From Climate Data to Climate Action: Experiences from Boulder, Colorado, USA

ICLEI Local Governments for Sustainability

With grant support from Google.org

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The City of Boulder is taking bold, innovative, and collaborative actions to create systemic change that equitably addresses the global climate crisis and ensures the quality of life in Boulder and beyond. Data analysis, collection, and monitoring provide a basis for Boulder's Climate Mobilization Action Plan. Boulder is an example of how cities can use data to ensure precise, supervised, and effective climate action.

Introduction

Local governments are increasingly developing policies and programs designed to adapt, mitigate, and become resilient to climate change. Growing commitments, scientific evidence, and the climate emergency generate new dimensions for monitoring and evaluating climate action, and more specifically, the use of that data in local decision-making. Thus, there are new sources and uses for data support in locally based climate action.

This case study examines key innovations on how the City of Boulder (see Figure 1) manages and uses robust data to strategize, monitor, and evaluate the city's climate commitments. Additionally, the case study presents examples of key data-driven decisions, such as Boulder's Climate Action Plan

Figure 1- Map of Boulder, Created in QGIS, ICLEI©

Facts & Figures

Population (2020)
108,091

Area
66.5 km^2

GHG Emissions (2019)
1.46 Mt CO_2e

Average temperatures
3.3° - 18.6 (°C)

Average precipitation
525 mm (per year)

Figure 2 - Boulder's Climate Mobilization Action Plan (CMAP), The City of Boulder©

Tax, the city's Climate Mobilization Action Plan (CMAP) (Figure 2) and involvement in the Urban Drawdown Initiative. These decisions are based on reliable data that lead to evidence-based project planning and climate actions prioritization besides tracking and monitoring those actions impacts and success. The city recognizes that climate action is not just about tracking data but setting ambitious targets and concrete actions to achieve those goals ensuring transparency and community engagement.

Data management for climate action

To track climate action, the City of Boulder manages a data repository which helps to monitor progress towards key performance indicators (KPIs). The city's climate-related efforts are publicly available and monitored through the *"BoulderMeasures"* dashboard, which displays data from city programs and community indicators, to help the local government define and align goals and priorities [1]. *BoulderMeasures* manages community-wide data from GHG emissions by source and sector, and GHG emissions from city operations and facilities, local renewable energy generation, and waste diversion. Additionally, Boulder's open data catalog contains reported data on building performance, community energy use and consumption of city managed electric vehicle (EVs) charging stations, mobility, and more [2]. This data helps the city to not only set, update and refine climate targets, but to monitor the progress and impact of the community's climate action efforts. Another community engagement strategy is the Climate Mobilization Action Plan (CMAP), a community-based process that focuses on five major climate action areas: energy, ecosystems, circular economy, land use, and financial systems. With this initiative, Boulder is working to design a community centered process to address the climate emergency. In all action areas the community provides feedback and ideas, so their contributions can be integrated into short- and long-term sustainability development and climate targets.

Boulder's Climate Initiatives Department manages the datasets and conducts quality control, assuring the data is useful to track progress according to the city's established climate commitments. It also maintains an inventory of all its datasets, detailing the sources, dataset name, description of data and technical details besides point of contact for each dataset. To ensure reliability, all the data collection and storage systems are programmed to flag errors, automatically compare to previous datasets, and report anomalies for further verification. The city's climate data is collected and stored

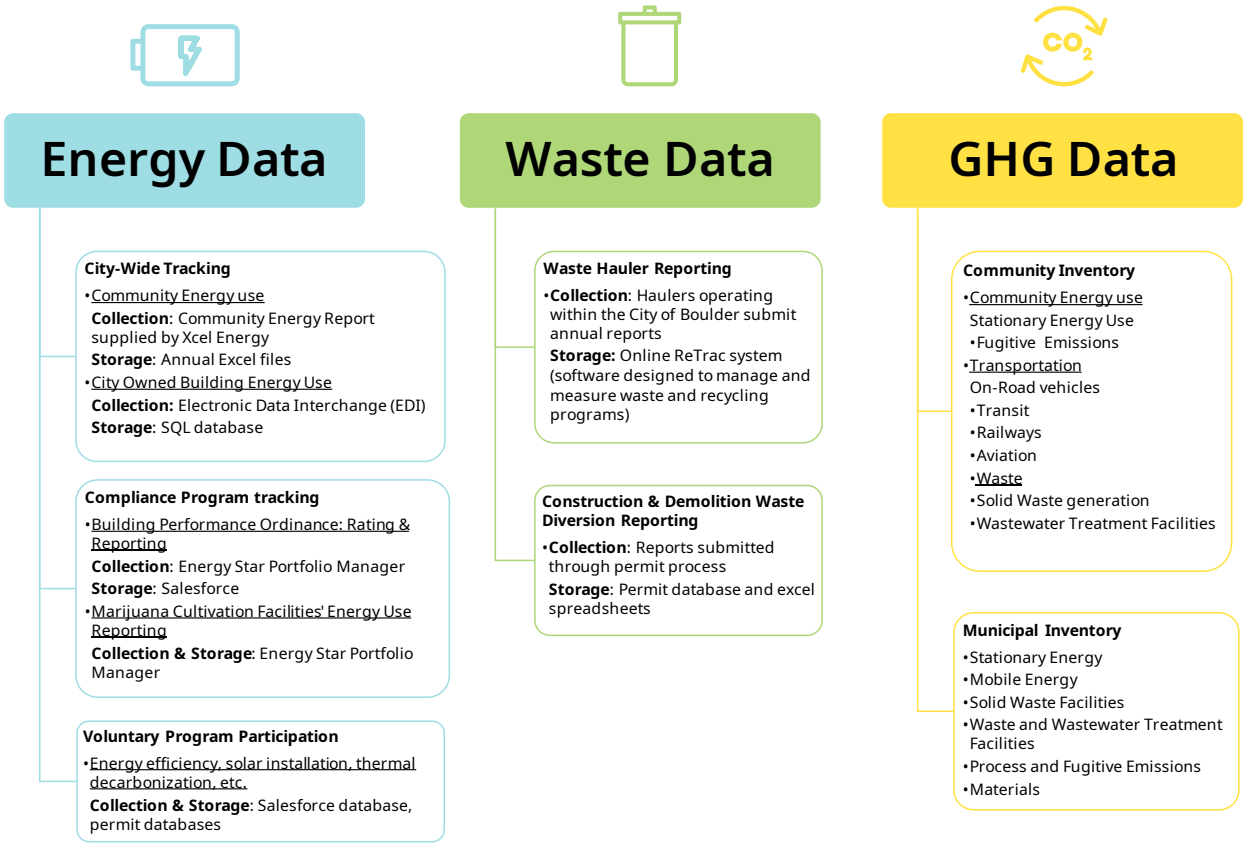

Figure 3 - Boulder's Climate data flow, The City of Boulder©

in various systems as shown in figure 3. The overall data reported and stored allows Boulder to conduct annual GHG emissions inventories based on the Global Protocol for Community-Scale GHG Emissions Inventory (GPC)[1]. Since 2015, the city accounted and reported their GHG emissions for the year 2012 and from 2015 to 2019 (a total of 7 inventories) comparing to the baseline inventory from 2005 [6]. For managing the inventory and reporting emissions data to third-party entities, the city uses the online ICLEI ClearPath calculation tool. ClearPath is an online software platform aligned with the GPC reporting requirements for completing city and local governments greenhouse gas inventories [8].

Climate data interpretation, monitoring and decision making

Boulder uses data to design and form locally based climate actions, data driven policies, and programs. As an example of a data driven decision/action, the city tracks carbon intensity to understand how this affects climate change and ultimately to set science-based targets. In 2005 (the baseline year of Boulder's GHG inventory), electricity made up 55 percent of Boulder's community emissions which led to prioritizing energy supply and consumption in the city's climate action framework [9]. This included promoting renewable energy, working with homes and businesses to become energy efficient, and ultimately leading a community-based decision to work towards municipalization of Boulder's electricity supply. The decision to explore the creation of a locally owned electric utility was driven by a thorough analysis of technical, legal, and financial data, ultimately leading the community to pursue the creation of its own utility for both climate and economic objectives.

1 The GPC provides a framework to develop a comprehensive and robust GHG emissions inventory in order to support climate action planning [7]

The City of Boulder identified electricity as a key source of emissions standing at over 1 million Mt CO_2e in 2005 but after accomplishing a 36% reduction in electricity emissions in 2019, the city recognized that emissions associated to heating and transportation became a larger share. Therefore, as Boulder drives towards a 100% renewable electricity supply, they also decided to focus on converting heating and vehicle systems to electricity and eliminate other fossil fuels from their energy and transportation systems.

Another example for data interpretation and emissions monitoring is a spreadsheet-based model called the *"Climate Commitment Tool"*. The tool allows the analysis of different scenarios and the calculation of community-based emissions under varying scenarios. The outputs of the Climate Commitment tool help Boulder decide how to adjust and set science-based targets for ongoing climate action policies and programs. Examples derived from the tool include using it to set targets for VMT (vehicle miles traveled) reduction, electric vehicle adoption, building electrification, and more. When using the Climate Commitment tool, Boulder can see if the pace of implementation and impact on VMT reduction is aligned with the target and alter the model to determine how many more EVs, homes, and businesses would need to be electrified to make up for the emissions if, for example, VMT did not reduce to the levels predicted. Moreover, Boulder's monitoring of VMT data has helped to shape and improve Google's Environmental Insights Explorer (EIE) tool [10]. The EIE tool expands the possibilities to enhance existing data sources, make the data collection process more efficient, and recognize data trends over time [11]. To further integrate data in decision making, Boulder has also developed a decision-making matrix which helps the local government to decide how to invest funds in future programs and climate related work. This matrix includes a scoring of items like GHG emission reduction potential, scalability/ replicability, equity benefits, resilience benefits, community visibility, contribution to economic activity, impact on community health, and partnership development. All these elements are weighted and scored for each project proposal which helps Boulder to consider both qualitative and quantitative impacts when deciding how to allocate a limited budget. Furthermore, the city recognizes that the systemic issues they face are intersectional – meaning that solutions that will clean Boulder's air, improve health, and aim

Figure 4 – The City of Boulder, Unsplash©

for environmental equity will simultaneously drive down GHG emissions. Therefore, the city's current focus is to measure equity and resilience as indicators for the success of the CMAP. As a result, GHG emissions reduction is more of an outcome to addressing social equity in Boulder's community than an exclusive driving force of climate action.

> *"As a result of Climate Action Plan funded programs, many of which exist today, Boulder has reduced community emissions by 21% as of 2019 compared to a 2005 baseline despite a growth in population, jobs and economic activity during that period. None of this would have been possible without the action and buy-in of our biggest stakeholder – our residents."*
>
> – Lauren Tremblay, Sustainability Analyst at City of Boulder

Investment opportunities based on climate data

Boulder is using emissions data alongside multiple other criteria to prioritize investments in commercial advising, rebates, and regulatory programs. To optimize energy upgrades, efficiency, and electrification of homes , the city is working with Radiant Labs, which supplies a software tool to model and analyze energy policies, providing insights into which homes and buildings have a high propensity to upgrade their buildings so that Boulder can target candidates for fuel switching, energy upgrades, and renewable energy opportunities [12]. Additionally, Boulder works with 350.org, a movement that promotes renewable energy, to learn how to best use data for future financial strategies and decisions such as, where to invest, who supplies financial services, what types of products and services are bought [13].

One of Boulder's most important buy-in stakeholders when it comes to climate action is its own community. The *"Climate Action Plan Tax"*, is the country's first voter-approved carbon tax. The decision to promote this initiative was made by conducting a funding analysis that included resource inventory cataloging, city taxes, fees, and bonds, as well as applicable grants and programs that could potentially supply funds for GHG mitigation. The inventory highlights existing revenue sources or fund balances that could potentially be directed to the GHG Program. Xcel Energy, the investor-owned utility serving Boulder, agreed to collect the tax on Boulder's behalf on the condition that it was passed by the voters. On November 7, 2006, the voters approved the initiative, marking it the first time in the nation that a municipal government imposed an energy tax on its residents to directly combat climate change [14].

Another example where data inspired economic benefits corresponds to solar adoption from residents and companies alike. The city conducts various analyses on the solar installed capacity on its facilities to evaluate the potential demand savings which bring an economic incentive beyond emissions savings. Partnering with the National Renewable Energy Laboratory (which research and develop renewable energy technologies) and private-sector partner Mapdwell (which supply tools to discover solar potential), Boulder evaluated the actual solar potential on the city rooftops using Light Detection and Ranging[2] data to map rooftop space by slope orientation, and architectural and tree shading [15][16]. The Mapdwell product was a precursor to similar tools now offered by Google, displaying a real-time interactive map allowing community members to be informed about the possibilities of household and community power generation and how they can take the next step towards a solar energy transition [16].

Boulder was recognized by the Colorado Energy Association as having one of the highest rates of installed solar capacity per capita in the USA in 2014.

2 LiDAR - a method for measuring distances by illuminating the target with laser light and measuring the reflection with a sensor.

Data translated into climate action projects and programs

Based on the recent climate science and the evidence of what needs to occur at the global scale within the next 10 years, Boulder took note of the need to not only reduce carbon but also to capture and sequester it. By developing a strategy to see carbon as a resource to be captured rather than see it simply as a problem to be eradicated – Boulder has worked to remove more carbon from the atmosphere. This means putting carbon back into vegetation, back into soils, and back into oceans. These efforts have led to Boulder and partner cities to launch the Urban Drawdown Initiative to help cities draw down carbon across the globe, pulling it out of the air and putting it back into natural systems. By flipping the conventional view of the climate problem on its head and treating carbon as a resource rather than a problem, Boulder is pushing to create a more comprehensive approach to address climate change and become more resilient recognizing the local benefits that effective ecosystem management brings to the community through having more trees, better land use decisions and plans and improved health, among others. Data plays a key role throughout this process, helping cities understand how their carbon sinks have changed over time due to changes in land use, the potential for carbon sequestration, and ultimately how ecosystem services support communities. To implement this program, Boulder is using geospatial information and data[3] to calculate the carbon sequestration potential of Boulder's trees and regional forests. With the United States Geological Survey (USGS) and Earth Resources Observation and Science (EROS), and the National Land Cover Database (NLCD) combined with iTree Canopy and Google Earth Pro, Boulder can see the loss or gains of nature-based sequestration over time. Figure 5 shows Boulder's tree inventory data that can be accessed through the open data catalog. The main goal is to set a baseline for understating sequestration sinks in Boulder and how they have changed over time due to land use and natural impacts such a fire and pests. Boulder then plans to use satellite data for carbon management planning and map out future tree planting scenarios and land-use decisions. The city is currently working with ICLEI to incorporate carbon sequestration of forests and trees into

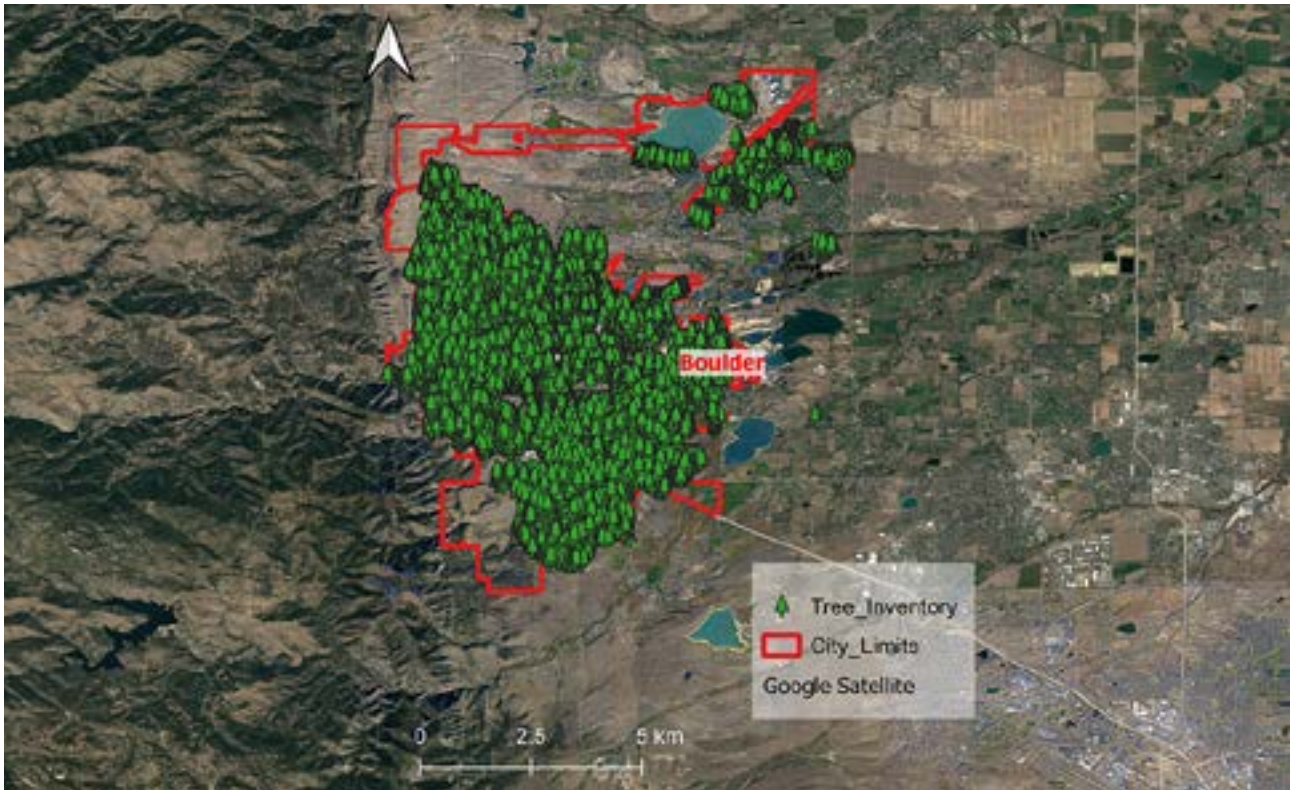

Figure 5 - Map of Boulder's Tree Inventory, Created in QGIS, ICLEI©

3 Data and information having an implicit or explicit association with a location relative to Earth (a geographic location or geographic position).

their GHG inventory to understand the history of carbon sinks in their community. Boulder is also collaborating with a group of local governments through Urban Sustainability Directors Network (USDN) to develop a carbon management tool that will allow cities to manipulate scenarios of various planting and land use activities, with the tool projecting which projects could yield the greatest sequestration of carbon from the atmosphere. Furthermore, Boulder expects to use multiple geographic information systems (GIS) and additional data, to model the ecosystem benefits (such as urban heat island reduction, stormwater management, reduced building cooling load, etc.) associated with these carbon management practices.

Lessons Learned

Climate data is critically important to the City of Boulder's climate commitment strategy. The main insights from this case study are:

- Boulder's key strategy on transforming data into climate action is engaging the community by keeping them informed of their local actions, programs, trends, and the progress on the achievement of climate goals. Publicly available and accessible data is critical for community involvement, engagement, transparency, and feedback to prioritizing climate action targets and programs.
- While greenhouse gas emissions have been and will continue to be an important measure in addressing climate change, they are not the only measure. It is important for cities to incorporate indicators that evaluate progress in realms of equity, resilience, and economic vitality. And because solutions should be intersectional, programs that reduce emissions also have net benefits of improving air quality, community health, etc. Therefore, we need to ensure we measure success in a way that draws out those local benefits while provoking largescale system wide change.
- Data can be used to generate buy-in from relevant stakeholders and identify economic opportunities. In Boulder the data interpretation led the local community to approve a tax that will support funding to implement their climate action commitment.
- It is important to establish institutional arrangements to properly manage and analyze climate data in the local government. A municipal department that is specialized and/or designated to work, maintain and perform quality control and assessment on data, enables an organized data infrastructure and the availability of precise and relevant data for aggregation and further analysis.
- An organized data infrastructure enables data driven decision making by the relevant authorities which adds other related co-benefits such as performing accurate analyses, storing historical data, collecting and monitoring data for climate action including definition of indicators and targets beside supporting successful implementation and formulation of key programs and projects.
- Guaranteed funding for data management and analysis is required to assure new and historical data is available for aggregation and trends in order to track progress and plan for future actions.
- Seeking new collaborations with private and public companies for data collection and interpretation can lead to efficient measurement, reporting and verification of climate action targets.

These insights are important so local governments can understand how data presents possibilities to achieve the climate commitments on adaptation, mitigation, and resilience to addressing climate change.

Figure 6 - The City of Boulder, Unsplash©

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