unhelpful or inaccurate responses. Several interviewees proposed that C40 staff (i.e., city advisors) complete the CDP submission on a city's behalf. Some city officials reported feeling inundated with multiple data requests whose demands on city staff could be reduced, and felt that information their city had submitted to platforms like CDP had not been fully used. One city official shared the following example:

"Our relationship manager from C40, he sent me an email seeking a whole lot of data, data points, of which the majority of them were available in the CDP. I was like, 'You need to go check that first.' So, back to that point earlier about how you do all this work, and who looks at it. Even our own people in C40 themselves are not using it. So, that was quite disappointing."

As the networks are already collecting some information that could be included in a CDP submission, particularly the sectoral actions whose status is captured in the KPI Progression Tables, there may be unexploited opportunities for streamlining data collection and data dissemination processes. To the extent possible, anticipated data collection requests from all C40 services could be consolidated on quarterly or less frequently to reduce duplications and provide city officials with ample advance notice of requests.



D. Knowledge transfer stage

In Chapter II, we described the Knowledge Hub and its role as an information clearinghouse. We elaborate on those findings here, but with a focus on the avenues and limitations of knowledge transfer that arise in the networks.

1. C40's expectations of member cities

Although C40 membership is monetarily free, the organization expects that cities will "give back" by sharing their learnings in the network. One C40 interviewee described the obligations for network participation: "There are two expectations. One, you're actively contributing and engaging; and two, you're demonstrating to us what you're delivering as a result of this." This exchange of learning and sharing enables knowledge to flow from C40 technical staff, to selected cities, to the broader C40 community, and larger regional networks in which some member cities are embedded.

2. Capabilities and limitations of the Knowledge Hub

Although knowledge transfer is in the networks' DNA, the most outwardly visible forms are the written knowledge products added to the Knowledge Hub. Network managers are expected to regularly generate content to include in the Knowledge Hub. Given their proximity to cities who are pioneering new policies or engaging in climate actions with broad appeal, they are well-positioned to identify cities and topic areas around which case study materials should be developed. To reduce the

burden of content development on city officials, C40 often takes the lead and has internal teams to produce and disseminate professional materials. As mentioned in Chapter II.D, the migration of content from the C40 Exchange to the Knowledge Hub means that thematic knowledge products that flow from network activities will be accessible to any interested party, not just officials from C40 member cities.³⁰

Effective use of the Knowledge Hub will be always be a starting point, not an ending point, of knowledge transfer. Similar to our observations with respect to climate action planning, published materials present only a thin layer of all the resources, background requirements, backstories, preparation, and negotiations that result in some documented outcome of interest. Consider the example of a city that has rolled out a bike-share scheme whose preliminary results point to strong ridership. A policy brief or case study is unlikely to document the missteps a city made in bike dock siting, charging equipment selection, or in assuaging community concerns about appropriated parking spots or sidewalk space. Avoiding those missteps would often require speaking to the parties who experienced them. Aside from learning from missteps, cities wishing to pursue their own bike-share scheme often want to establish a relationship that can help them throughout the process. As one C40 interviewee shared, cities often want something more interactive than the Knowledge Hub and that "require[s] deeper conversation, maybe linking them with the city or national officials who did the design, who did the thinking, what were things that were tried and tested that didn't work, which you don't usually find in the Knowledge Hub." The Knowledge Hub features "Forums" in which registered users can ask and respond to questions, but content does not yet appear to be meaningfully organized; all posts are simply listed under "All Discussions." Posts that are currently on the site have had limited exposure. The majority of posts have been viewed fewer than 100 times, and many posts requesting feedback or guidance remain unanswered even months after their posting date.

The Knowledge Hub architecture supports conducting basic web analytics on pageviews, an article's upvotes count, and the number of replies to questions posted on the forums. For users who have created a log-in account and are signed in when accessing Knowledge Hub materials, these types of analyses help C40 carry out web usage analytics for each city and across user accounts affiliated with a city. Website users who do not log in can still access the majority of Knowledge Hub resources but limit C40's ability to analyze who is using the materials (whether member cities, non-C40 cities, or other entities), and in what ways they are engaging with the website's content. At the end of an article, a feedback box asks users three questions regarding employer type, their opinion of the article, and their ability to take action on the article. It is not yet clear how results from these feedback requests will influence Knowledge Hub design or functionality.

3. Knowledge transfer and networks' closed structure

The primacy of C40 members in network activities may overlook opportunities to effectively collaborate with and learn from cutting-edge, non-member cities. Network programming primarily caters to the needs and experiences of member cities who benefit from peer engagement. However, the existing architecture precludes non-C40 cities from leading webinars or being more active as the source of potential lessons learned. One city official shared that non-member cities, even those who might be world-class in advancing a specific climate policy or practice, may be daunted by C40's

³⁰ Content available in the Knowledge Hub is not exclusively created by C40 and its member cities. Among other content creators, original material is sourced from Arup, AXA, Global Covenant of Mayors, the New Climate Institute, and the Sunrise Project.

participation standards or resource demands. She recommended that C40 “try to find a way to involve those cities who have best practices to share with C40 cities.”

Given the networks’ mission, with a major emphasis on nurturing safe spaces for city officials to be candid, many aspects of knowledge transfer will not be documented or accessible to outside parties.

Because network activities also surface negative lessons learned, like mistakes to avoid in a procurement process, network members accumulate knowledge that may be unflattering if it were public. The network calls, workshops, and other meetings are the key forums in which such experiences will be shared, and often only because another member is considering undertaking a similar action. Consequently, the set of knowledge products that are publicly distributed by C40 network activities will understate the total “knowledge” accumulated by members through network participation.



VI. Recommendations

C40 occupies a unique position of providing direct climate policy support to many of the world’s most populated and dynamic cities. City officials state they gain a lot of value from C40 programs and are proud to work for cities that are actively involved in C40. Although overall, we consider the C40 programs to be highly effective in supporting cities to engage in a level of ambitious action they would either be unlikely to engage in or slower in performing in the absence of C40’s support, our evaluation identified areas for potential improvement. We summarize our key recommendations for improving both the climate action planning and thematic network-related activities in Table VI.1, categorized by the most pertinent maturity stage at which they apply, and elaborate on these recommendations below. Recommendations are drawn both from outstanding needs and delivery gaps that interviewees shared, as well as improvement suggestions and shifts in priority for existing services. Our recommendations for the thematic networks are tempered by the expectation that the current mode of service delivery will change greatly in coming years, as network standards enter effect and network activities shift toward a more explicit “supporting role” in enabling cities to make faster progress with their climate action plans.

Table VI.1. Overview of key recommendations by activity and maturity stage

Maturity stage	Climate action planning	Thematic networks
Planning and design	Support cost estimate planning earlier in CAP formulation	Continue exploring regional network models to leverage economies of scale and common policy approaches
Execution	- Build out implementation-stage resources, tools, and supports like C40 Cities Finance Facility, to prepare for the inevitable demand growth - Support cities in identifying best practices for addressing consumption-based emissions	
Progress monitoring	- Seize opportunities to rigorously monitor pilot programs to identify the most cost- and carbon-effective approaches before scaling citywide - Develop standardized guidance on KPI identification, data collection, and prioritization	- Continue to prioritize measuring C40’s contribution to alleviating barriers to action instead of outputs, and rely more on qualitative data collection - Tighten coordination across C40 service delivery components with respect to information and data requests
Knowledge transfer	Formalize more opportunities for intra-regional collaboration and lesson-sharing	- Retool C40’s website to more effectively drive Knowledge Hub traffic - Provide more tools and links to existing resources on Knowledge Hub

We do not imply that C40 should be solely responsible for considering and undertaking all of these recommendations. C40 has a specific comparative advantage that may not align with some needs that interviewees have articulated. For some of these recommendations, cities themselves will need to lead, while for others, third-party organizations might be a better option. Consultations among C40, its

member cities, and C40's funders would be a fruitful way to discuss possible channels for the expansion of existing services and the development of new supports, and to identify sustainable organizational approaches to ensure service continuity.

A. Climate action planning and CAPs

1. Planning and design stage

Cities should engage with climate action cost estimates at an earlier stage in CAP development. For cities receiving TA, potential climate actions are largely prioritized according to the sectors contributing the largest share of total emissions. Greater emissions are assumed to lead to greater emissions-reduction opportunities. Because compliance with the Paris Agreement means that eventually all sectors need to reach zero or near-zero emissions, an alternative approach would be to prioritize the lowest cost mitigation options. A ton of CO₂e abated from the transportation sector has the same atmospheric effect as a ton from the waste sector, and even if the transportation sector has a larger emissions footprint, its mitigation opportunities may not be economically more favorable. Current and projected abatement costs should be a driving input in action selection, prioritizing the least-cost marginal abatement opportunities. More affordable actions should be undertaken now, especially for developing countries that will likely be richer a decade from now, with better resources to undertake more expensive actions in the future. Just as unit costs for wind and solar electricity generation have plummeted over the past decade, action prioritization should be informed by expected future costs. We appreciate that accurate cost estimates require many assumptions that will suffer from large uncertainties but believe there are advantages to obtaining even an imperfect price tag early on. The sooner cities have an estimated price tag for fulfilling their climate objectives, the sooner they can identify their financing needs and develop solutions. Delaying conversations about total costs another one to two years will likely create additional stress on an already compressed timeline of achieving large emission cuts by 2030. Cities that are first to implement CAP actions will be in the thickest fog with respect to accurate data on the costs and effectiveness of mitigation actions. As more cities progress, so, too, will the amount of information available about realized costs and action efficacy. Ideally, cities would contribute data on realized action cost and actual tons abated to a global database, akin to [Project Drawdown](#), which would provide policymakers more insight on the comparative performance of mitigation actions they are considering.

2. Execution stage

C40 has been building the plane while flying it; as it continues to help the remaining member cities produce their plans, C40 should also finalize the tools and resources that cities will need to execute their plans. Interviewees have described C40's current TA approach as building the tools and supports to develop action plans while the action plans are being developed instead of beforehand. As cities shift from CAP design to CAP implementation, they will presumably require new sets of tools and supports. For example, as discussed below, cities require additional guidance on how to monitor and report their CAP progress, but such guidance is not yet available. Ideally, the majority of implementation-related tools would be available to cities on day zero of their completion of a CAP, to minimize delays in transitioning from plan design to implementation. Similarly, the CFF will be a key financing support vehicle, but it is not clear that in its current state it can satisfy the immense demand growth that will be expected once CAPs are written and immediate actions can be identified. Additional resources should be expended when feasible to ensure that cities are not waiting for those tools to be developed. We recognize that cities' eventual needs cannot be predicted with certainty. Cities that have

transitioned from CAP design to implementation will be invaluable partners in supporting the development of such tools and identifying resources that could ultimately be useful to all member cities.

Cities are requesting support for how to best address consumption-based emissions. Several interviewees and reviewed CAPs report that tackling consumption-based emissions (CBE) is on policymakers' radar, but note the lack of a road map to give them a clear direction on what works. For example, should cities be forming coalitions with business and civil society to pressure upstream GHG reductions in supply chains, or should they be focused on information campaigns and promoting behavioral change? This issue is especially relevant among Global North cities that can make earnest reductions in their territorial emissions, only to reveal that their CBE may be several factors larger than their territorial emissions (C40 2018ad). The issue will grow in importance as global consumption of tradable goods increases, and as the consumption profile of Global South cities converges to that in Global North cities. Given C40's co-authoring of research in this space (e.g., C40 2018d, University of Leeds et al. 2019) and its centering of lifecycle accounting methodologies in some of the thematic networks (e.g., Clean Construction Forum, Waste to Resources, and Food Systems), C40 has signaled leadership on CBE management. Cities may be wondering whether C40 will develop additional programming and resources on this topic, which would be welcomed. If C40 ultimately decides against building out a comprehensive CBE program, then cities should be advised accordingly. It may turn out that other organizations are better situated to tackle CBE, and could be key partners for C40 cities to work with.

3. Progress monitoring stage

Pilot projects carried out during early initial implementation phases will offer opportunities to experiment with competing approaches; these opportunities should be exploited. Many of the actions under consideration in a CAP will be implemented only after pilots have been deemed successful, whether the action encompasses energy efficiency investments, rooftop solar installations, or bike lane construction. Where possible, cities should conduct experiments to assess the cost and mitigation performance of competing alternatives. For example, policymakers have multiple tools to encourage rooftop solar adoption, and each will involve negotiating some trade-offs. Is covering the cost of a free, on-site consultation by an installer substantially more effective than simply running an information campaign with contact information for qualified installers? Although the political and geographic limits of an individual city are incompatible with some experimental approaches, oversubscription models, gradual phase-in, and encouragement designs are viable approaches that should be considered (see Duflo et al. 2007). Experiments would help build an evidence base on the cost-effectiveness and the actual, not modeled, mitigation impact of competing approaches. Such an evidence base would help steer decision makers toward the most effective approaches when actions are inevitably scaled-up. The results of such experiments could be shared widely through the network and knowledge dissemination infrastructure that C40 has established.

Cities would likely benefit from more detailed guidance on selecting KPIs and developing monitoring protocols to track CAP progress. Just as the GPC standardized the processes and requirements for completing a GHG inventory, cities will likely need more guidance on which data streams and collection practices should be adopted to ensure that CAP progress monitoring is accurate and sufficiently informed. Some KPIs are obvious, such as annual community-scale emissions and building energy use per square meter. Many of the necessary KPIs will be process-oriented, such as the

legislative status of energy efficiency or zero emission fleet measures as they pass through various committee and review processes. We foresee opportunities for cities with established track records in specific sectors to support the process of standardizing a set of KPIs, so that less-established cities can immediately adopt best practices, avoiding investment in data that ultimately yields little insight. Funders could support this process by collectively agreeing to the metrics used for progress monitoring over a set period, potentially covering a five-year cycle. We think this approach would improve on the current state in which each year ushers new indicators into data reporting requests, often without sufficient guidance for how cities should collect or process the relevant data. As our review of CDP submissions demonstrates, the data that cities report is often not comprehensive or high quality, and further effort should be made to ensure that whatever KPIs cities ultimately monitor should provide accurate and timely insight into their progress.

4. Knowledge transfer stage

Additional opportunities should be pursued at the region level for lesson-sharing and cross-city collaboration on CAP actions. There are likely to be many untapped opportunities for cities with shared financial, climatic, and political realities to trade best practices and collaborate in advancing climate actions through joint procurement and alliances like ZEBRA. As one C40 interviewee noted, there is no network dedicated to CAPs, leaving knowledge transfer to potentially be siloed at a sector or technology level. Many aspects of CAP execution transcend those silos, such as the optimal design of interagency governing bodies, generic contracting and procurement best practices, and recommendations on action prioritization and sequencing. New forums should be developed that address CAP execution as a whole. The evaluation team is aware of some efforts to coordinate CAP-related issues among cities in a region through WhatsApp groups, but it is not clear how comprehensive their scope is or whether more formalized avenues might more effectively yield lesson-sharing and collaboration. C40 and member cities should assess what the optimal architecture for such regional engagement might look like and how much it borrows from a typical network in its functioning, albeit with a broader topical focus and with a narrower membership.

B. Thematic networks

1. Planning and design stage

C40 should continue exploring how to regionalize network-based activities and define which actor types should be incorporated; models are likely to vary and should be responsive to local member cities' needs. C40 staff are aware that the organization's future will entail some degree of regionalization, but the organization has not yet articulated an exact vision of what that implies. The absence of a clear view may partly be driven by a large diversity of views over the appropriate spatial scale and stakeholder types to integrate. Does a regional model exist at the level of region (e.g., Cambodia, Vietnam, and Thailand), country (e.g., cities within Thailand), or metropolis (e.g., areas surrounding Bangkok)? Is a mixed model appropriate? Consistent with C40's structure, should a regional model also consist only of cities, or, cognizant of the interdependencies involved in advancing climate action, should business and civil society also have a role? We recommend C40 engage with member cities to solicit their views on what types of regional programming models would be of interest to them, and what they envision as the key benefits of such an approach, because they are likely to be the center of any hub-and-spoke model when it comes to agenda-setting and standard-setting. Member cities whose mayoral powers are hamstrung by regional actors would be well-positioned to test a regional model. We think there may be additional opportunities for C40 to plug into existing efforts, such as the

[Alliances for Climate Action \(ACA\)](#), through which six national coalitions are in operation and connecting a variety of non-state actors.³¹ At minimum, more information should be circulated within the regions about member city events (e.g., climate week activities) and programs, to facilitate coordination and possible piggybacking.

2. Progress monitoring stage

C40 recognizes that network activities cannot be causally linked to cities' adoption or implementation of ambitious climate actions; evaluations of network effectiveness should emphasize contribution and not attribution. We believe that C40 would be best served by continuing to focus on the contributions that network participation offers cities in propelling new actions or scaling-up existing initiatives and soliciting those insights through qualitative means. Such an approach tacitly acknowledges that policy change operates in complex, contested environments where the impact of a network interaction, or network-obtained knowledge, is contingent on macro-level political and economic factors. The types of ambitious policy reforms that C40 advocates for have long delays before mitigation effects can be observed. For example, introducing a zero-carbon building energy code will avoid GHG emissions only after its introduction to committee, passage, approval of new building permits, completion of new construction, and move-in of tenants. Such lengthy sequences of events make monitoring and evaluation exceedingly difficult, as progress can be halted at any of those stages. Near-term monitoring activities should concentrate on developing the evidence base for which types of assistance are most effective at lifting specific barriers, and are more likely to be informational, political, or financial than technical. Although organizations like C40 face external pressures to demonstrate a causal connection attributing cities' policy success to their programs, policy change is exceedingly messy and unlikely to unambiguously hinge on a single factor or interaction. Instead, by working with city officials to identify and document its contributions to policy outcomes, C40 will obtain clear guidance on what aspects of network activities are most effective at supporting climate policy progress.

There is scope for further coordinating the various C40 service delivery components with respect to data requests and sharing information with cities. Several city officials we interviewed cited redundant data requests as a source of frustration, with Network A asking for the same information as Network B. This situation contributes to a sense of feeling overwhelmed by requests that could be resolved by closer communication among C40 teams. Although not all data requests will have a known lead time, covening a biannual meeting of the various networks and service delivery arms to schedule requests for the following six months could be an effective way to avoid duplication and provide city officials with a transparent calendar of upcoming needs.

3. Knowledge transfer stage

C40's website is not optimized for steering visitors to the Knowledge Hub, whose content would benefit from additional resources and organization. Despite the Knowledge Hub hosting an abundance of content that is immediately relevant to the networks, individual network pages do not directly link to the Knowledge Hub. Similarly, programs with pertinent resources in the Knowledge Hub, such as the Building Energy 2020 Programme or Measurement and Planning, also do not link to any

³¹ The ACA is a set of multi-sectoral, national coalitions with a common purpose of achieving carbon neutrality. Partners and signatories include representatives from regional, state, and local governments; the private sector; civil society; academia; and other organizations. C40 is a lead facilitator for the South African alliance.

Knowledge Hub materials. The Knowledge Hub should include links to more tools and databases from organizations like the International Energy Agency, Rocky Mountain Institute, and World Resources Institute, that C40 routinely refers cities to. Content should be organized in a way that underscores their sequential nature and guides users through the process, similar to the [C40 Climate Action Planning Resource Center](#). As the Knowledge Hub grows, C40 will need to invest additional resources in how best to manage content. At the moment, Knowledge Hub users are asked to answer a brief feedback form. The Knowledge Hub could incorporate more feedback options requiring user input to indicate the types of materials that users would find helpful. For example, a city interested in establishing an air quality monitoring system might read the related posts on the Knowledge Hub and eventually be directed to the Environmental Defense Fund guide, “Making the Invisible Visible” (Craft et al. 2019). If the user wished to signal interest in learning about best practices for procuring sensors or issuing RFPs for system setup, there appear to be no immediate means of doing so aside from informing a network manager or posting on the forum.

4. Operationalizing the recommendations

These recommendations are the result of observations heard and seen throughout the evaluation and will require different operational approaches. For some, C40 may be best positioned to lead, especially when a recommendation involves an alteration or continuation of an existing service. At the same time, C40 cannot be omnipresent, and will narrow its programs to those areas where it will exert global leadership. Resource constraints and comparative advantage prevent any single organization from assisting cities with all their climate action needs. Still, cities look to C40 for advice and leadership on a wide range of areas. When C40 makes a foray into an area, it may be interpreted by cities as an intention to eventually develop a complete service program. As a result, cities may wait and believe that guidance is forthcoming, instead of developing it themselves. We think it will continue to be important for C40 to signal to its members its intentions on which aspects of climate action support they will be a leader in, and to support relationship-building between its members with other organizations who can provide leadership in areas outside C40’s scope.



VII. Conclusion

Achieving global decarbonization on the timetable necessary to avert costly climate change is one of the most monumental challenges that humanity has faced. The task of climate policy formulation and execution has conventionally been seen as the responsibility of the nation-state. Through C40's Deadline 2020 program, cities now have their own road map for developing Paris-compliant climate action plans and quickly converting proposals into progress. The scale of change this undertaking requires will be enormous. For most C40 cities, achieving plan targets will imply reducing current per capita emissions by about 40 percent within the next 10 years and reaching carbon neutrality by 2050 (C40 and Arup 2016a). Though the programs and resources that C40 has developed to help cities achieve zero net emissions were designed for its member cities, many of the resources and knowledge products that C40 has created will support cities in general to devise and advance climate policy.

Although many C40 cities have made progress in reducing their per capita emissions, particularly those in the Global North who are thought to have already peaked in their emissions, cities admit that the pace of mitigation has fallen short of their targets. This finding does not mean that decarbonization by 2050 is infeasible or unlikely, because past performance is a poor predictor of future returns. The climate emergency and Fridays for Future movements have injected more urgency and energy into propelling climate policy at all governance levels, and the emissions reduction targets that cities are currently setting bear little resemblance to what cities were articulating even just five years earlier. At the same time, the COVID-19 global pandemic threatens to derail climate progress if the next several years are not spent on climate-proofing the economic recovery. For example, bailout funds for airlines and automakers can be attached to conditions for improving the energy efficiency standards of new planes and vehicles, or lawmakers can choose to suspend existing standards in the interest of reducing manufacturing costs. How countries respond is likely to have a substantial effect on whether post-recovery economies are more or less carbon-intensive than when the pandemic began.

Cities may be responsible for the majority of global GHG emissions. However, they often lack policymaking or regulatory authority over some of their most emissions-intensive sectors. Achievement of CAP targets will therefore require a vision shared by numerous stakeholders, including regional and national governments, utilities, the private sector, civil society, and citizens. Such joint ventures will require new network governance structures that are likely to vary dramatically across countries and even across cities within a country. The resources that C40 has developed enable cities to make a compelling case for action, and C40 has convincingly articulated that such action needs to happen now.

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Appendix

Table A.1. C40 member cities by region

	Africa	Central East Asia	East, SE Asia, & Oceania	Europe	Latin America	North America	South & West Asia
	Abidjan	Beijing	Auckland	Amsterdam	Bogotá	Austin	Amman
	Accra	Chengdu	Bangkok	Athens	Buenos Aires	Boston	Bengaluru
	Addis Ababa	Dalian	Hanoi	Barcelona	Ciudad de México	Chicago	Chennai
	Cape Town	Fuzhou	Ho Chi Minh City	Berlin	Curitiba	Houston	Delhi NCT
	Dakar	Guangzhou	Jakarta	Copenhagen	Guadalajara	Los Angeles	Dhaka
	Dar es Salaam	Hangzhou	Kuala Lumpur	Heidelberg	Lima	Miami	Dubai
	Durban (eThekweni)	Hong Kong	Melbourne	Istanbul	Medellín	Montréal	Jaipur
	Freetown	Nanjing	Quezon City	Lisbon	Quito	New Orleans	Karachi
	Johannesburg	Qingdao	Seoul	London	Rio de Janeiro	New York City	Kolkata
	Lagos	Shanghai	Singapore	Madrid	Salvador	Philadelphia	
	Nairobi	Shenzhen	Sydney	Milan	Santiago	Phoenix	
	Tshwane	Wuhan	Tokyo	Moscow	São Paulo	Portland	
		Zhenjiang	Yokohama	Oslo		San Francisco	
				Paris		Seattle	
				Rome		Toronto	
				Rotterdam		Vancouver	
				Stockholm		Washington, DC	
				Tel Aviv			
				Venice			
				Warsaw			
Count	12	13	13	20	12	17	9

Table A.2. CAP assessment framework indicator descriptions

Theme	Indicator	Description and key features	Source
City vision and collaboration	City vision	- Aims to achieve carbon neutrality by 2050 with net zero emissions in key sectors (buildings, transportation, industry, grid-supplied energy, waste treatment) - Aims to reduce consumption-based emissions - Endorses Paris Agreement - Commits to collaborate with community and other key stakeholders	a
	Prioritizing actions	- Prioritizes mitigation and adaptation actions based on highest potential emissions reductions, greatest possible impact, risk reduction, and/or estimated co-benefits - Considers consequences of prioritizing some actions over others - Uses data to guide action prioritization and policy design	a, g
	Communication, education, advocacy	Influences consumer habits via media campaigns, meetings, outreach, educational activities, and other events	a, d
	Engaging stakeholders	Includes commitments and engagements from key stakeholders including businesses, governmental agencies, community-based organizations, community, etc.	a
	Tailored to city context	Considers local climate, geography, resource management, environmental quality, and other relevant factors	a
	Equity	- Considers co-benefits (social, environmental, economic factors, etc.) and SDGs - Employs inclusive climate action to advance well-being of vulnerable populations	a
Mitigation actions	Renewables	Incentives, programs, policy, or infrastructure for centralized and/or decentralized renewables	b, c, d
	District energy systems	District heating and cooling, electricity utility networks	d
	Smart grid management	Flexible, controllable electricity demand	d
	Efficiency standards for new buildings	High-efficiency energy standards and building codes for new buildings	b, c
	Building retrofits	Renovation of roofs, walls, windows, doors, and lighting, repurposing of old buildings, urban regeneration, etc.	b, c, d
	Updates to energy efficient appliances	Updates to heating, ventilation, and cooling (HVAC) systems and water heaters, increases low-carbon technologies (electric heat pumps, efficient air-conditioning, electric/solar-based water heating), etc.	b, d
	Lighting upgrades	Conversion to LED-based lighting solutions	b, d
	Building automation and controls	Smart controls, adaptive thermostats, light sensors, plug load monitors, demand-side management, and load-shifting incentives	b, d
	Transit-oriented development	Urban and regional planning for higher density development via mixed use buildings, urban containment, affordable housing, efforts to reduce sprawl, etc.	b, c, d

Theme	Indicator	Description and key features	Source
	Deterrents for private vehicles	Parking restrictions, reduced parking, tolls, diesel bans, etc.	b, c, d
	Mode shift	Shift toward public transportation, walking, cycling, biking, and car sharing	b, c, d
	Electric vehicles	Designated driving lanes and parking spots, subsidies, zero-emission zones, charging infrastructure, zero-emission buses, etc.	b, c, d
	Commercial freight optimization	Night delivery, parcel lockers, zero emission fleets	b
	Waste management	Circular economy, pay-as-you-go mechanisms, recycling and composting programs, efforts to divert methane, regulations and bans against single-use and non-recyclable materials, segregated food waste, illegal dumping bans, etc.	b, c, d
	Utilities improvements	Wastewater treatment, solid waste landfilling, efficient water fixtures, plumbing, repair leaky infrastructure, decentralized water systems, etc.	d
	Low carbon diet	Carbon labeling, meat and dairy taxes, subsidized produce for low-income houses, etc.	c
	Coastal city adaptations	Barriers and building design for sea level rise	c
	Drainage systems	Sustainable urban drainage systems for managing excess rainfall	c
	Flood risk maps and models	Flood risk maps and models	c
Adaptation actions	Green infrastructure and green spaces	- Cooling infrastructure (green building envelopes, cooling roofs/pavements, etc.) - Green spaces (parks, climate appropriate plants, etc.)	c, d
	Resilient transportation	Integrating climate risk and adaptation needs into public transit infrastructure and service	c
	Resilient buildings	Integrate climate risk and adaptation into building code and retrofit programs	c
	Climate hazard assessment	- Identification of climate hazards, quantifies probability and intensity of hazards and how hazards may influence each other - Commitment to update assessments regularly, and projections through 2050	a
	Climate impact assessment	- Identifies potential impact of hazards on systems of urban planning, food, transportation, energy etc. - Quantifies impacts on persons affected, cost of damages, etc. - Considers cascading effects of damages, interdependencies between sectors, and systems' adaptive capacity	a
	Powers and resources	- Diagrams sectors and subsectors under city jurisdiction, and those that are under the control of other governing bodies, agencies, and the private sector - Specifies who will lead actions, how collaboration will occur, and how progress will be tracked - Commits to lobbying/advocacy efforts for actions outside city's jurisdiction	a

Theme	Indicator	Description and key features	Source
	Human and financial resources	- Identifies funding sources for at least one year - Describes plans for securing long-term funding - Outlines commission, team, working group, or capacity-building efforts to support climate action work	a, e
Monitoring and data collection	Measurable targets	Disaggregates targets into actionable steps, associated with key performance indicators and milestones	a, e
	Monitoring plan	- Specifies implementation timeline and outlines progress in phases - Commits to regularly and publicly update the CAP, emissions inventory, and risk reduction impacts	a, g
	GHG residual emissions	- Quantifies residual emissions - Commits to monitor and address residuals via offsets, carbon sinks, etc.	a
	GHG emissions inventory	- Reports GHG inventory covering key sectors (buildings, transportation/industry, grid-supplied energy, waste, consumption-based emissions) - Describes data sources and inputs	a
	GHG emissions trajectory	- Models emissions trajectories, including BAU scenario and complete CAP compliance scenario - Decomposes trajectories by sector and action - States rationale/calculations for carbon budgets (if applicable) - Accounts for projected population growth and economic changes	a, g
	GHG emissions monitoring	- Includes short-, medium-, and long-term targets and/or carbon budgets that are based on emissions inventory/modeling - Indicates how emissions will be tracked - Identifies inputs and assumptions, accounts for projected population growth and economic changes - Details plans for maintaining relevant data and producing data visualization for broader climate communication purposes	a, g
	Air quality monitoring	- Improves air quality data collection and analysis - Establishes health impacts of air pollution and clean air benefits	c
	Data management strategy	- Demonstrates strategic importance of climate data (e.g., its importance, uses, alignment with other citywide data initiatives, etc.) - Identifies data strengths and weaknesses, and plans for improvement	g

Note: a. C40 2020c; b. McKinsey and C40 2018; c. C40 2019d; d. Deetjen et al. 2018; e. Bassett and Shandas 2010; f. OECD 2019; g. C40 2019e
LED = light-emitting diode; SDG = Sustainable Development Goal.



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Appendix B

Resumes

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Proposed staff are listed below in the order in which their resumes appear in this appendix.

Name	Affiliation	Role
Dheeya Rizmie	Mathematica	Project Director
Anthony D'Agostino	Mathematica	Senior Advisor
Hannah Kornfeld	Ascent	Task 2 Co-Lead
Poonam Boparai	Ascent	Task Co-Lead
Areen Sattar	Mathematica	Task 1 Lead
Nathan Chesterman	Mathematica	Task 2 Co-Lead
Courtney Cappalli	Mathematica	Task 3 Lead
Alex Bauer	Mathematica	Task 4 Lead
Kai Elwood-Dieu	Mathematica	member of Task 1 and Task 2
Evan Christo	Mathematica	member of Task 2 and Task 3

Dheeya Rizmie

Researcher

Selected Experience

Mathematica

Task Lead, Strategy and Learning Partner, Climate and Health Exploration Fund (2023-). Serve as subject matter expert and technical advisor to a large foundation's ongoing climate and health strategy. This involves developing theories of change for several health investments and identifying relevant and realistic indicators to monitor progress and learnings for future investments in this area.

Quantitative Research and Subject Matter Expert, Cost-Benefit Analyses of Wastewater Monitoring for Health Biomarkers (2023-). Serve as subject matter expert and researcher in conducting a cost-benefit analysis on the effectiveness of introducing wastewater monitoring for early detection of enteric diseases in vulnerable populations in Bangladesh. Assess and project the feasibility of using wastewater monitoring for early detection of climate-sensitive infectious diseases across different climate scenarios.

Researcher, Monitoring and Evaluation Learning Partner Pandemic Preparedness Response (2022-). Serve as a researcher on a large international foundation's learning agenda relating to its COVID-19 pandemic activities and analytics. This role involved interviewing key informants to identify successes and learnings from COVID-19 rapid research activities globally to suggest optimal ways of working for better resilience and responsiveness to future health emergencies.

Modeling Lead, Climate and Weather: Analysis, Trends, and Community Health (ClimaWATCH) Dynamic Tool (2022-). Serve as subject matter expert and modeling lead for quantitative analysis to develop and manage the tool. Role includes designing research questions and programming analysis to explore the causal effects of heatwaves on highly susceptible populations. The tool analyzes national health data sets alongside hyper-localized weather metrics to help community officials, hospitals, policy makers, funders, and researchers see where climate issues are concentrated, flag who is most at risk, and identify policies to relieve system stress. By summarizing historical trends and patterns in weather and health data, Mathematica clarifies shifts in climate exposures and corresponding shifts in disease burden to help communities develop data-driven emergency plans, adapt response equitably, and build climate resilience.

Technical Advisor and Researcher, Global Center for Adaptation Resilience Platform (2023). Served as subject matter expert and researcher for a scoping review to understand the suitability of building a global data platform for locally led adaptation. The work included interviewing key informants across various organizations and users to understand data needs, feasibility, and use cases.

Task Lead, Go Forward Climate and Health Strategy (2022-2023). Served as subject matter expert and researcher to help develop and support a large international foundation's strategy on embedding climate change considerations in their health strategy and investments.

Task Lead, Environmental Health Capacity Assessment (2022-2023). Assessed the implementing of environment-related mitigation strategy in communities disproportionately affected by COVID-19. The work

Education

2021 Ph.D., Health Economics
(Environmental Economics),
Imperial College London

2017 M.Res., Economics, Imperial
College London

2015 M.P.H., Global Health,
Imperial College London

2014 B.Sc., Biomedical Sciences,
University of Warwick

Positions

2022- Mathematica

2022 Visiting Researcher,
University of Barcelona

2017-2022 Imperial College London

2022 Module Leader/Lecturer

2022 Visiting Researcher

2017-2021 Graduate Teaching
Assistant

2020 COVID-19 Researcher

2016 Technical Officer, World
Health Organization

2016 Communications Officer, The
Carbon Trust UK

focuses on 20 environmental justice communities in Massachusetts that were hit hard by COVID-19. Helped develop a strategy to identify exemplar communities that represent diverse environmental justice needs and worked with community-based organizations to identify interventions to mitigate their communities' environmental concerns.

University of Barcelona; Barcelona, Spain

As **Visiting Researcher (2022)**, researched how rainfall changes and shocks impact children's nutritional development and dietary profiles in India.

Imperial College London; London, United Kingdom

As **Module Leader (2022)**, organized, prepared, and delivered a series of lectures on health and environment to M.Sc. international health management students. Taught about the cyclical impacts of climate change and pollution on health and health services. Advised on identifiable impacts and potential solutions. Designed Health National Adaptation Plans to mitigate environmental shocks and adapt health systems.

As **Visiting Researcher (2022)**, researched how environmental exposures (extreme weather events, pollution) and environmental policies influence health and well-being. Worked with the Centre for Health Economics and Policy Innovation.

World Health Organization; Geneva, Switzerland

As **Technical Officer (2016)**, worked on strategy, planning coordination, and support associated with the response to the 2016 Zika epidemic. Served as chief of staff to support and coordinate the response to the 2016 Democratic Republic of the Congo-Angolan yellow fever outbreak and coordinated the first fractionated vaccination campaign. Conducted resource allocation and planning activities while coordinating various roles and information across different disciplines and informational sources (for example, epidemiology, logistics, vaccine delivery, financing, and so on).

The Carbon Trust UK; London, United Kingdom

As **Communications Officer (2016)**, copy-edited technical and nontechnical publications and reports for nontechnical audiences involving decarbonization and energy efficiency programmes.

Selected Papers and Publications

de Preux, Laure, Dheeya Rizmie, Daniela Fecht, John Gulliver, and Weiyi Wang. "Does It Measure Up? A Comparison of Pollution Exposure Assessment Techniques Applied Across Hospitals in England." *International Journal of Environmental Research and Public Health*, vol. 20, no. 5, 2023, p. 3852. doi:10.3390/ijerph20053852.

Rizmie, Dheeya, Laure de Preux, Marisa Miraldo, and Rifat Atun. "Impact of Extreme Temperatures on Emergency Hospital Admissions by Age and Socio-Economic Deprivation in England." *Social Science & Medicine*, vol. 308, 2022. doi:10.1016/j.socscimed.2022.115193.

de Preux, Laure, and Dheeya Rizmie. "Beyond Financial Efficiency to Support Environmental Sustainability in Economic Evaluations." *Future Healthcare Journal*, June 2018, pp. 103-107. doi:10.7861/futurehosp.5-2-103.

Presentations

Rizmie, Dheeya, Aparna Keshaviah, and Cindy Hu. "ClimaWATCH: Exploring How Heatwaves Affect Health Service Use and Spending Among U.S. Medicaid Beneficiaries." Presentation at American Society of Health Economists Annual Conference, St. Louis, 2023.

Rizmie, Dheeya, Laure de Preux, and Marisa Miraldo. "Sweet Dreams Are Made of This: How Is a Pedestrianisation Policy in Paris Influencing Sleep?" Presentation at American Society of Health Economists Annual Conference, St. Louis, 2023.

Rizmie, Dheeya, Laure de Preux, and Marisa Miraldo. “Sweet Dreams Are Made of This: How Is a Pedestrianisation Policy in Paris Influencing Sleep?” Presentation at Royal Economics Society, Glasgow, Scotland, 2023.

Rizmie, Dheeya, Laure de Preux, and Marisa Miraldo. “Does Pollution Disrupt Sleep? Evidence from a Pedestrianisation Policy in Paris.” Presentation at European Association of Environmental and Resource Economists Annual Conference, Rimini, Italy, 2022; the Winter Health Economics Study Group, Leeds, England, 2022; and the UK Network for Environmental Economists Annual Conference, London, England, 2020.

Rizmie, Dheeya, Laure de Preux, and Marisa Miraldo. “Does Pollution Disrupt Sleep? Evidence from a Pedestrianisation Policy in Paris.” Virtual presentations for the Royal Economics Society Annual Conference, 2022; the Online Summer Workshop in Environment, Energy, and Transportation (Economics), 2021; the American Society of Health Economists Annual Conference, 2021; the International Health Economics Association World Congress, 2021; and the European Health Economics Association PhD Congress, 2021.

de Preux, Laure, Dheeya Rizmie, Daniela Fecht, John Gulliver, and Weiyi Wang. “Does It Measure Up? A Comparison of Pollution Exposure Assessment Techniques Applied Across Hospitals in England.” Virtual presentations for the Online Summer Workshop in Environment, Energy, and Transportation (Economics), 2021; the American Society of Health Economists Annual Conference, 2021; and the International Health Economics Association World Congress, 2021.

Rizmie, Dheeya, Laure de Preux, Marisa Miraldo, and Rifat Atun. “Impact of Extreme Temperatures on Emergency Hospital Admissions by Age and Socio-Economic Deprivation in England.” Presentation at the European Health Economics Association Annual Conference, Maastricht, The Netherlands, 2021; the Lancet’s UK Public Health Science Conference, London, England, 2019; the European Association of Environmental and Resource Economists PhD Summer Conference, Venice, Italy, 2019; the International Health Congress, Oxford, England, 2018; and the European Health Economics Association PhD Congress, Sardinia, Italy, 2018.

Rizmie, Dheeya, Laure de Preux, Marisa Miraldo, and Rifat Atun. “Impact of Extreme Temperatures on Emergency Hospital Admissions by Age and Socio-Economic Deprivation in England.” Virtual presentation at the American Society of Health Economists Annual Conference, 2020.

Anthony Louis D'Agostino

Senior Researcher

Selected Experience

Mathematica

Project Director, USAID Agriculture, Forestry, and Other Land Use (AFOLU) Greenhouse Gas (GHG) Calculator (2023-). Provide GHG accounting and geospatial data analysis subject matter expertise to help lead the development of a new AFOLU GHG calculator for U.S. Agency for International Development (USAID) projects to report their results. Coordinate closely with information technology subcontractor to ensure quality and timeliness within an Agile framework. Total contract value is \$5 million with a 24-month period to release a final calculator version, followed by a three-year maintenance period.

Principal Investigator, Independent Evaluation of the Kosovo Threshold Program Transparent and Accountable Governance Project (2022-). Co-led research design of this mixed-methods evaluation of a three-pronged Millennium Challenge Corporation (MCC) investment seeking to improve data transparency in Kosovo's judiciary, increase the availability and use of air quality data to reduce health impacts from air pollution exposure, and promote an open data culture through funding competitive grants windows.

Project Director, The Economic Disamenities and Health Impacts of Animal Feeding Operations' Practices in the United States (2022-). Provide research support for range of data acquisition and cleaning, applied econometrics, and geospatial analysis tasks to examine the effects of proximity to animal feeding operations on water bodies, human health, and property markets. Serve as an external consultant on this \$596,000 project managed by the University of Chicago and funded through the U.S. Department of Agriculture, National Institute of Food and Agriculture competitive grants window.

Senior Analyst, Evaluation of the Niger Irrigation and Market Access Project (IMAP) (2018-). Support design and execution of a mixed-methods evaluation of the \$255 million IMAP of the Niger Sustainable Water and Agriculture Compact, funded by MCC. Serve as project lead for the collaboration between MCC, RTI, the National Aeronautics and Space Administration, and Mathematica to use drone and satellite data to predict agricultural outcomes on and off the Konni irrigation perimeter. IMAP seeks to increase agricultural productivity and agricultural sales through four complementary activities: (1) establishing or rehabilitating irrigated land in two regions in Niger, (2) upgrading rural roads, (3) training farmers, and (4) promoting policy reform. Sample household survey respondents based on all available satellite data (for example, Sentinel-2, optical and radar-fused WATEX groundwater data, Climate Hazards Group InfraRed Precipitation with Station [CHIRPS] and MODIS [Moderate Resolution Imaging Spectroradiometer] precipitation and temperature), raster, plot outlines, and sampling frame data. Lead implementation of an impact evaluation using matched comparison group design of small-scale irrigation recipients in the Sia area, using data collected from in-person surveys and satellite data.

Education

2017 Ph.D., Sustainable Development, Columbia University

2015 M. Phil., Sustainable Development, Columbia University

2008 M.P.P., Social and Environmental Policy, National University of Singapore

2002 B.A., Philosophy, summa cum laude, Rutgers University

Positions

2018- Mathematica

2023- Senior Researcher

2018-2023 Researcher

2017-2018 Postdoctoral Scholar, Stanford University

2012-2017 Columbia University

2012-2017 Teaching Assistant

2014, 2016 Research Assistant

2012-2014 Graduate Researcher

2009-2011 Research Fellow, National University of Singapore

2008-2009 Research Intern, World Resources Institute

2007 Intern, United Nations Environment Programme

2003-2004 Case Manager

2003 Residential Counselor

Project Director, Youth & Agri-Food Systems Foresight Analytics (2023). Directed a six-person team in developing a suite of custom visualizations summarizing key trends, relationships, and forecasts in youth employment and agri-food systems in Africa. Provided data interpretation and facilitation support during four-day workshop in Mombasa, Kenya, attended by more than 80 youth leaders and advocates. Project was funded through Mastercard Foundation with Systemic Link Consulting serving as the prime.

Senior Analyst, Global Center on Adaptation Resilience Platform (2023). Supported interview instrument design and interviewed experts in global climate data management, regional climate model downscaling, and locally led adaptation practices.

Project Director, Ghana Sustainable Land Use Finance for Self-Reliance (2021-2023). Led project team in household survey instrument design, primary and secondary data analysis, and creation of geographic information system (GIS)-based cost-benefit analysis recommendations on the social and ecological returns to sustainable cocoa and shea production. Project seeks to stimulate \$4 million in private sector investment in sustainable cocoa and shea production in Ghana. Team is subcontracted to Bioversity International/International Center for Tropical Agriculture with the U.S. Agency for International Development as the prime client.

Spatial Analysis Lead, Head Start: Recruitment, Selection, Enrollment, and Retention of Especially Vulnerable Families (2021-2023). Devised a GIS-based workflow to address research questions on the spatial distribution of Head Start programs and service provision relative to service needs, proxied by American Community Survey tract-level data. Led mapping and regression analysis tasks through writing specifications, conducting code reviews, and presenting findings to the Office of Planning, Research, and Evaluation.

Transformed Medicaid Statistical Information System Analytic Files Geocoding Principal Investigator and Sub-Task Lead, Medicaid and CHIP (Children's Health Insurance Program) Business Information Solution Business Analytics and Data Quality Development (2019-2023). Devised a comprehensive geocoding and georeferencing workflow to assign spatially explicit information to an annual average of 75 million Medicaid beneficiaries and millions of health care providers serving Medicaid patients. Served as co-principal investigator for an access-to-care pilot study examining heterogeneity in Medicaid beneficiaries' spatial access to primary care and obstetrics services, resulting in a research brief and interactive web platform. Developed data quality products assessing the availability and comprehensiveness of address information for beneficiaries and providers. Wrote technical specifications and requirements in consultation with client. Led weekly meetings with multi-contractor Analytics and Reporting Environment for Medicaid and CHIP technical team to address technical and logistical issues. Supported team tasked with race and ethnicity imputation on appropriate use of geocoded data products. Managed team of private contractors to produce quality-assured geocoded versions of beneficiary and provider data for CY2020.

Climate Change Subject Matter Expert, Improving National Science Foundation's (NSF's) Analytic Capacity (2022). Provided guidance and quality assurance in the creation of a codebook to classify NSF research proposals into climate change subcategories. Supported coding team by reviewing proposals that coders independently disagreed about and continuously refining categorization guidance. Part of a \$295,000 NSF-funded project to create ground truth labels to support NSF in running natural language processing models to categorize historical proposals.

Spatial Analysis Adviser, Evaluation of the Lusaka Water Supply, Sanitation, and Drainage Project (2021-2022). Helped project team analyze the effect of new drainage infrastructure on urban flooding in Lusaka by advising on spatial and statistical analyses. Conducted code reviews and quality assurance on draft version of final report chapter on flooding impacts. Regression analysis draws on household survey data, GIS layers for water bodies and elevation (Shuttle Radar Topography Mission data), and satellite precipitation data (CHIRPS).

Senior Analyst, Evaluation of Malawi Environmental and Natural Resource Management (ENRM) Project (2018-2022). Led data collection and analysis using GIS to evaluate grantee site selection. Incorporated downscaled regional forecasts of climate models into analysis of a model for sedimentation transport. Provided quality assurance of remote sensing and analysis of hydrological modeling conducted by

project subcontractor, the International Food Policy Research Institute. Served as lead author of final report on effects of weed and sediment management investments on hydroelectricity performance using interrupted time series methods. The ENRM project is part of MCC's five-year compact in Malawi that seeks to reduce sedimentation and aquatic weed growth in the Shire River and improve land use practices with the goal of better hydropower generation on the Shire.

Geocoding/Spatial Analysis Task Lead, Evaluation of the Comprehensive Primary Care Plus Model (2021). Produced geocoded output for 10 million Medicare beneficiaries using Esri's StreetMap Premium. Conducted quality assurance on data.

Remote Sensing Task Lead, Moldova Transition to High-Value Agriculture Project Evaluation (2020). Oversaw use of satellite data to monitor crop choice and crop productivity over the irrigation command areas involved in this MCC-funded \$129 million project. Contributed to client memo which outlined the several reasons why pursuing remote sensing-based analysis was unlikely to support evaluation objectives. The project rehabilitated irrigation infrastructure; transferred water-management rights; established a credit line for agricultural investments; and promoted high-value agriculture production and sales through training, technical assistance, and other activities.

Remote Sensing Task Lead, Evaluation of the Burkina Faso Agricultural Development Project (ADP) (2019-2020). Developed an end-to-end satellite data analysis that used crop cut data from the Di perimeter to predict agricultural production, cropping choices, and crop yields using satellite data and output from machine-learning algorithms. Workflow leveraged crop type predictions generated using Sen2-Agri from primary data labeled by project team. Led analysis calibrating regression models to predict crop yields based on plot-specific features derived from Sentinel-2 bands. The ADP was a \$140 million project under the MCC's Burkina Faso Compact that aimed to expand the availability of agriculturally productive land to increase rural incomes and employment.

Project Director, C40 Phase 3 Grant Activities (2019-2020). Directed a mixed-methods performance evaluation of C40's programming on climate action plans and sector-focused peer-to-peer networks. Project was funded by the Children's Investment Fund Foundation (CIFF) to provide insight on the status, progress, and challenges associated with developing Paris Agreement-compliant climate action plans, and to provide an update on the performance of C40's thematic networks. Designed and oversaw data collection, coding, and analysis for qualitative and quantitative research components. Data collection included conducting 40 interviews with C40 leadership and technical staff, C40 member cities, non-C40 cities, stakeholders from partner organizations, and independent researchers. Managed a team that developed a novel assessment framework of climate action plan contents and analyzed city-level greenhouse gas emissions data compiled by CDP. Generated recommendations that fed into business planning processes for CIFF and C40.

Project Director, Does What Gets Measured Get Done? An Evaluation of the Impacts of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) on City Climate Action (2018-2020). Oversaw the execution of a matched comparison group evaluation for CIFF of a technical assistance program implemented by C40. The program was designed to expand adoption of the GPC in establishing city-level greenhouse gas emission inventories, which provided the foundation for devising mitigation actions and setting emission reduction goals. CIFF financed implementation of the technical assistance program in 30 C40 member cities in Africa, Asia, and Latin America.

Stanford University; Stanford, CA

As a **Postdoctoral Scholar (2017-2018)** at the Center on Food Security and the Environment/Department of Earth System Science, conducted research on estimating health impacts from pollution exposure and understanding the responsiveness of agricultural yields to climate change. Mentored area high school student on environmental economics methods through the Stanford Earth Young Investigators program.

Columbia University; New York, NY

As **Teaching Assistant (2012-2017)**, taught recitations; developed lecture, problem set, and exam materials; graded problem sets and exams; and held office hours for masters- and undergraduate-level courses in

Microeconomics and Policy Analysis II, Human Ecology and Sustainable Development, Quantitative Techniques and Systems Analysis in Policymaking, Challenges of Sustainable Development, and Economics of Energy.

As **Research Assistant (2014, 2016)** in the School of International and Public Affairs, conducted research on machine learning approaches to relate crop suitability with observed cropping outcomes in India. Contributed to the development of a global, gridded daily temperature data set.

As **Graduate Researcher (2012-2014)** in the Financial Instruments Sector Team at the International Research Institute for Climate and Society, developed and maintained R code used to construct key parameters of weather index insurance contracts sold to smallholder farmers in partner countries. Provided in-person code training support to Nairobi-based implementing partner, the Syngenta Foundation.

National University of Singapore; Singapore

As **Research Fellow (2009-2011)**, in the Lee Kuan Yew School of Public Policy, was the lead researcher for the energy security section of the Asian Trends Monitoring Bulletin, a monthly publication funded by the Rockefeller Foundation and distributed to ministers, corporate heads, civil servants, and academics throughout Southeast Asia. Served as part of a three-person energy security cluster funded by the MacArthur Foundation to research multilateral-sponsored off-grid renewables projects through fieldwork conducted in Papua New Guinea, Mongolia, and China.

World Resources Institute; Washington, DC

As **Research Intern (2008-2009)** for Greenhouse Gas Protocol, convened life cycle assessment experts and stakeholders from Fortune 500 companies, governments, nongovernmental organizations, and academia in technical working groups to produce the Product Life Cycle Accounting and Reporting Standard and Corporate Value Chain (Scope 3) Standard. Analyzed impact of greenhouse gases on bus, light rail, and business-as-usual transportation options for Maryland Transit Authority's proposed Purple Line transit corridor. Findings were submitted as public comment.

United Nations Environment Programme; Bangkok, Thailand

As **Intern (2007)** in the Regional Office for Asia and the Pacific (ROAP), wrote a series of briefs for the regional director that examined the built environment's contribution to climate change and were used to inform the ROAP-Bangkok Metropolitan Authority partnership's work program on sustainable building renovations in Bangkok. Was a member of the Asia-Pacific Forum for Environment and Development's 2007 Showcase Programme short-listing committee for awarding U.S. \$30,000 grants to Southeast Asian organizations.

Selected Papers and Publications

JOURNAL ARTICLES

Elders, Akiko, Mark Caroll, Christopher Neigh, Anthony Louis D'Agostino, Christopher Ksoll, and Margaret Wooten. "Estimating Crop Type and Yield of Small Holder Fields in Burkina Faso Using Multi-Day Sentinel-2." *Remote Sensing Applications: Society and Environment*, vol. 27, 2022.

D'Agostino, Anthony Louis, and Wolfram Schlenker. "Recent Weather Fluctuations and Agricultural Yields: Implications for Climate Change." *Agricultural Economics*, vol. 47, no. S1, 2016, pp. 159-171.

D'Agostino, Anthony Louis, Johannes Urpelainen, and Peter Lund. "The Business of Distributed Solar Power: A Comparative Case Study of Centralized Charging Stations and Solar Microgrids." *Wiley Interdisciplinary Reviews: Energy and Environment*, vol. 5, no. 6, 2016, pp. 640-648.

D'Agostino, Anthony Louis, Johannes Urpelainen, and Alice Xu. "Socio-Economic Determinants of Charcoal Expenditure in Tanzania." *Energy Economics*, vol. 49, 2015, pp. 472-481.

Bambawale, Malavika Jain, Anthony Louis D'Agostino, and Benjamin K. Sovacool. "Realizing Rural Electrification in Southeast Asia: Lessons from Laos." *Energy for Sustainable Development*, vol. 15, no. 1, 2011, pp. 41-48.

D'Agostino, Anthony Louis, and Benjamin K. Sovacool. "Sewing Climate-Resilient Seeds: Implementing Climate Change Adaptation Best Practices in Rural Cambodia." *Mitigation and Adaptation Strategies for Global Change*, vol. 16, no. 6, 2011, pp. 699-720.

D'Agostino, Anthony Louis, Benjamin Sovacool, Kirsten Trott, Catherine Ramos, Saleena Saleem, and Yanchun Ong. "What's the State of Energy Studies Research?: A Content Analysis of Three Leading Journals from 1999-2008." *Energy*, vol. 36, no. 1, 2011, pp. 508-519.

REPORTS

D'Agostino, Anthony Louis, Edith Felix, Maarten Froeling, and Faraz Usmani. "Sustainable Land Use Finance for Self-Reliance in Ghana: Cost-Benefit Analysis Final Brief." Report submitted to USAID. Washington, DC: Mathematica, July 2023.

Ksoll, Christopher, Anthony Louis D'Agostino, Margo Berends, Sam Studnitzer, and Poorva Upadhyaya. "Niger Irrigation and Market Access Project Baseline Report—Part II: Dosso-Gaya Region." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, July 2023.

Null, Clair, Nathan Chesterman, Dadirai Fundira, Anthony Louis D'Agostino, Joy Nyabwari, Jeremy Page, Grant Anapolle, and Adriana Gonzales. "The Lusaka Water Supply, Sanitation, and Drainage (LWSSD) Project: Endline Evaluation Report." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, June 2023.

D'Agostino, Anthony Louis, Josh Meuth Alldredge, Hailey Hannigan, Matt Sloan, and Ksenia Miliutinskaia. "Independent Evaluation of the Kosovo Threshold Program Transparent and Accountable Governance (TAG) Project: Evaluation Design Report." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, December 2022.

D'Agostino, Anthony Louis, Jacqueline Shieh, and Kristen Velyvis. "Final Report for the Evaluation of the ENRM Project in Malawi. Volume II: The Weed and Sediment Management Activity, Environmental Trust, and Overall Project Evaluations." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, September 2022.

D'Agostino, Anthony Louis, Christopher Ksoll, and Margo Berends. "Niger Irrigation and Market Access Project: Evaluation Design Report for Small-Scale Irrigation Activities and Complementary Investments in the Dosso-Gaya Region." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, June 2021.

Ksoll, Christopher, Margo Berends, Esteban J. Quinones, Anthony Louis D'Agostino, and Poorva Upadhyaya. "Niger Irrigation and Market Access: Baseline Report." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, June 2021.

D'Agostino, Anthony Louis, Alejandra Nichte Aponte, Sam Studnitzer, Eva Ward, and Anu Rangarajan. "Does What Gets Measured Get Done? An Evaluation of the Impact of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories on City Climate Action: Final Report." Report submitted to the Children's Investment Fund Foundation. Oakland, CA: Mathematica, December 2020.

Ksoll, Christopher, Elena Moroz, Abbie Turiansky, Anthony Louis D'Agostino, Yiriyabin Bambio, Daniel Roberge, and Randall Blair. "MCC Burkina Faso-Agriculture Development Project." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, November 2020.

D'Agostino, Anthony Louis, Sara Bryk, Sam Studnitzer, and Anu Rangarajan. "Evaluation of Climate Action Plans and C40's Thematic Networks." Report submitted to the Children's Investment Fund Foundation. Oakland, CA: Mathematica, August 2020.

Harris, Anthony, Anthony D'Agostino, Sara Litke-Farzaneh, Beryl Seiler, and Matt Sloan. "Morocco Land Productivity Project: Evaluation Design Report." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, July 2020.

D'Agostino, Anthony, Christopher Ksoll, Patricia Costa, Galina Lapadatova, and Matt Sloan. "Niger Irrigation and Market Access: Evaluation Design Report." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, December 2019.

Coen, Thomas, Anthony D'Agostino, Naomi Dorsey, Arif Mamun, Hua Xie, Yating Ru, Ephraim Nkonya, and Claudia Ringler. "Interim Report for Evaluation of the ENRM Project in Malawi." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica and IFPRI, November 2019.

Litke-Farzaneh, Sara, Anthony Harris, Beryl Seiler, Anthony D'Agostino, Sarah Hughes, and Matt Sloan. "Evaluability Assessment for the Morocco Land Productivity Project." Report submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica, May 2019.

Stanimirova, Radost, Helen Greatrex, Rahel Diro, Geoff McCarney, Jessica Sharoff, Bristol Mann, Anthony Louis D'Agostino, Marshall Rogers-Martinez, Sarah Blakeley, Christopher Small, Pietro Ceccato, Tufa Dinku, and Daniel E. Osgood. "Using Satellites to Make Index Insurance Scalable: Final IRI Report to the UN ILO Microinsurance Innovation Facility." New York: The Earth Institute, Columbia University, 2014.

RESEARCH AND ISSUE BRIEFS

D'Agostino, Anthony Louis, Jacqueline Shieh, and Kristen Velyvis. "Increasing Efficiency of Hydropower Generation in Malawi: Investments Improved and Increased Electricity Supply." Evaluation Brief. Washington, DC: Millennium Challenge Corporation, 2022.

D'Agostino, Anthony Louis, Andrea Wysocki, Stephanie Tuerk, Kim Proctor, and Jessie Parker. "Using Geocoded 2016-2019 TAF Data to Assess Medicaid Beneficiaries' Access to Health Care: A Pilot Study." TAF Brief. Baltimore: Centers for Medicare & Medicaid Services, 2022.

WORKING PAPERS

Rode, Ashwin, Rachel E. Baker, Tamma Carleton, Anthony Louis D'Agostino, Michael Delgado, Tim Foreman, Diana R. Gergel, Michael Greenstone, Trevor Houser, Solomon Hsiang, and contributing authors. "Labor Disutility in a Warmer World: The Impact of Climate Change on the Global Workforce." Working paper, September 2022.

D'Agostino, and Anthony Louis. "Technical Change and Gender Wage Inequality: Long-Run Effects of India's Green Revolution." Job market paper. New York: Columbia University, September 2016.

Presentations

D'Agostino, Anthony Louis. "Satellites and Sampling—Leveraging Remote Sensing to Enable an Impact Evaluation of Irrigation Investments in Niger." Virtual presentation at the GeoField Convening, 2023.

D'Agostino, Anthony Louis. "Climate Data to Support Locally Led Adaptation: Setting the Scene." Virtual presentation at the Annual Global Gobeshana Conference, organized by the International Centre for Climate Change and Development, 2023.

Ksoll, Christopher, Anthony Louis D'Agostino, and Margo Berends. "MCC Niger IMAP: Dosso Gaya Baseline Report." Virtual presentation at the Millennium Challenge Corporation, Washington, DC, 2022.

D'Agostino, Anthony Louis. "Satellites and Sampling - Leveraging Remote Sensing to Select Comparison Group Households in a Niger Agricultural Evaluation." Lightning Talk at SatSummit 2022, Washington, DC, 2022.

D'Agostino, Anthony Louis and Kristen Velyvis. "MCC Malawi Environmental and Natural Resources Management (ENRM) Project: Final Evaluation Findings." Presentations in Lilongwe and Blantyre, Malawi, and for the Millennium Challenge Corporation, virtual, 2022.

D'Agostino, Anthony Louis and Kristen Velyvis. "Interim Evaluation Results for the MCC Malawi Environment and Natural Resource Management (ENRM) Project." Presentation at the Millennium Challenge Corporation, Washington, DC, 2020.

D'Agostino, Anthony Louis. "Cities and Climate Change: On Learning and Diffusion." Presentation at the C40 and EY Empowering Cities with Data Workshop, New York, 2019.

D'Agostino, Anthony Louis and Eyal Frank. "The Local Welfare Impacts of Factory Farms in the U.S." Presentation at the Sustainable Development Research Symposium, New York, 2018.

D'Agostino, Anthony Louis. "Technical Change and Gender Wage Inequality: Long-Run Effects of India's Green Revolution." Presentation at the Southern Economic Association, Tampa, FL, 2017; Pacific Conference for Development Economics, UC Riverside, CA, 2017; Cornell Dyson School, Ithaca, NY, 2016.

D'Agostino, Anthony Louis. "Rural Credit and Adaptation to Climate Change." Presentation at the National Bank for Agriculture and Rural Development, Mumbai, India, 2015.

D'Agostino, Anthony Louis and Ron Miller. "Moist Static Energy as an Indicator of South Asian Summer Monsoon Dynamics." Poster presented at the American Geophysical Union Fall Meeting, San Francisco, 2014.

D'Agostino, Anthony Louis. "Energy Insecurity for ASEAN's BOP: The Un-electrified 160 Million." Presentation at the Energy Studies Institute-Singapore Ministry of Defense Workshop on Energy Security: Options, Implications and Outlook, Singapore, 2010.

D'Agostino, Anthony Louis and Malavika Jain Bambawale. "Energy Poverty in the Asia-Pacific Region." Presentation at the Harvard Project for Asian and International Relations, Singapore, 2010.

D'Agostino, Anthony Louis. "Resources and Trade-Offs: The Energy-Water Nexus in Asia." Presentation at the Energy Studies Institute Energy Security Conference, Singapore, 2009.

Referee

Agricultural Economics

American Journal of Agricultural Economics

Applied Economic Perspectives and Policy

Asian Development Review

Climate and Development

Climate Change Economics

Land Economics

Nature Sustainability

World Development

Professional Affiliations

2022-	Affiliate, Center for Environmental Economics and Policy, Columbia University
2018-	Affiliated Scholar, Center on Food Security and the Environment, Stanford University
2014-	Fellow, Center for Development Economics and Policy, Columbia University

Professional Service

2023-	Member, GeoField Evaluator Community of Practice
2021-	Co-Lead Representative from International Unit, Mathematica GIS Affinity Group
2022	Member, Natural Resource, Energy, & Environment policy track, Association for Public Policy Analysis & Management (APPAM) Program Committee Review
2022	Panel Chair, Panel Discussant; APPAM Fall Research Conference
2016	Judge, Network of Schools of Public Policy, Affairs, and Administration Student Simulation Competition
2013	Co-Organizer, Interdisciplinary Ph.D. Workshop in Sustainable Development, New York
2012-2013	Vice President, Sustainable Development Doctoral Society, Columbia University
2011-2012	Treasurer, Sustainable Development Doctoral Society, Columbia University

Fellowships and Grants

2022-2025	External Consultant, “The Economic Disamenities and Health Impacts of Animal Feeding Operations’ Practices in the United States,” National Institute of Food and Agriculture, U.S. Department of Agriculture
2023	Fellow, Convergence Research Institute, “Tackling Climate-Induced Challenges with AI,” National Science Foundation, University of California, San Diego, San Diego Supercomputer Center
2011-2016	Faculty Fellowship, Columbia University
2015	Student Research Grant, Center for Development Economics and Policy
2015	Development Colloquium Research Grant, Columbia University
2014	Graduate Global Policy Research Fellowship, Global Policy Initiative, Columbia University

Honors and Awards

2006-2008	Lee Kuan Yew Graduate Scholarship for Public Policy, National University of Singapore
2007	Harwin Gold Award for Academic Studies, National University of Singapore
2002	Jacob Cooper Prize for Excellence in Philosophy & Logic, Rutgers University
2002	Phi Beta Kappa
1998-1999	Samuel Henry Bell Scholarship, Davidson College

Information Technology

R, QGIS, Stata, Google Earth Engine, ArcGIS Pro, Git, Databricks, LaTeX, Sen2-Agri, Python

Languages

Spanish (conversational)



Hannah Kornfeld, AICP

PROJECT MANAGER

YEARS OF EXPERIENCE 8

EDUCATION

Master of City and Regional Planning,
California Polytechnic State University,
San Luis Obispo

BA, Political Science, Environment,
University of Michigan, Ann Arbor

CERTIFICATIONS

American Institute of Certified Planners
(No. 31389)

PROFESSIONAL AFFILIATIONS

American Planning Association (APA)

Clean Energy Leadership Institute,
National Fellowship Coordinator (2022),
Bay Area Director (2021), Fellowship
Coordinator (2021), Fellow (2019)

Vermont Climate Catalyst Leadership
Program (2023)

California Planning Roundtable,
Planning Leadership Academy (2023)

APA Sacramento Valley Section, Young
Planners Group, Chair (2019), Vice Chair
(2016–2018)

SOFTWARE CAPABILITIES

Konveio, Consider.it, SurveyMonkey,
CalEEMod, Cal-Adapt

REPRESENTATIVE PROFESSIONAL PRESENTATIONS

"Community Engagement and
Consensus Building for Climate Action
Plans," Session Panelist, APA
Conference, Anaheim, October 2022.

"Rising to the Challenge of Carbon
Neutrality," Session Panelist, AEP
Conference, Yosemite, April 2022.

AWARDS

Distinguished CELI Alumni Award. 2022.
Clean Energy Leadership Institute.

Milpitas Climate Action Plan Update.
2022. Climate Change Document –
Merit. Association of Environmental
Professionals.

PUBLICATIONS

Hannah Kornfeld, Dan Krekelberg, and
Erik de Kok. 2019 (June 11).
"Decarbonized California: A Bold Vision."
AscentShare White Paper.

Hannah Kornfeld, AICP, is a climate action project manager with experience in developing and managing climate action and adaptation planning efforts. Hannah serves as the Climate Action and Adaptation Planning Practice Leader at Ascent. She has expertise in creating carbon neutrality plans and assisting local agencies with some of their most challenging climate change projects. Using her technical expertise in greenhouse gas quantification, she works to bridge the gap between technical analyses, ever-evolving climate regulation, and local policymaking through crafting first-of-their-kind mitigation strategies.

In 2023, Hannah was selected to participate in the Vermont Council on Rural Development's Climate Catalyst Leadership Program, where she focused on building templates for schools throughout Vermont to develop school-specific climate action plans. Hannah led the development of the first high school climate action plan for Hanover High School, an interstate high school that serves Vermont and New Hampshire. Additionally, Hannah serves as an advisor for the Vermont Energy Education Project (VEEP) Youth Climate Leaders Academy.

PROJECT EXPERIENCE

SAU 70 District-wide Climate Action Plan

SAU 70 School District

Project Director

Hannah is leading the development of a school district-wide climate action plan for the SAU 70 School District, serving Hanover, NH and Norwich, VT. The school district includes two elementary schools, one middle school, and one high school. This effort serves as an extension of the Hanover High School Climate Action Plan that Hannah led with support from students and staff. The district-wide climate action plan will include technical greenhouse gas analyses for each school and engagement with students from each school to develop ambitious yet achievable climate action plans to reduce the schools' emissions in alignment with state policy objectives.

Alameda County Community Climate Action Plan and Safety Element Update

County of Alameda

Project Manager

Ascent is assisting the County of Alameda to prepare an updated Community Climate Action Plan (CCAP) and Safety Element. The CCAP update considers lifecycle GHG accounting, a carbon neutrality target, a new pathway to reducing GHG emissions, equity and environmental justice, and the interplay between climate mitigation and adaptation. The Safety Element update addresses climate adaptation and resilience, flooding, wildfires, and evacuation routes. The project includes extensive and diverse community input throughout each phase of the work. Hannah is serving as the project manager and overseeing all technical aspects of the project.

Elk Grove Climate Action Plan Update

City of Elk Grove

Project Manager

Ascent is assisting the City of Elk Grove with an update to its 2019 CAP, which will be known as Climate Compass. The CAP will serve as a CEQA-qualified roadmap for reducing local GHG emissions across various sectors while building resilience to future impacts posed by climate

Hannah Kornfeld, AICP

change. New recommended measures will prioritize GHG reduction in transportation, integrating electric vehicle infrastructure, energy efficiency improvements, renewable energy generation, and energy storage system implementation. GHG reduction measures will also cover major sectors contributing to GHG emissions (i.e., building energy, on-road transportation, off-road transportation, waste, water, wastewater, agriculture, and City operations). The project features an inclusive and collaborative process that actively engages all Elk Grove residents, particularly those in hard-to-reach communities, by addressing common engagement barriers, tailoring communication tools, and working to rebuild trust to engage diverse perspectives. Hannah serves as the project manager and oversees all aspects of the project.

Milpitas Climate Action Plan Update, Santa Clara County

City of Milpitas

Project Manager/GHG Lead

Ascent supported the City of Milpitas in updating its Climate Action Plan to provide the City with a roadmap to achieve deep GHG reductions by 2030 and beyond, identifying measures that will enable the City to reduce emissions in line with the State of California's reduction goals and legislation. Hannah served as the project manager and GHG lead on developing on the CAP update.

Natural and Working Lands Climate Mitigation and Resiliency Study

Association of Monterey Bay Area Governments

Project Manager

Ascent is assisting AMBAG with the development of its Natural and Working Lands Climate Mitigation and Resiliency Study. The study includes estimating the carbon storage and sequestration potential of various land uses and developing strategies to enhance carbon storage through nature-based solutions. The study will create a carbon model that calculates the carbon stored in the natural and working lands of the Monterey Bay Area. Other integral parts of the project include conducting stakeholder engagement, as implementation of the strategies identified in the study will be carried out by many natural and working lands stakeholders to create a more resilient Monterey Bay Area. Hannah is serving as the project manager and oversees all aspects of the project.

Monterey County Community Climate Action and Adaptation Plan

County of Monterey

Project Manager

Ascent is assisting the County of Monterey with its effort to develop a CEQA-qualified Community Climate Action and Adaptation Plan (CCAAP) for 2030 and update its Municipal Climate Action Plan. The CCAAP will focus on developing strategies and programs to meet stringent GHG reduction targets through carbon-free electricity, building decarbonization, transportation decarbonization, zero waste, and carbon sequestration from working lands and urban forestry. Hannah is serving as the project manager and conducting extensive outreach to stakeholder groups to ensure effective climate solutions are incorporated in the CCAAP.

Bakersfield Climate Action Plan, Kern County

City of Bakersfield

Project Manager

Ascent is supporting the City of Bakersfield with the development of its first Climate Action Plan (CAP). The City is concurrently developing a General Plan, Housing Element update, and Sphere of Influence update, aligning all projects to complement each other and provide a comprehensive pathway for the City to accommodate anticipated growth in an economically, environmentally, and socially responsible way. The CAP will focus on GHG reduction and climate adaptation strategies that can be incorporated into other policy documents for the City. Hannah is serving as the project manager, overseeing all technical aspects of the CAP, and conducting community outreach to derive equitable climate solutions.

Tuolumne County Climate Action Plan

County of Tuolumne

Project Manager/GHG Lead

Ascent assisted Tuolumne County in developing its first Climate Action Plan to align with state GHG reduction targets for the year 2030. The CAP includes strategies for reducing GHG emissions from all sectors, as well as addresses the effects of climate change and develops strategies to promote adaptation and resilience due to increased wildfire risk, flooding, extreme heat, and other effects. Ascent also updated the County's baseline GHG inventory and prepared an assessment of climate change effects and primary exposure areas, as well as identified GHG reduction and adaptation strategies, and conducted public outreach and stakeholder engagement. Hannah served as the project manager and GHG lead on developing Tuolumne County's CAP.



Poonam Boparai

PRINCIPAL

YEARS OF EXPERIENCE

15

EDUCATION

MS, Environmental Engineering (focus: Air Quality Engineering and Science), University of Illinois, Urbana-Champaign

BE, Chemical Engineering, Birla Institute of Technology and Science, Pilani, India

TRAINING

Lakes Environmental AERMOD Air Dispersion Modeling Course

PROFESSIONAL AFFILIATIONS

Association of Environmental Professionals

Air and Waste Management Association

American Association for Aerosol Research

Poonam Boparai is an Ascent principal and the firm's Southern California Regional Director. She has over 15 years of experience in the public and private sectors conducting climate action planning and air quality and GHG analyses. She possesses a unique skill set that combines technical expertise with a keen understanding of planning and environmental policy. She leads climate action planning processes that are informed by robust technical analysis, and inclusive, meaningful engagement of agency and community stakeholders to develop effective and locally appropriate and effective climate mitigation and adaptation policies and plans. She has successfully applied her expertise in assisting agencies such as the County of San Diego, the County of Santa Barbara, Imperial County Transportation Commission, SANDAG, the San Diego Unified Port District, BAAQMD, and Sacramento Metropolitan Air Quality Management District (SMAQMD) with air quality and climate change policy development, analysis methodologies, GHG reduction strategies, and development of GHG thresholds of significance.

Poonam serves on the AEP Climate Change Committee, a group of leaders of climate action planning practices from consulting firms and agencies that have led many of the local GHG reduction planning efforts across California.

RELEVANT PROJECT EXPERIENCE

Climate Action Implementation Plan

City of San Diego

Principal-in-Charge

The City of San Diego Climate Action Implementation Plan charts how the City can accomplish the 190+ actions in the CAP and calculates the expected costs of climate action in San Diego. Ascent led the development of the Implementation Plan, which organizes the City's processes and government structure around those actions - centering equity, accountability, and transparency. The Implementation Plan rounds out the City's comprehensive approach to climate action, going beyond the traditional plan document and discrete implementing activities. The Implementation Plan includes cost estimates and Council-driven prioritization scores to inform all budgeting decisions. Additionally, it outlines responsibilities to be carried forward by departments and reported through annual work plans created by departmental liaisons required by an administrative regulation. Poonam served as the principal-in-charge of the effort.

Irvine Climate Action and Adaptation Plan, Orange County

City of Irvine

Principal-in-Charge

Ascent is working with the City of Irvine to develop its Climate Action and Adaptation Plan, which will seek to achieve the City's goals to reduce climate warming emissions and prepare the city for the impacts of climate change. Work includes establishing baseline and future GHG emissions from municipal operations and communitywide activities, assessing the City government's and the community's vulnerabilities to climate impacts, setting GHG reduction targets for the City and crafting measures to achieve those targets, identifying strategies to adapt to climate impacts, achieving CEQA compliance for the CAAP, and preparing an implementation plan. Ascent is also supporting the CAAP's community engagement strategy, which includes the preparation of a

Poonam Boparai

community engagement strategy and marketing and communications plan, formation of and coordination with internal and external stakeholder working groups, and public workshops, survey tools, marketing, and branding.

Bakersfield Climate Action Plan, Kern County

City of Bakersfield

Principal-in-Charge

Ascent is supporting the City of Bakersfield with the development of its first Climate Action Plan. The City is concurrently developing a General Plan, Housing Element update, and Sphere of Influence update, aligning all projects to complement each other and provide a comprehensive pathway for the City to accommodate anticipated growth in an economically, environmentally, and socially responsible way. The CAP focuses on GHG reduction and climate adaptation strategies that can be incorporated into other policy documents for the City. Ascent has helped the City will outreach to internal and external stakeholders.

SANDAG Climate Planning Services, San Diego County

San Diego Association of Governments

Project Manager

Ascent was retained by SANDAG to standardize and streamline climate action planning in the San Diego region, which is faced with the challenge of balancing sensitive environmental resources and ecosystems with the need for economic vitality. SANDAG, in its capacity as the regional planning agency, is uniquely positioned to transcend jurisdictional boundaries and engender a regional approach to this challenge. Ascent assisted SANDAG in developing a regional framework that leverages research and regional capacity to create a consensus-based mechanism for combating climate change and reducing GHG emissions. The regional framework is intended to guide local governments in developing consistent GHG emissions inventories and projections, streamline data collection, set consistent GHG reduction targets that align with state goals, quantify GHG reduction measures, and develop CAPs consistent with CEQA, as applicable. Ascent has also completed CAPs for the Cities of San Marcos, Escondido, Encinitas, Solana Beach, Vista, Lemon Grove, and El Cajon under this contract. Poonam served as the project manager for this program. She also worked with Vista, San Marcos, and Escondido to develop individual GHG screening thresholds for projects.

Imperial Valley Regional Climate Action Plan

Southern California Association of Governments

Principal-in-Charge

Ascent developed a Regional CAP for the Imperial Valley region with funding from SCAG and in coordination with the Imperial County Transportation Commission (ICTC). Unincorporated Imperial County and the Cities of Brawley, Calexico, Calipatria, El Centro, Holtville, Imperial, and Westmorland are SCAG member agencies. The region presents unique challenges and opportunities in climate planning with longer trip lengths, large-scale agricultural operations, proximity to the United States/Mexico border, underlying air quality issues, and a local utility (Imperial Irrigation District) that supplies water and electricity. Any plan for GHG reductions in the region needs to be developed while being sensitive to local economic conditions with the goal of setting the SCAG member agencies up for success. The Regional CAP includes a tailored profile and plan for each member agency that helps prioritize actions with multiple local co-benefits. Poonam served as principal-in-charge for this effort.

Monterey County Community Climate Action and Adaptation Plan

County of Monterey

Principal-in-Charge

Ascent is assisting the County of Monterey with its effort to develop a CEQA-qualified Community Climate Action and Adaptation Plan for 2030 and update its Municipal Climate Action Plan. The CCAAP will focus on developing strategies and programs to meet stringent GHG reduction targets through carbon-free electricity, building decarbonization, transportation decarbonization, zero waste, and carbon sequestration from working lands and urban forestry. The Ascent team has coordinated with several internal and external stakeholders to develop and ground-truth the County's GHG emissions inventory and a carbon sequestration analysis. The agricultural sector is particularly important to the region and Ascent's approach to the CCAAP is considering both the potential for emissions reductions as well as enhanced carbon sequestration potential of these uses. The analysis also considers the County's land use jurisdiction and potential for concentrated growth in urban centers to reduce vehicle miles traveled in the rural areas. The existing building stock also represents an area of opportunity for the County and is being evaluated for potential reductions.

Areen Sattar

Information Technology Product Manager

Selected Experience

Mathematica

Quality Assurance (QA) Lead, Medicaid and Children's Health Insurance Plan Learning Collaboratives Unwinding (2022-). Developed test cases for functional and regression testing. Created test data for the user acceptance testing environment. The Unwinding project supports states in recertifying Medicaid participants eligibility as the public health emergency ends.

Quality Control Processes Co-Lead, Quality Measures Management and Support for the Quality Payment Program (2020-). Led QA review of quality measure specifications and related documentation. Supported implementation of automated QA of specifications and supporting documentation. Mathematica coordinates measure updates between Centers for Medicare & Medicaid Services (CMS) program and policy staff, Measure Stewards, and other CMS program support contractors.

Systems Lead, Electronic Clinical Quality Measures (eCQM) (2020-). Develop and support annual automation programs used to track changes in the measures. Implemented Agile ceremonies to standardize the software development process and manage requests for additional features. Introduced unit testing to stabilize the programs and support automated regression testing. Updated the project's Confluence site to be the ultimate reference for all business and system requirements. Initiated weekly status calls to improve communication between programming and research teams. CMS engaged Mathematica and its partners to help develop, test, and maintain eCQMs.

Program Data Management Deputy Task Lead, Accountable Health Communities (AHC) Model Implementation (2020-). Managed and executed a data management plan that enables the collection, storage, and analysis of program data submitted by grant recipients to the Center for Medicare & Medicaid Innovation (the Innovation Center). The data is used to measure and improve AHC Model implementation, conduct learning system and technical assistance activities, and monitor and improve the project. Managed communications between model team and model participants on upcoming activities. Presented at a CMS-sponsored webinar on maximizing data quality in the model.

Information Technology (IT) Technical Assistance Task, Accountable Health Communities Model Implementation (2020-). Assisted IT technical assistance team in deploying a data validation solution and reporting templates to model participants for data collection and submission to the Innovation Center. The AHC Model Implementation, Learning System, Technical Assistance, and Monitoring contract supports the Innovation Center in connecting Medicare and Medicaid beneficiaries with social support services to improve their health status.

Systems Analyst, Comprehensive Care for Joint Replacements (CJR) (2019-). Led initiative to create a Confluence portal for the project. Created a central dashboard space for the team to track deliverables,

Education

1997 B.A., Computer Science,
Smith College

Positions

2018- Mathematica

2021- Information Technology
Product Manager

2020-2021 Business Analyst

2018-2020 Systems Analyst

2013-2017 Senior Developer, CU
Direct

2005-2012 Software Design and
Development Consultant

2001-2005 Manager, Web
Development, Affidia Systems

1999-2001 Technologist, Viant, Inc.

1999-2001 Webdiva, DigitalEve
Boston

1998-1999 Technical Consultant,
Compaq Computer Corporation

1997-1998 Software
Developer/Webmaster, Digital
Equipment Corporation

1996 Consultant/Intern, Boston
Catalyst Group

manage project documents, and understand the individual tasks. Integrated Jira to serve as a gateway to all project activity. Developed a crosswalk between the SAS programs and the existing technical specifications for the SAS Enterprise Business Intelligence task. Rewrote the technical specifications to make them current with the programs and created new ones where the documentation was missing. Updated the Python programs and implemented quality control standards for the reconciliation reports associated with bundled payments to hospitals and other care facilities. Generated monthly and quarterly production reports. Mathematica supports the Innovation Center in implementing the CJR episode-based bundled payment model.

Data Portals Deputy Systems Lead, Radiation Oncology Implementation and Monitoring Contract (2021-2022). Supported user access activities for the Radiation Oncology Administrative Portal (ROAP) and the Secure Data Portal (SDP). Developed guidance on how to access the portals and presented at a webinar on portal access sponsored by CMS. Developed interface control documents for importing data into the Salesforce data warehouse and exporting data to the SDP. Created electronic file transfers to import data into the SDP from Salesforce. Provided technical assistance on access-related questions that came to the help desk. The Radiation Oncology Model was the first payment reconciliation model to require participation from all oncology service providers.

Requirements and Testing Lead, Opportunity Life Cycle Management Project (2021-2022). Designed and led training sessions to teach users of the existing GovWin system how to write use cases. Gathered and tracked requirements for the transition to Agiloft. Tracked the development of test cases and hosted office hours to support writers. Mathematica transitioned from managing contracts and related data in GovWin to Agiloft.

Data Systems Lead, Delivery of Case Investigation, Contact Tracing, and Daily Monitoring Support for the State of Washington Department of Health (DOH) (2020-2022). Led a team of programmers in transitioning COVID test result data from clinicians to investigators. Managed weekly reporting of case investigation and contract tracing efforts to the DOH. Developed risk and quality management plans to support tasks. Designed a mechanism for automating workforce reduction strategies. Mathematica partnered with the DOH to improve the pipeline of test results being reported by clinicians and provided to investigators to help prevent the spread of COVID-19.

Trainer, Delivery of Case Investigation, Contact Tracing, and Daily Monitoring Support for the State of Washington Department of Health (2020-2021). Trained a multilingual workforce of 600 contact tracers and investigators. Washington State engaged Mathematica to help prevent the spread of COVID-19 by establishing resources for case investigation and contact tracing. The partnership between Mathematica and its partners augmented DOH's workforce, enabling it to reach a minimum of 350 COVID-19 cases and 700 contacts daily and respond quickly to surges in caseloads.

Systems Analyst, Behavioral Health Measure Development and Inpatient and Outpatient Measure Maintenance (BHIOMM) (2020). Created comprehensive technical documentation for the existing suite of BHIOMM programs. Established guidelines for program assumptions and input/output files. An iterative approach to the development of the documentation led to a refactoring of the suite of programs and introduced efficiencies in the design of the overall process. CMS contracted with Mathematica to develop, maintain, reevaluate, and support the implementation of quality outcome and process measures for the CMS Inpatient Psychiatric Facility, Inpatient, and Outpatient Quality Reporting Programs.

Systems Analyst, Bundled Payments for Care Improvements (BPCI) (2020). Created technical specifications for a new measure calculation. Based technical specifications on existing SAS programs and identified gaps between the documentation and the measure specification. Developed a maturity model for a Continuous Integration/Continuous Delivery process that provides a roadmap for the project to determine where they fit in the spectrum and indicates next steps to take for reaching the next level. Mathematica provided technical assistance to the Innovation Center on developing and implementing methods to determine bundled payment rates, reconcile payments to BPCI awardees, and analyze post-episode spending.

Systems Analyst, Clinical Quality Measure Reporting (CoreSet) (2018-2019). Managed delivery of the CoreSet Measure Specific Tables Reports based on state CMS data. Engaged the project leads to manage

functional changes to the reports. Established a QA process to thoroughly test each feature against the requirements before being included in the final report. Leveraged Agile ceremonies and led a process improvement task force on the CoreSet project. The Mathematica team provides technical assistance and application support to CMS and states on four core sets of health care quality measures: Child, Adult, Health Homes, and Maternal and Infant Health.

CU Direct; Ontario, CA

As **Senior Developer (2013-2017)**, re-envisioned a Windows Presentation Foundation (WPF)-based analytics tool into an Angular-based web application utilizing a web service to encapsulate data access. Deconstructed an SSIS Package and converted it into a web service. Extracted business logic from the package and implemented it as a C# application, reducing the time it took to run the package by two-thirds. Implemented an NServiceBus backbone to manage the process flow. Was instrumental in migrating an enterprise client management tool written in WPF to a fully secured web application built on MVC 4 and HTML5 using SQL Server. Developed User Stories, Epics, and Tasks to track project deliverables and progress. Participated in bimonthly sprints with full Scrum ceremonies. Led a team of developers that triaged software bugs across the company's product lines.

Viant, Inc.; Boston, MA

As **Technologist (1999-2001)**, used Visio to create logical and physical network diagrams of Viant's existing and future internal infrastructure. Migrated all of Viant's internal applications to a consolidated hardware environment based on MS IIS, SQL Server and ASP. Implemented a knowledge management system for internal applications and documented installation procedures for each migrated application. Assessed various chat software solutions and presented report to International Data Corporation's team on software's potential value to their customers. Identified business requirements for a site dedicated to analysts and translated them into functional specifications. Developed research documents, analyst information section, and an area for saved searches based on ATG Dynamo platform, using JSP and servlets. Created DTD and XML data samples using XML Spy to be used as data feeds to an Oracle database. Wrote and managed the table creation and data insertion SQL scripts used in the maintenance of each database environment. Created JSPs displaying user request history and user request detail information including pricing calculation. Used JUnit framework to develop Java classes to unit test each Java class used by application. Developed and executed browser compatibility tests designed to identify browser and OS-specific errors. Interfaced with client to determine functional requirements for a Javascript-based college cost calculator. The tool calculated a customer's anticipated savings from the rewards program and compared it to the estimated cost of college tuition based on the child's age.

Compaq Computer Corporation; Boston, MA

As **Technical Consultant (1998-1999)**, developed reports for an internal senior management reporting tool using ASP, Crystal Reports, and a SQL Server database. Implemented a third-party ActiveX grid control to replace existing HTML tables using Active Data Objects. Documented user interface and wrote test scripts for third-party software application. Presented a DIGITAL Business Bus product demonstration to a South African telecommunication company's senior Executives.

Digital Equipment Corporation; Boston, MA

As **Software Developer/Webmaster (1997-1998)**, provided user support and VBA code enhancements for the Demand Forecasting and Logistical Planning application in Digital's Worldwide Manufacturing and Distribution Division. Developed MS Access forecasting reports used by senior management during each biweekly planning cycle. Led the migration of the multi-user desktop application to an ASP-based intranet reporting tool. Managed worldwide SQL Server product database and identified product code discrepancies for each planning cycle.

Certifications and Training

2017	Certified Scrum Developer, C-Prime
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Information Technology

Angular, JavaScript, jQuery, C#, .Net, MVC, XML, HTML, CSS, WPF, REST, SOAP, Visual Studio .Net, SQL, MS SQL Server, Entity Framework, IIS, NServiceBus, GitFlow, Jira, Agile Methodologies, Scrum Ceremonies

Nathan Chesterman

Research Analyst

Selected Experience

Mathematica

Research Analyst, Youth and Agri-Food Systems Foresight Analysis (2023). Supported a Mastercard Foundation initiative, Foresight4Food, with mapping indicators and data sources to a model of agri-food systems and producing analyses to support entrepreneurs and policymakers in making informed investments to improve youth employment prospects. Led the team in obtaining over 100 indicators from more than 15 data sources, mapping indicators to the agri-food system model, and preparing data visualizations for a workshop with agri-food system entrepreneurs to encourage reflection and action-planning. Coordinated the development of a website to host data visualizations of indicators and accompanying narrative describing the implications on agri-food system dynamics.

Research Analyst, AGRA Monitoring, Evaluation, and Learning (MEL) Project (2023). Supported the development of a robust MEL plan for a complex multicountry portfolio of agricultural programs aimed at improving farmers' resilience. Identified data sources and developed methodologies to collect and analyze data to help program staff monitor implementation milestones and key program outcomes.

Research Analyst, Evaluation of the Kosovo Threshold Transparent and Accountable Governance (TAG) Project (2023-). Use qualitative analysis of key informant interviews and focus group discussions to conduct a contribution analysis of the Millennium Challenge Corporation-funded TAG program's impact along its theory of change. Use Facebook data to conduct a social network analysis among key civil society organizations in R. Access open data on air quality, population networks, and road density to build maps visualizing year-round and monthly pollution in Kosovo using QGIS.

Research Analyst and Task Lead, Evaluation of the Lusaka Water Supply, Sanitation, and Drainage Project (2021-2023). Led task to evaluate the impacts of Millennium Challenge Corporation-funded drainage infrastructure on mitigating flooding in Lusaka and improve solid waste management services. Oversaw collection of 1,000 household surveys. Used household-level flooding reports to produce GIS layers interpolating flooding probability across surveyed areas. Derived data from remote sensing layers, including elevation and slope (NASA Shuttle Radar Topography Mission Digital Elevation Model), water bodies (HydroATLAS), and precipitation (Climate Hazards Group InfraRed Precipitation with Station data) to control for external variables in investigating the impacts of drainage infrastructure on household flooding. Conducted pre-post analysis on residential flooding, flood-related impacts, and sanitation behaviors.

Research Analyst, Senegal Agriculture Decision Support Tool (2021-2022). Extracted 30 years of projected daily temperature and precipitation data at 8 sites in Senegal from geospatial climate projection data

Education

2018 M.S., Natural Resources and Environment, School for Environment and Sustainability, University of Michigan

2014 B.S., Evolutionary Anthropology and Behavioral Neuroscience, honors, College of Literature, Science and the Arts, University of Michigan

Positions

2021- Mathematica

2019-2021 Associate, Environmental Incentives

2019 Research Assistant, Forest Trends

2017-2019 International Forestry Resources and Institutions Network

2018-2019 Research Associate

2017-2018 Graduate Research Assistant

2017-2018 Student Monitoring and Evaluation Consultant, ADHENO—Integrated Rural Development Association

2016 Consultant, World Bank

2014-2015 Research Assistant, Ngogo Chimpanzee Project

sets (CMIP-6) to use as inputs to agricultural risk models. Project sought to create an interactive data dashboard on projected agricultural productivity and risks to enable policymakers to make more evidence-informed decisions.

Environmental Incentives; Washington, DC

As **Associate (2019-2021)**, provided technical service in evidence-based decision making, adaptive program management, and learning for the U.S. Agency for International Development (USAID) Measuring Impact II and USAID Economics of Natural Capital in East Africa projects. Co-facilitated workshops for project funders, implementers, and key stakeholders to collaboratively develop theories of change and MEL plans. Conducted two qualitative assessments of adaptive management in biodiversity programming, interviewed more than 30 key informants, and summarized insights from more than 70 key informant interviews. Managed research and reporting on an 1,100-household survey on livelihood resilience projects in Madagascar. Advised on research design; GIS data visualization; and monitoring, evaluation, and learning for the USAID Economics of Natural Capital in East Africa Project. Produced 15 webinars, 12 newsletters, and 2 flagship learning events for cross-project learning.

Forest Trends; Washington, DC

As **Research Assistant (2019)**, aggregated data to track progress on corporate commitments to reduce deforestation in supply chains. Contributed to metrics development and reporting for contracts.

International Forestry Resources and Institutions Network; Ann Arbor, MI

As **Research Associate (2018-2019)**, supervised a team of 10 GIS analysts for land-cover change analysis on 9,500 km² in Ethiopia and Tanzania. Wrote Python and R scripts to process household surveys and satellite imagery. Completed one month of fieldwork in Ethiopia to backstop data collection and implement a survey sampling plan. Prepared annual report for National Aeronautics and Space Administration grant funders.

As **Graduate Research Assistant (2017-2018)**, analyzed satellite imagery and managed data to assess land-cover change around industrial agricultural developments in Ethiopia and Tanzania.

ADHENO—Integrated Rural Development Association; Debre Berhan, Ethiopia

As **Student Monitoring and Evaluation Consultant (2017-2018)**, designed a mixed-methods framework to evaluate the impacts of rural farmer training and reforestation programs. Developed proposals to secure \$55,000 in funding for the study, and managed project budget. Coordinated an enumerator team to collect 500 household surveys and 121 ecological plots in 10 weeks of fieldwork. Analyzed household surveys, ecological data, and satellite imagery in R, ArcGIS, and Stata to prepare an evaluation report.

World Bank; Washington, DC

As **Consultant (2016)**, assisted in writing reports on health impacts of traditional cook stoves. Managed communication with 75 stakeholders for a consultation on monetizing co-benefits of efficient cook stoves. Provided logistical support for on-site and online health system management courses for 70-800 attendees

Ngogo Chimpanzee Project; Uganda

As **Research Assistant (2014-2015)**, tracked and collected data from a 200-member community of wild chimpanzees in a rainforest for 11 hours a day. Managed outreach at a rural primary school to build capacity and implement a garden-lunch program; coordinated \$14,000 crowdfunding campaign to build classrooms and girls' bathrooms.

Papers and Publications

Sandel, A.A., R.N. Derby, N.S. Chesterman, A. McNamara, M.M. Dudas, and I. Rawat. "Parallel Lasers and Digital Photography to Estimate Limb Size of Chimpanzees (*Pan troglodytes*) at Ngogo, Kibale National Park, Uganda." *Primates*, vol. 63, 2022, pp. 217-224. doi:10.1007/s10329-022-00982-6.

Williams, T.G., S.A. Trush, J.A. Sullivan, C. Liao, N. Chesterman, A. Agrawal, S.D. Guikema, and D.G. Brown. “Land-Use Changes Associated with Large-Scale Land Transactions in Ethiopia.” *Ecology and Society*, vol. 26, no. 4, 2021, pp. 34. doi:10.5751/ES-12825-260434.

Childebayeva, C., J.M. Goodrich, N. Chesterman, F. Leon-Velarde, M. Rivera-Chira, T.D. Brutsaert, A.W. Bingham, and D.C. Dolinoy. “Blood Lead Levels in Peruvian Adults Are Associated with Proximity to Mining and DNA Methylation.” *Environment International*, vol. 155, October 2021. doi:10.1016/j.envint.2021.106587.

Chesterman, Nathan, Tess Present, Lexine Hansen, Sara Grange, Caroline Cook, and Varsha Suresh. “Adaptive Management in the USAID Combating Wildlife Trafficking (CWT) Portfolio: Current Practice and Opportunities.” Washington, DC: Environmental Incentives, 2020.

Flower, Kathleen, Nathan Chesterman, Robynne Locke, Olivia Saucier, and Ronaldo Iachan. “USAID Madagascar Conservation and Communities (CCP) Project Baseline Household Survey Final Report.” Washington, DC: Environmental Incentives, 2020.

Chesterman, N., S. Angedakin, G. Mbabazi, J. Tibisimwa, A.A. Sandel. “Evidence and Ecology of Historic Human Settlements in Kibale National Park, Uganda.” *Human Ecology*, vol. 47, 2019, pp. 765-775. doi:10.1007/s10745-019-00103-w.

Chesterman, N., E. Entwistle, M. Chambers, H. Liu, A. Agrawal, and D.G. Brown. “The Effects of Trainings in Soil and Water Conservation on Farming Practices, Livelihoods, and Land-Use Intensity in the Ethiopian Highlands.” *Land Use Policy*, vol. 87, 2019. doi:10.1016/j.landusepol.2019.104051.

Chambers, Matthew, Nathan Chesterman, Julia Entwistle, and Hsiao-Chin Liu. “ADHENO Integrated Rural Development Association – Impact Assessment Report.” Capstone Report. Ann Arbor: University of Michigan, 2018.

Presentations

Chesterman, Nathan, and Esteban Quiñones. “Advancing Local Dairy Development in Nigeria (ALDDN) Evaluation - Midline Findings.” Presentation at the Association for Public Policy Analysis & Management conference, Washington, DC, 2022.

Honors and Awards

2017	Rackham Summer Fellow, University of Michigan
2017	Mertz Family Fellow, University of Michigan
2016	Academic Leadership Fellow, University of Michigan

Information Technology

R, Stata, ArcGIS, QGIS, Python, GitHub, ERDAS, Atlas.ti, NVivo, Microsoft Office, G Suite

Courtney Cappalli

Managing Consultant

Selected Experience

Mathematica

Analyst, Catalyzing State Medicaid Leadership on Climate Change Mitigation (2023). Helped conduct landscape scan, where 200+ resources were reviewed to inform state engagement and guide findings for future products. Facilitated outreach, focus groups and interviews, and synthesized findings for state engagement task, engaging six states that openly expressed willingness to act on climate change mitigation. Authored policy brief (“Catalyzing Change: How State Medicaid Agencies Can Lead Health Care to Reduce Harmful Greenhouse Gas Emissions”) which presented an overview of options that state Medicaid agencies can explore to reduce harmful greenhouse gas production in health care and motivate change within their agency to help safeguard the health of tens of millions of Medicaid beneficiaries. The purpose of this project was to motivate state Medicaid agency action on health care sector decarbonization.

Analyst, Climate Change Effects Options and Strategies (2022-2023). Led rapid landscape scan of literature and developed a list of climate adaptation and climate mitigation strategies and policies, as well as an accompanying decision matrix for the Washington State Health Care Authority (HCA). Co-wrote final report on policy approaches to preventing adverse effects of climate change on the health of Washington Medicaid clients. Under this project, Mathematica conducted work to support HCA and changes in the health care system to reduce harmful emissions.

Project Manager, Value-Based Care Learning System Contract (2022-). Provide support to the project director. Develop client reports and monthly internal reporting to senior management. Lead financial management, budgeting and re-budgeting, contract and subcontract modifications, and contract and subcontract invoicing. Develop tools to monitor financials and resources. Under this project, Mathematica helps to facilitate learning among participants in the Global Professional Direct Contracting and Kidney Care Choices models as well as among accountable care organizations participating in the Medicare Shared Savings Program. This includes (1) convening various virtual and in-person learning events, such as webinars, affinity groups, virtual learning collaboratives, and conferences, (2) providing targeted technical assistance (TA) to implement benefit enhancements and on data to support performance improvement, and (3) developing written products, such as toolkits, case studies, and journal articles, for public release. Mathematica gathers input from model participants through annual needs assessment surveys, focus groups, interviews, and post-event surveys to design curriculum plans that meet the needs of model participants and helps the Centers for Medicare & Medicaid Services (CMS) achieve the models’ aims of reducing costs while improving quality and beneficiary experience.

Project Manager, Accountable Health Communities (AHC) Model Implementation, Learning System, Technical Assistance, and Monitoring (2019-2022). Provided support to the project director and deputy project director. Led development of client reports and communication, monthly internal reporting to senior management, oversight of project finances, team management, and contract modifications. Ensured cross-task communication and collaboration. Helped conduct leadership meetings. Led oversight of subcontractor invoicing and coordination with Accounting Department to create monthly client invoices. The

Education

2022 PMP, Project Management Institute

2017 B.A. Environmental Science, The University of Iowa

Positions

2019- Mathematica

2023- Managing Consultant

2021-2023 Advisory Services Analyst

2019-2021 Health Associate

2016-2018 The University of Iowa

2017-2018 Research Assistant

2016-2017 Lab Assistant

2016-2017 Field Technician

2016 Student Panel Speaker

2015-2016 Intern, The Iowa Geological Survey

project involved providing implementation, learning system, TA, and monitoring support for the AHC Model, which seeks to identify the health-related social needs (including housing instability, food insecurity, interpersonal violence, and transportation) of community-dwelling Medicare and Medicaid beneficiaries and to address their identified needs by connecting them with community services. This project was conducted for CMS, U.S. Department of Health and Human Services.

The University of Iowa; Iowa City, IA

As **Research Assistant (2017-2018)** at IIHR-Hydrosience and Engineering, managed a team working under a university grant. Monitored team progress and updated supervisors. Designed a field schedule to help organize the analysis of hundreds of samples. Compiled and maintained a detailed log of field activities. Ensured timelines were met for uploading of results and creation of reports. Managed all data collection, data transfers, and field equipment.

As **Lab Assistant (2016-2017)**, managed the retrieval of samples from the Iowa Geological Survey and other national colleges and scientists. Organized hundreds of samples the lab received daily using Excel. Analyzed results published on a nationwide website and presented findings to supervisors. Assigned samples to assistants. Mentored and monitored new assistants in the multi-step process of soil particle analysis.

As **Field Technician (2016-2017)**, collaborated with peers and professors for a project requiring monthly visits to 11 sites to conduct water quality tests. Was a member of the team that used test results to determine how toxins were flowing into the Iowa River. Delivered results to the State Hygienic Laboratory of Iowa, which were published on a national website. Led the effort to present findings to peers and professors to help determine which areas were at a higher risk for exposure.

As **Student Panel Speaker (2016)**, presented to prospective life sciences students about the programs at The University of Iowa. Provided guidance to prospective students and helped address questions and concerns.

As **Intern (2015-2016)** with the Iowa Geological Survey, worked closely with geologists using ArcGIS to map the location of wells and their underlying rock structures. Cataloged information from hundreds of strip logs and uploaded the data to the Iowa Geological Survey website. Led the transformation of data into compatible files to use with applications including ArcGIS to create maps of the rock structures beneath Iowa.

Papers and Publications

Cappalli, Courtney, Christopher Chen, Corrie Haley, and Paul Shattuck. "Catalyzing Change: How State Medicaid Agencies Can Lead Health Care to Reduce Harmful Greenhouse Gas Emissions." Princeton, NJ: Mathematica, April 13, 2023.

Kim, J., N.E. Blair, A.S. Ward, and K. Goff. "Storm-Induced Dynamics of Particulate Organic Carbon in Clear Creek, Iowa: An Intensively Managed Landscape Critical Zone Observatory Story." *Frontiers in Water*, Oct. 28, 2020 (contributing author). doi:10.3389/frwa.2020.578261.

Dere, A.L., A.W. Miller, A.M. Hemje, S.K. Parcher, C.A. Cappalli, and E.A. Bettis III. "Solute Fluxes Through Restored Prairie and Intensively Managed Critical Zones in Nebraska and Iowa." *Frontiers in Earth Science*, vol. 7, no. 24, 2019. doi:10.3389/feart.2019.00024.

Honors and Awards

2016, 2017	Dean's List, The University of Iowa, three semesters
2013-2017	National Merit Scholarship, The University of Iowa

Information Technology

Microsoft Project, Microsoft Word, Excel, PowerPoint, Outlook, Adobe

Alex Bauer

Advisory Services Analyst

Selected Experience

Mathematica

Project Director and Task Lead, Environmental and Climate Justice in Human Services Agencies (2022-). Lead efforts to craft an offering for how the Mathematica Human Services Unit can support human services agencies in advancing work to support environmental justice and adapt to climate change. Lead efforts with the American Public Human Services Association (APHSA) to embed environmental justice into human services programming. Led development of and conducted two workshops with human services leaders at APHSA conferences, and led subsequent analysis to understand leaders' perspectives of climate change and environmental justice. In partnership with APHSA, lead efforts to develop a framework for how human services agencies can engage in practices that promote environmental justice.

Site Lead and Liaison, Family Self-Sufficiency Demonstration Development Grants Evaluation Support (2021-).

Lead and support work with three workforce programs to build their capacity to use data and evidence to make decisions and their ability to engage in research and analytic activities. Convened discussions to better understand the program interventions and interests in evaluation. Led efforts to help the programs define their program model and intervention by creating a logic model and identify core components. Teach each program about relevant types and aspects of evaluation based on their interests and needs and provide coaching support as they work through evaluation activities. This includes coaching one site through an implementation evaluation of three of its programs to understand how well its case management approach is implemented; supporting one site in designing, implementing, and testing a new career readiness assessment and helping to refine their data system to track relevant outcomes; and supporting the third site in taking a culturally responsive and equitable approach to defining its program model. The Office of Planning, Research, and Evaluation (OPRE) funds this work to build the capacity of programs to conduct evaluation and prepare programs for future testing.

Analyst, Evidence Capacity Support (2022-). Support development of learning agendas in response to the Evidence Act for OPRE's Division of Economic Independence (DEI) and the Office of Child Support Enforcement (OCSE). For DEI, review and synthesize key resources under various topics related to welfare and family self-sufficiency, such as human services delivery systems, capacity building within human services agencies, and the building of human capital to identify key findings and gaps within the topic area, which will be used to inform DEI's learning agenda and future priorities. For OCSE, lead development and facilitation of a series of workshops with federal and non-federal experts, as well as individuals with lived experience, to help identify topics to explore as part of their learning agenda. This work is funded by OPRE and helps various offices and divisions to create their learning agenda and develop the process for updating it.

Connecticut Department of Energy and Environmental Protection; Burlington, CT

As **State Land and Habitat Management Intern (2017-2018)**, performed a cost-benefit analysis of the state's Agricultural Agreement Program to evaluate the economic efficiency of the program and recommend

Education

2022 M.A., Organizational Leadership and Learning, George Washington University

2017 B.A., cum laude, Environmental Studies, Political Science, University of Connecticut

Positions

2018- Mathematica

2021- Advisory Services Analyst

2020-2021 Program Analyst

2018-2020 Program Associate

2017-2018 State Land and Habitat Management Intern, Connecticut Department of Energy and Environmental Protection

2016-2018 Research Assistant, University of Connecticut

2016 Environmental Analyst, Intern, Connecticut Office of Policy Management

potential improvements. Collaborated with states in New England, via phone and email, to compare programs within the region.

University of Connecticut; Storrs, CT

As **Research Assistant (2016-2018)** in the Geography Department, performed qualitative and quantitative data collection, entry, and analysis on international climate change policies. Worked with team to construct database for analysis of potential geographic links among adaptation strategies.

Connecticut Office of Policy Management; Hartford, CT

As **Environmental Analyst, Intern (2016)**, researched statewide development projects to ensure compliance with the National Environmental Policy Act, the Connecticut Environmental Policy Act, the State Conservation and Development Plan, and municipal environmental standards and regulations. Revised the Drought Plan and Transit Oriented Development Policy to improve language clarity and strength. Managed project collecting data on municipal transit initiatives, performed spatial analysis (ArcGIS 10.4), and developed municipal profiles to assist in future state-funded transportation grant allocations.

Papers and Publications

Selekman, Rebekah, Alex Bauer, Shannon Weaver, Pamela Holcomb, and Heather Zaveri. "Child Support Learning Agenda: A Brief Synthesis of Select Child Support Literature." OPRE brief 2023-213. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2023.

Weaver, Shannon, Rebekah Selekman, Alex Bauer, Pamela Holcomb, and Heather Zaveri. "Child Support Learning Agenda: Describing Workshops to Inform Development of a Child Support Learning Agenda." OPRE brief 2023-228. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2023.

Baumgartner, S., C. Ross, E. Sama-Miller, N. Fung, K. Conroy, D. Aharpour, A. Bauer, and A. Carrillo-Perez. "Strengthening Two-Generation Initiatives that Support Child Development and Improve Family Economic Security: Insights from the Next Steps for Rigorous Research on Two-Generation Approaches Project." OPRE Report #2023-207. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2023.

Bauer, Alex, Nickie Fung, and Scott Baumgartner. "Using Rapid-Cycle Learning to Build Momentum for Change in Two-Generation Service Delivery." OPRE Report #2023-196. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2023.

Green, Chloe, Collen Psomas, Matt Stagner, and Alex Bauer. "Human Services' Unique Position: Flexing New Ways to Pursue Environmental Justice." *APHSA Policy & Practice*, May 2023.

Bauer, A., S. Baumgartner, P. Holcomb, and D. Friend. "Adopting a Motivation-Driven Approach to Case Management in HMRE Services." OPRE Report #2023-074, Washington, DC: Office of Planning, Research and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2023.

Friend, Daniel, Avery Hennigar, Rebecca Dunn, Armando Yañez, Annie Buonasina, Mark Ezzo, Camila Fernandez, Hannah McInerney, Alex Bauer, Scott Baumgartner, and Robert G. Wood. "Conducting Rapid-Cycle Learning with Healthy Marriage and Relationship Education Programs for Adults: Findings from the Strengthening the Implementation of Marriage Programs (SIMR) Project." OPRE Report #2023-042. Washington, DC: Office of Planning, Research, and Evaluation, Administration for Children and Families, U.S. Department of Health and Human Services, 2023.

Green, Chloe, Alex Bauer, Colleen Psomas, Shaun Stevenson, Anu Rangarajan, Matthew Stagner, and Jacque Gombach. "We Can't Be on the Sidelines: The Role of Human Services in Advancing Environmental Justice." *APHSA Policy & Practice*, August 2022.

Holdbrook, Jeanette, N'gadi Osman, Alex Bauer, Mark Ezzo, AnnaMaria McCutcheon, Katie Bodenlos, Samantha Zelenack, Kelley Borradaile, and Annalisa Matri. "Employment Advancement and Retention Network (EARN) Redesign Staff Manual." Manual prepared for Philadelphia Works, Inc. Princeton, NJ: Mathematica, September 2021.

Kalisher, Allon, Michelle Derr, Nathan Mix, and Alex Bauer. "Building Evidence Using Learn, Innovate, Improve (LI²) Training." Report submitted to Casey Family Programs. Princeton, NJ: Mathematica, December 2020.

McCutcheon, AnnaMaria, and Alex Bauer. "Program Representative Manual: How to Improve Philadelphia's Workforce System Through Coaching and Technical Assistance." Report submitted to Philadelphia Works. Princeton, NJ: Mathematica, November 2020.

Bauer, Alex, Jonathan McCay, and Michelle Derr. "Goal4 It!: A Quick Guide for Direct Service Staff." Washington, DC: Mathematica, July 2019.

McCay, Jonathan, Michelle Derr, and Alex Bauer. "Goal4 It!: A Quick Guide for Program Leaders, Managers, and Supervisors." Washington, DC: Mathematica, July 2019.

Stephenson, Scott R., Neil Oculi, Alex Bauer, and Stephanie Carhuayano. "Convergence and Divergence of UNFCCC Nationally Determined Contributions." *Annals of the American Association of Geographers*, vol. 109, no. 4, 2019, pp. 1240-1261. doi:10.1080/24694452.2018.1536533.

Presentations and Workshops

Green, Chloe, Alex Bauer, Matthew Stagner, and Jacque Gombach. "Reimagining Human Services in Light of Environmental and Climate Injustice: How We Can Build More Resilient and Equitable Communities." Workshop at the APHSA National Health and Human Services Summit, Baltimore, MD, May 2023.

Green, Chloe, Alex Bauer, Shaun Stevenson, Matthew Stagner, and Jacque Gombach. "Environmental Justice and SNAP Design Lab." Workshop at the APHSA Economic Mobility and Well-Being Annual Conference, Savannah, GA, August 2022.

Green, Chloe, Alex Bauer, Shaun Stevenson, Anu Rangarajan, Matthew Stagner, and Jacque Gombach. "The Role of Human Services in Fighting for Environmental Justice." Workshop at the APHSA National Health and Human Services Summit, Arlington, VA, June 2022.

Bauer, Alex, Candace Cadena, Janet Wolfson, and Katie Grobe. "Findings from the Frontlines: Scaling Goal4 It! in Colorado Works." Presentation at the National Association for Welfare Research and Statistics Workshop, New Orleans, July 29, 2019.

McCutcheon, AnnaMaria, Alex Bauer, Patricia Blumenauer, and Tyrone Hampton. "Improving Participant Engagement Using a Human-Centered Approach to Service Redesign." Presentation at the Helping Families to Overcome National TANF State Director's Summit, Arlington, VA, September 2019.

Kai Elwood-Dieu

Software Engineer

Experience

Mathematica

Full-Stack Software Engineer, North Carolina Transitions to Community Living Dashboard (2023-). Built sizable full-stack features in the custom web application. Solved bugs and added features requested by end users.

Software Engineer Intern (2022). Developed and implemented end-to-end smoke tests with Cypress and Percy. Delivered features in Typescript and Angular for data dashboard application to state of North Carolina. Built data graphics with D3.

Politico; Arlington, VA

As **Interactive News Intern (2022)**, pitched, designed, coded, and delivered a story on the 2022 midterm election. Coded components for election-night live results page in React using SCSS, Storybook, and Next.js. Built and designed interactive charts and graphics with D3.

Participated in the following project:

Midterms Educational Divide (2022). Developed concept, designed wireframe using Figma., and coded with React and Next.js. Worked with reporters to develop main idea and ensure that writing was consistent with story idea. Built all data visualizations using React and React-scroll.

Center for Strategic and International Studies (CSIS); Washington, DC

As **Data Visualization and Web Development Assistant (2021-2022)**, developed data graphics with Svelte, D3, Datawrapper, and Highcharts. Analyzed and cleaned data in Python and JavaScript. Contributed to rollout of new CSIS program websites using JavaScript, PHP, SASS, and HTML.

Participated in the following project:

Nuclear Network Website (2021). Worked with team to develop and deliver a new website for the CSIS Project on Nuclear Issues. Technologies utilized: JavaScript, PHP, HTML, SCSS, WordPress (backend)

U.S. Embassy Beijing; Remote

As **Intern (2019-2020)**, translated and synthesized Chinese news sources and reports into English, contributed to diplomatic cables on Mid-Autumn Festival and Golden Week holidays, and conducted economic research on Chinese tourism trends.

Information Technology

JavaScript, Typescript, React, Angular, Svelte, Next.js, Material UI, Storybook, HTML, Python, Java, D3.js, NodeJS, Socket.IO, NumPy, Pandas, Seaborn, Matplotlib, RiTa.js, p5.js, Liquid, SCSS, CSS, Bootstrap 4, Apple Logic Pro X, Percy, Cypress, Figma, Datawrapper, Highcharts, PHP, SASS, HTML, WordPress

Certifications

2018 Hanyu Shuiping Kaoshi (Chinese Proficiency Test) level 4, 5, and 6 certifications

Education

2023 B.S., Interactive Media and Business, New York University, Shanghai

Positions

2022- Mathematica

2023- Software Engineer

2022 Software Engineer Intern

2022 Interactive News Intern, Politico

2021-2022 Data Visualization and Web Development Assistant, Center for Strategic and International Studies

2019-2020 Intern, U.S. Embassy Beijing

Honors and Awards

2022 Pearce Prize Achievement Award, Center for Strategic and International Studies

Languages

Mandarin Chinese (highly proficient), Spanish (proficient)

Evan Christo

Research Associate

Selected Experience

Mathematica; Cambridge, MA

As **Research Associate (2022-)**, provided technical and project management assistance on water and sanitation, climate, energy, and agriculture projects. Co-developed an interactive cost-benefit analysis tool in Excel to inform the U.S. Agency for International Development (USAID) investments in water collection technologies in rural Uganda. Cleaned, sampled, and analyzed farmers' data in Stata to evaluate the impact of an agricultural extension program in Kenya, Mozambique, and Nigeria. Co-wrote the methodology section of the final report and created statistical graphics in Stata. Organized interviews, created interview guides, and researched the need for downscaled climate data platforms to support locally led adaptation. Supported business development efforts in the energy sector.

San Mateo Community College; San Mateo, CA

As **AmeriCorps Energy Systems Analyst Fellow (2021-2022)**, served as an internal sustainability consultant for the San Mateo Community College District. Developed utility consumption and cost visualizations in Microsoft Excel for internal quarterly sustainability reports. Researched vehicle fleet electrification initiatives, analyzed existing campus vehicle fleet in Excel, and proposed electrification opportunities with cost analyses to Facilities & Operations directors and managers. Supervised student intern. Inventoried district energy meters to allow for the evaluation of future energy incentive opportunities. Assisted and reviewed the external development of a carbon emissions model and climate action plan for the District.

Seaside Sustainability; Gloucester, MA

As **Green Scholars and Sustainability Consulting Intern (2022)**, developed and facilitated curricula to inspire and enable students to create sustainable change in their communities. Provided research assistance and support to the primary sustainability consultant.

Aliados Foundation; Tena, Ecuador

As **Sustainable Agriculture and Forest Conservation Intern (2020)**, supported the organization and execution of reforestation projects with local communities, conducted sapling counts and maintenance, and assisted with community distribution and planting. Created reforestation maps on Google Earth and Explorer. Land using global positioning system data for grant submissions, designed internal monitoring and evaluation survey, and managed and presented the data in Google Sheets.

Information Technology

Excel, Stata, R, Google Earth Engine, MATLAB

Languages

English (fluent), Spanish (intermediate)

Education

2021 B.A., Engineering Modified with Environmental Sciences, magna cum laude, Dartmouth College

2021 B.E., Environmental Engineering, Dartmouth College

Positions

2022- Mathematica

2021-2022 AmeriCorps Energy Systems Analyst Fellow, San Mateo Community College

2022 Green Scholars and Sustainability Consulting Intern, Seaside Sustainability

2020 Sustainable Agriculture and Forest Conversation Intern, Aliados Foundation

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