Understanding challenges in municipal greenhouse gas emission inventories

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***Abstract*—A necessary prerequisite for impactful climate mitigation action is the availability of suitable and reliable baselines of emissions. This is especially true for urban and city-level actions and strategies that need reliable local data about emissions to prioritize actions and investments to achieve the highest possible impact. We describe the work of the Carbon Track and Trace project (CTT) done in collaboration with the municipality of Trondheim, Norway, to better understand the current gaps in emission reporting and monitoring based on GPC and discuss initial steps to address them.**

Keywords—climate action; emissions; GHG emission inventory; GPC; municipal climate mitigation actions

I. INTRODUCTION

Dealing with anthropogenic climate change is one of the main challenges for research and governance, which is why mitigation actions at different scales are being proposed and implemented. With growing urbanization, cities are responsible for more than 70% of global energy-related emissions of greenhouse gases [5] and thus need to take action.

Consequently, local municipal decision makers are not only looking for tailored emission reduction and mitigation strategies, but also need accurate ways to measure the impact of their cities' or regions' mitigation actions. This not only serves accounting and reporting purposes, but also focuses and prioritizes future actions. A common way to provide baseline and ongoing data is monitoring and reporting through yearly greenhouse gas (GHG) inventories. However, there are two major drawbacks to current municipal GHG emission data repositories. First, they are expensive and time-consuming to build, maintain, validate, and evaluate. Second, there is an ongoing struggle with data acquisition and data quality when building inventories [3]. Furthermore, the absence of detailed cost/benefit calculations means that governments often lack even basic understanding of projected or outcome costs and benefits of their mitigation strategies.

We present in this paper ongoing work done within the Carbon Track and Trace project (CTT) that addresses the issue of information gaps and uncertainty about municipal greenhouse gas emissions and inventories. We use the example of Trondheim, Norway, to give an overview of issues and discuss potential solutions, while most aspects are generalizable to cities worldwide that face similar issues.

A. Policy background

Norwegian national climate targets, corresponding to those of the EU, are a 30% reduction by 2020, 40% by 2030, and carbon-neutrality by 2050. Within Trondheim, transport and thermal stationary energy are of particular concern. The goal is to reduce overall emissions from transport by at least 20% between 2008 and 2018 through a combination of measures including road tolls, increased investment in public transport, walking and cycling facilities, urban densification, and shifts in fuel mix. While many of the policy goals either have been met or are on track to be met, there is still a large information deficit on GHG emissions from the transport sector.

II. MAIN IDENTIFIED CHALLENGES

We present the results of the analysis of the status quo and discussions with stakeholders [1, 2]. This is based on a comparison of current approaches with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) [5] recommended practices. We focus on key issues in data acquisition and quality considerations. Our results highlight the need for better data and more accurate emission inventories in order to track progress toward climate goals. Current approaches mostly rely on a combination of top-down calculations for downscaling national statistical data together with bottom-up local estimations to determine GHG emissions tied to activity and consumption within a city, but do not employ direct measurements.

GHG information deficit: It remains difficult for cities to pinpoint accurately and precisely how and where GHGs are emitted, to what degree the city's mitigation policies are working, if they are successful or not, and how. The stationary energy mix in Norway (primarily hydropower) and limited district heating facilities make the inventories from the stationary energy sector quite robust, but the transport, waste, and consumption-based emissions are extremely complicated to work out. Combined with slow feedback loops between mitigation actions taken and impact on reported emissions, policy and impact are getting decoupled.

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The statistics problem: Often, top-down national statistics are not sufficiently adapted for municipal use. For example, national statistical city-level GHG emissions use downscaled calculations of national per capita energy consumption expressed in CO_2-equivalents. Such numbers are of limited use since downscaling means that the influence of cities' mitigation actions is hard to validate. Moreover, national statistics are not directly compatible with the reporting requirements of city-level emission inventory methodologies such as GPC [5]. As a result, there are few, if any, existing means for cities to validate and check the reliability of the national data against local specifics.

Consumption-based inventories are resource- and time-intensive: As an example of the important insights from inventories, for city operations the climate impact of indirect energy usage through purchasing and operations can be 50 times higher than the direct climate impacts, and the building stock can be responsible for almost half the total carbon footprint [4]. However, due to the complexity and cost of such a detailed assessment, a city cannot conduct such a review every year. Experience shows that even relatively simple inventories can take 2-6 person months for a city with 100.000 inhabitants. Also, seemingly simple tasks such as deciding upon the geographical and topical inventory boundary are highly complex.

Costs and benefits of inventories are unclear: Commonly, cities are neither able to determine the costs of inventories nor can quantify the direct benefits of mitigation action. Since emission inventories in Europe are mostly voluntary commitments, decision-making processes on implementing climate action are often cost- and not benefit-driven. Cities also struggle in calculating the investment in terms of time and staff involved. The benefits of implementing mitigation action such as costs savings from energy efficiency and renewable energy are usually calculated up-front, but not measure-specific, as a standard in the monitoring process, and on the local level.

Cities need to drive mitigation: City- and city-region climate policies are considered a key driver to securing the overall goal of a maximum of 2°C warming by 2100. Ambitious climate targets need to involve local governments, but this requires a convergence of the political framework (mandates, political commitment) with a technical framework (vertical integration of inventories, transparency and accountability). Moreover, a pre-condition for tapping into finance for mitigation measures is that cities can clearly demonstrate impact, linking investment to direct or indirect reductions in GHG emissions, prioritized for environmental return.

III. CONCLUSION

Most cities today continue to struggle with data acquisition and data quality when conducting GHG emission inventories. Moreover, the lack of high-granular data (building- or street-level) inhibits the ability of cities to pinpoint the actual or potential impacts of mitigation strategies, which has been shown to be a significant barrier to attracting commitment from local actors and capital for mitigation action.

Initial results of the gap analysis point to a significant need for new approaches to GHG emissions inventory methods, focusing on a combination of top-down and bottom-up calculation as well as direct/indirect measurement of activity data together with the verification of local modeling approaches. This showcases the demand for stronger measurement- and data-driven approaches.

For future work, we will complement the initial understanding and overview presented here with two measures. Improved inventory workflow will support greater automation and reduced costs for city-level emissions reporting using GPC (or other) GHG emission reporting standards. Data provision will be massively improved by the use of local data by building- and street-level sensors as well as improved data modeling and the use of existing data sets. The deployment of GHG emissions sensors and networks will enable development of real-time analytic capacity of transportation emissions. By combining the sensor data with other existing data sets (toll road counts, traffic data, air quality data, atmospheric diffusion data, passenger data, satellite measurements), analysis approaches can derive new insights. In short, we address the issues from multiple angles:

- Standards-compliant inventories
- Inventory-building workflows
- Access to verified/verifiable statistical data
- Measuring GHG concentrations inside the city

This will enable us to deliver new highly local insights to cities that can inform better policy and mitigation actions.

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