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# Consumption-based emission inventories in Nordic municipalities—a quest to develop support for local climate action

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Municipalities can play a large role in achieving global climate targets. Integrating a consumption-based perspective is key to being able to mitigate global emissions. We conducted a survey among municipality officials in four Nordic countries (Denmark, Finland, Norway, and Sweden) and held several workshops to deepen our understanding of municipalities' work to address consumption-based emissions. Findings show that less than half of the municipalities in the studied countries worked actively on measuring consumption-based emissions but that there is a broad interest in further developing GHG inventories that incorporate emissions from municipalities' own consumption as well as from citizens' consumption. Both expectations and challenges related to consumption-based inventories are remarkably similar across the four countries. A majority of the survey respondents perceived that the municipality could influence consumption-based emission from the municipality as a society by cooperating with residents and businesses. Similarly, information on consumption-based emissions was broadly identified as a key need to identify just and sustainable measures toward climate neutrality. The information generated was recognized by municipal employees to be useful for making better climate plans, optimizing their own operations' emission reductions, and helping residents and companies to reduce their emissions. We argue that it is essential that municipalities can base their actions on coherent and reliable information on consumption-based emissions that is comparable across municipalities and that can be connected to national tracking of emissions. This requires standardized methods and base-line data as not all municipalities can mobilize the needed human and financial resources to make their own inventories.

## KEYWORDS

municipalities, GHG emissions, consumption, Nordic, climate neutrality

## 1 Introduction

To reach the targets established under the Paris Agreement, greenhouse gas (GHG) emissions need to be reduced drastically. Cities account for around 70% of global GHG emissions (Lwasa et al., 2022). Many cities and municipalities have set climate targets, often exceeding the national targets. Greater ambition is, however, needed (Salvia et al., 2021). The EU encourages this through the Mission Climate-Neutral and Smart Cities, which aims

to achieve climate neutrality in 100 cities by 2030.<sup>1</sup> In the EU, the overall frame is set by the Climate Law<sup>2</sup> which has set a target of 55% emission reduction by 2030 and a goal of EU-wide climate-neutrality by 2050.

Cities can be regarded as centers of consumption, that need special attention (Balouktsi, 2020). Cities, or more broadly, municipalities potentially play an important role in steering and incentivizing households' consumption because they are close to the daily life of citizens. However, changing the consumption patterns of households or individuals is difficult (Dawkins et al., 2021a) as individuals' consumption behavior is influenced by several factors such as socio-economic background, influence of "significant others," the level of environmental knowledge, information, risk perception, etc. (Saari et al., 2021).

Like individual decision-making on consumption behavior, municipal decision-making on climate actions is influenced by a number of factors. Municipalities can also tackle consumption in many ways. They can implement policies in climate-relevant sectors such as land-use planning, waste management, infrastructure, housing, and community development. They can also experiment with climate solutions and forge partnerships with the private sector and international entities (Dubash et al., 2022). Municipalities can further influence consumption through procurement, for example by demanding electric vehicles for public transport, or through land use planning that facilitates low-carbon lifestyles. Additionally, municipalities can provide extension services on, for example, energy efficiency or circular economy, and provide support for activities that mitigate climate change.

To target their actions and to evaluate them, municipalities need information about emissions. For tracking emission reductions, municipalities have so far generally relied on a territory-based or production-based approach, which is the standard for international emission inventories reported to the United Nations Framework Convention on Climate Change (UNFCCC). The focus has been on the so-called Scope 1 and 2 emissions that cover emissions generated within municipal borders (Scope 1) and emissions associated with the use of energy derived from the grid (Scope 2). Emissions caused by goods and services that are partly or fully produced outside the municipality but consumed within its borders (Scope 3) are generally excluded.<sup>3</sup>

The emission accounting frameworks (scopes) highlight different aspects of the overall process of decarbonization (Lwasa et al., 2022). So far a part of the decarbonization has been achieved by outsourcing production-based emissions (Rosenbloom, 2021), resulting in carbon leakage (Grubb et al., 2022). This is a general problem for industrialized countries. Available country-level data from OECD countries indicate that emissions abroad, embodied in domestic final demand, decreased more slowly between 2005 and 2015 compared to territorial emissions (Yamano and Guilhoto, 2020).

The Greenhouse Gas Protocol (GHG-P) is a widely used approach to assess emissions from companies, organizations, and recently also cities. In 2021, the World Resources Institute, C40 Cities, and ICLEI updated the GHG-P with a module for cities with the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC)<sup>4</sup> as an applicable Gold Standard for cities' CO<sub>2</sub>e emissions inventorying combining and expanding the existing framework's citywide inventorying methods by the organizations. Most municipalities, both large and small, still lack experience, guidance, and tools on how to address consumption-based emissions (Klemetsen et al., 2020).

In this paper, we examine the challenges faced by municipalities regarding consumption-based inventories and their expectations in developing and using consumption-based emission data to develop practical support for municipal climate action. We present new information from the Nordic region, which is often highlighted as a forerunner when it comes to taking climate action.<sup>5</sup> Many Nordic municipalities strive to become "climate-neutral" well before the EU's 2050 target (Karhinen et al., 2021; Huovila et al., 2022; Vanhuysse et al., 2023). We examine the potential role of consumption-based inventories in achieving those targets and the requirements needed to develop and use municipal consumption-based inventories. We also explore to what extent the challenges and expectations are similar among municipalities in the different countries we have studied.

The paper is structured as follows: In the Materials and Methods section, we provide an overview of the current situation with respect to municipal consumption-based inventories in the four examined Nordic countries: Denmark, Finland, Norway, and Sweden. Furthermore, we provide a description of the methodological approach used. In the Results section, we provide comparative information from the survey and workshops. In the Discussion section, we highlight what the findings imply for further development and use of municipal consumption-based GHG inventories.

## 2 Materials and methods

### 2.1 Background—the focus area and countries under study

In our study, we focused on municipalities in four Nordic countries: Denmark, Finland, Norway, and Sweden (Figure 1). The economies, politics, governmental structures, and value systems of these neighboring countries are comparable. The population varies between about 5 million (Norway) and 10 million (Sweden) people. In the following, we provide a brief overview of the setting in the four Nordic countries regarding the general state of climate work and consumption-based emission inventories.

1 [https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities\\_en](https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en)

2 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1119>

3 <https://ghgprotocol.org/corporate-standard>

4 <https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities>

5 <https://www.germanwatch.org/en/21110>



FIGURE 1  
The four Nordic countries in blue.

## 2.1.1 Denmark

### 2.1.1.1 Political and regulatory framework

Denmark adopted a new climate law<sup>6</sup> in 2020 mandating it to reduce annual territorial CO<sub>2</sub>e emission by 70% in 2030 relative to 1990 levels. The measures that will be used to reduce the emission of GHGs must lead to real domestic reductions, but at the same time it must be ensured that Danish measures do not simply move the entire GHG emission outside Denmark's borders. The municipalities define their own goals and ambitions.

### 2.1.1.2 Municipal climate efforts

Since the year 2019, 96 out of 98 municipalities had signed up to the DK2020 programme<sup>7</sup> committing to reducing territorial CO<sub>2</sub>e emissions (in June 2023). The DK2020 work is anchored at the highest political level in the municipalities. When the municipalities apply to participate, the mayor and city council sign a letter that obligates the municipality to develop and support local political treatment of an ambitious local climate action plan that meets the objectives of the Paris Agreement, showing the way to net zero emissions for the municipality as a geographical area by 2050 at the latest. Municipalities receive advice and sparring from Local Government Denmark and the DK2020. The municipalities work with the same standard for climate planning, the Climate Action Planning Framework (CAPF),<sup>8</sup> adapted for use in smaller cities and municipalities.<sup>9</sup> There is no commitment to assess the

6 <https://www.retsinformation.dk/eli/lta/2020/965>

7 <https://www.kl.dk/kommunale-opgaver/klima/dk2020/oversigt-over-kommunernes-klimaindsatser/>

8 <https://resourcecentre.c40.org/climate-action-planning-framework-home>

9 <https://realdania.dk/projekter/dk2020>

consumption-based emissions from the municipality as a society in the CAPF.

### 2.1.1.3 Consumption-based emissions in Denmark

The first country-level assessment of Danish consumption-based climate footprint caused by the consumption of goods and services was compiled in 2020 and reported in 2021. It was calculated to be 61 million tons of CO<sub>2</sub>e per year, which corresponds to each individual Dane emitting 11 tons of CO<sub>2</sub>e per capita. Of the total footprint, 60% comes from private consumption, such as the purchase of food, car travel or charter holidays.<sup>10</sup> There are no solid estimations of municipal consumption-based emissions as these have not yet been developed. However, development work is undergoing as part of the next phase of the DK2020 process.

## 2.1.2 Finland

### 2.1.2.1 Political and regulatory framework and municipal climate efforts

According to the Climate Change Act of 2022 (423/2022), Finland aims for carbon neutrality by 2035 based on a territorial calculation. No national goals have been set for consumption-based emissions.

Many of the 309 municipalities and all the 19 regions in Finland work systematically to mitigate climate change. At the beginning of 2022, around 70 municipalities out of 309 had made an own municipal climate plan to guide their climate work (Ulvi et al., 2022). In many municipalities, the climate mitigation had been included in the general municipal strategy. As of 1st of March 2023 an obligation to draw up climate plans at the local, district or county level was included in the Climate Change Act (423/2022). However, the new conservative Government that came into power in June 2023 announced that it will cancel the obligation because it could cause additional costs to municipalities (Government of Finland, 2023, p. 257).

Even without an obligation many Finnish municipalities have individually or as part of a network set up their own climate target that are compatible with national efforts (Puurula et al., 2022). The voluntary network Toward Carbon Neutral Municipalities (Hinku), coordinated by the Finnish Environment Institute since 2008, includes 96 forerunner municipalities as of July 31 2023<sup>11</sup>. The municipalities in the network are committed with a decision by their municipal council to an 80% reduction in territorial GHG emissions from 2007 levels by 2030. Each municipality is responsible of preparing a plan for mitigating emissions in the whole municipality (Karhinen et al., 2021).

### 2.1.2.2 Consumption-based emissions in Finland

Consumption-based GHG emissions data for all Finnish municipalities and regions have been calculated for the year 2015 (Karhinen et al., 2023). The data includes both households, and municipal procurement and investments. The emissions per capita vary considerably between different municipalities and regions.

10 <https://kefm.dk/aktuelt/nyheder/2021/apr/foerste-officielle-vurdering-af-danmarks-globale-klimaaftryk>

11 [https://www.hiilineutraalisuomi.fi/en-US/Hinku/Hinku\\_municipalities](https://www.hiilineutraalisuomi.fi/en-US/Hinku/Hinku_municipalities)

The combined consumption-based GHG emissions of Finnish municipalities are  $\sim 57.4$  MtCO<sub>2</sub>e (10.5 t CO<sub>2</sub>e per capita). Of these municipal emissions, 83% are due to household consumption, 11% come from municipal procurements and the remaining 6% from investments. In household consumption emissions, housing accounts for 25%, food consumption for 23%, transportation for 22%, other goods for 16%, and other services for 14%. There is significant regional variability in the shares of different sources of emissions. Some cities have used consultancy services to provide themselves with more recent data.<sup>12</sup>

## 2.1.3 Norway

### 2.1.3.1 Political and regulatory framework

By 2030, Norway targets to reduce territorial emissions by 55% relative to 1990. This obligation can partly be fulfilled by buying emission quotas. By 2050, the Norwegian Climate Law set a target that the country has become a low-emission society with territorial emissions reduced by 90–95% relative to 1990, but it is unclear how much of this can be fulfilled by buying emission quotas. In addition, the Norwegian parliament also has a target of being climate neutral by 2030, where remaining emissions from 2030 will be balanced with emissions quotas or international cooperation on emission reductions. At the national level, Norway does not have a target for consumption-based emissions. The obligations of Norwegian municipalities regarding climate emissions are defined in the Norwegian planning guidelines for climate, energy, and adaptation.<sup>13</sup>

### 2.1.3.2 Municipal climate efforts

The primary focus of the climate policy in Norwegian municipalities is on direct (Scope 1) CO<sub>2</sub>e emissions within the geographic boundary of the municipality. Most municipalities have some sort of climate budget (Klemetsen et al., 2020) including emission reduction targets, mainly for direct emissions. Norwegian municipalities are sharing experiences and best practices through the Norwegian Association of Local and Regional Authorities (KS), and KS has produced guidelines for climate efforts in municipalities and counties. The Norwegian Environment Agency<sup>14</sup> provides guidance on how municipalities should approach indirect and consumption-based emissions in climate and energy planning.<sup>15</sup> The guidance highlights that accounting of indirect emissions should be kept separate from direct emissions, double counting of emissions and emissions reductions should be avoided, and discusses possible approaches to estimating indirect emissions from energy use. The guidance does not include specific recommendations on methodologies, data sources or emission factors.

12 <https://www.sitowise.com/fi/uutiset/kuntien-kulutuksen-hiilijalanjalkiselvitettiin-ensimmaista-kertaa>

13 <https://lovdata.no/dokument/SF/forskrift/2018-09-28-1469>

14 Utslipp av klimagasser i Norges kommuner og fylker - Miljødirektoratet (miljodirektoratet.no).

15 Beregne indirekte utslipp og livsløpsutslipp - Miljødirektoratet (miljodirektoratet.no).

### 2.1.3.3 Consumption-based emissions in Norway

Steen-Olsen et al. (2016) estimated the country-level consumption-based emissions in Norway to be 58.2 MtCO<sub>2</sub>e (11.1 t CO<sub>2</sub>e per capita) in 2017. While estimates at the municipal level cannot be retrieved from this study, the results provide useful information for municipalities in terms of identifying sectors with significant consumption-based emissions and getting an overview of consumption-based emissions in households. Grieg et al. (2022) summarize other recent studies of consumption-based emissions in Norway. Some analytical tools are also available for municipalities on a commercial basis, notably the climate-cost model “Klimakost model”<sup>16</sup> for companies and the Peoples footprint “Folkets fotavtrykk,”<sup>17</sup> for citizens but there are no national or municipal accounts of consumption-based emissions provided by the relevant authorities. The capital city Oslo is a front-runner in Norway and has its own assessment and planning<sup>18</sup> based on consumption.

## 2.1.4 Sweden

### 2.1.4.1 Political and regulatory framework

The Swedish Parliament has adopted a Climate Policy Framework that sets out that Sweden should reach net zero GHG emission by 2045 and then negative net emissions after 2050.<sup>19</sup> In 2020, a governmental investigation was initiated to explore Sweden’s opportunities to put in place a national consumption-based target corresponding to net zero emissions from consumption by 2045.<sup>20</sup> The investigation was finalized in 2022 but no parliamentary decision has yet been announced.

Sweden’s environmental policy framework has an overarching goal, the Generational Goal, that sets out the guiding principle for all environmental work at all levels in Sweden, which is “to hand over to the next generation a society in which the major environmental problems have been solved, without increasing environmental and health problems outside Sweden’s borders.”<sup>21</sup> To monitor the progress toward this goal Sweden has specified one indicator relating to consumption-based GHG emissions (Dawkins et al., 2021b) and Statistics Sweden has published environmental pressures associated with national consumption on a yearly basis since 2008 (Dawkins et al., 2021b). Sweden’s consumption-based carbon footprint is estimated to 7.65 tons CO<sub>2</sub>e per capita for 2020 (Swedish Environmental Protection Agency, 2022). Of these emissions, 60% can be associated with household consumption and the remaining 40% relates to public consumption and investments (Swedish Environmental Protection Agency, 2022).

16 Klimakost.

17 Folkets Fotavtrykk – Få et forbruksbasert klimaregnskap for innbyggerne i din kommune!

18 <https://www.klimaoslo.no/wp-content/uploads/sites/88/2019/11/Framtidens-forbruk.pdf>

19 <https://www.regeringen.se/artiklar/2017/06/det-klimatpolitiska-ramverket/>

20 <https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2022/04/sou-202215/>

21 <https://www.naturvardsverket.se/en/environmental-work/swedish-environmental-objectives/the-generational-goal/>

### 2.1.4.2 Municipal climate efforts

A large number of the Swedish municipalities have established a carbon budget for their territorial emissions.<sup>22</sup> A recent Swedish study found that many municipalities have also set their own local consumption-based emissions targets (Axelsson et al., 2023). However, many municipalities report that they lack the tools and capacities to analyze local consumption patterns in detail on their own, or to identify measures that address climate impact from consumption as a whole (Swedish County Administrative Board, 2015; Dawkins et al., 2021b; Axelsson et al., 2023). Indicators and targets are also considered important by public officials for creating a stronger commitment around sustainable consumption and for communicating credibly about it (Swedish County Administrative Board, 2015; Dawkins et al., 2021b; Klimatkommunerna, n.d.).

### 2.1.4.3 Consumption-based emissions for municipalities

In 2022, Stockholm Environment Institute launched a tool that estimates the consumption-based impacts of households for all Swedish municipalities down to postcode level. This tool shows that emissions related to household's car travel is the consumption category that generates the most emissions, followed by emissions from food, then air travel. The tool demonstrates that households' average consumption-based emissions range between 5.3 and 8.5 tons CO<sub>2</sub>e per capita at the municipality level. There can be even larger differences between households at different postcodes ranging between 3.5 and 18 tons CO<sub>2</sub>e per capita, pointing to a need to address the differences through targeted policies and measures (Dawkins et al., 2021b).

## 2.2 Quantitative survey

A quantitative online survey was designed to collect comparative insights from a large number of Nordic municipalities about their current practices, opportunities, barriers and needs in relation to consumption-based estimates and mitigation (see survey questions in SI). The survey design was based on document analysis and the authors' prior expert knowledge from participation in other research projects on consumption-based accounting, climate adaptation and mitigation. The survey was distributed during April–August 2022 to municipalities in Denmark, Finland, Norway, and Sweden. The distribution was based on personal and institutional networks to the municipalities in all four countries as well as through Local Government Denmark, in the case of Denmark, and the registration offices of Swedish municipalities. It should be noted that the uptake differed in the four countries with regard to the type of municipalities that responded to the survey. As illustrated by Table 1, the survey targeted networks of municipalities typically considered to be frontrunners with regards to work to address climate impacts in both Denmark and Finland, whereas the survey was sent to official registrar's offices respondents in Sweden and Norway where the uptake was more scattered among municipalities with different levels of progress toward firm climate action.

The survey was conducted using the online survey tools SurveyExact<sup>23</sup> and Webropol.<sup>24</sup> The survey was addressed to municipality officials with responsibility for climate and environment.

In total 257 municipalities responded to the survey. The response rates varied from 53% (Denmark) to 20% (Norway; Table 1).

## 2.3 Participatory workshops

During 2021–2022, a series of coordinated national meetings and workshops (both virtual and in-person) were conducted. The primary target group for these events were municipal officials with responsibility for climate and environment as well as selected experts from academia and other expert and research organizations. Apart from learning and exchanging experiences on current work practices among Nordic municipalities for estimating and mitigating consumption-based emissions, the workshops aimed to gather information about the municipalities' aspirations and needs with regards to overcoming barriers connected to this work. To reach municipalities, we used personal and institutional networks as well as the national municipal association in the case of Denmark.

In Finland, a workshop on consumption-based emissions and sinks was held 4th of April 2022. The workshop was attended by municipal climate work experts in the forerunner municipalities toward carbon neutral municipalities (Hinku) network. Two 1-h long sessions were facilitated by experts of the Finnish Environment Institute (Syke). In total 72 municipalities divided in three groups attended the discussions on consumption-based emissions. The experts provided viewpoints on the applicability of consumption-based emissions in the municipality. The challenges and respective solutions related to reducing emissions allocated for the municipality due to consumption were also discussed.

In Sweden, four different workshops were arranged to learn more about municipalities current work to address consumption-based emissions. Workshops were arranged in three municipalities (Umeå, Kalmar and Avesta) on 8th of April, 11th of April, and 8th of November 2022 to solicit municipalities feedback on what they perceive as being current barriers and opportunities to use consumption-based data to support a transition to sustainable consumption patterns among households in the municipality (six, five, and 43 participants, respectively). On 15th of November 2022, a workshop session was arranged as part of a conference about local carbon budgets where participants were invited to discuss the potential, challenges, and opportunities to link data on consumption-based emissions to local carbon budgets (22 participants). All these events were in-person workshops.

In Denmark, Aarhus University organized two in-person workshops hosted by the national association of municipalities<sup>25</sup> on the 21st of April and the 31st of May 2022 with participation of 20–30 Danish municipalities. In addition, Aarhus University

<sup>23</sup> <https://www.surveymact.dk/>

<sup>24</sup> <https://webropol.fi/>

<sup>25</sup> <https://www.kl.dk/>

<sup>22</sup> <https://www.klimatsekretariatet.se/skaffa-koldioxidbudget>

TABLE 1 Survey response rates.

Country	Methods of distribution	Total no. of municipalities (n)	Responses (n)	Response rate (%)
Denmark	Via the national association of municipalities (climate group) to all 98 Danish municipalities	98	52	53
Sweden	Sent to all municipalities official email addresses plus via the County Board	290	70	24
Norway	Sent to all municipalities official email addresses plus to selected recipients directly	356	67	19
Finland	Through the <i>Toward Carbon Neutral Municipalities</i> (Hinku) network (82 members) plus phone interviews with municipalities over 10k inhabitants	309	71	23
<b>Total</b>			<b>262</b>	

also organized a workshop together with the Municipality of Aarhus and the Municipality of Copenhagen (the two largest municipalities in Denmark and both part of the 100 Mission Adaptation cities), on the 18th of August 2022. Municipalities were solicited to provide feedback on their current barriers and opportunities to include consumption-based data in efforts to support a transition to sustainable consumption patterns among households in the municipality.

No separate workshops were arranged in Norway due to practical constraints at CICERO to host a workshop.

In November 2022, a joint Nordic workshop was arranged (online), inviting municipalities from across the four Nordic countries. About 50 participants attended the workshop on consumption-based emissions with an equal representation of municipalities from Denmark, Finland, Sweden, and Norway. There were also some participants representing regional authorities, research institutions and organizations across the four countries. The workshop consisted of a combination of orienting presentations and discussions in break-out groups. The topics of the group discussions were (1) opportunities and barriers for advancing the municipalities' work on sustainable consumption, and (2) challenges and opportunities associated to monitoring consumption-based impacts. In the break-out session, participants were divided into six groups. Each group was led by a member of the project team. The focus of the break-out session was on the municipalities' own consumption, however, discussions in several groups also touched upon the municipalities' work to address consumption-based emissions among the residents as well as scope 3 emissions from businesses. Using a Miro board,<sup>26</sup> participants were asked to write short notes (digital sticky notes) followed by an oral discussion on some of the elements identified.

We also hosted an official side-event in conjunction with the UN Stockholm 50+ conference<sup>27</sup> in Sweden that gathered more than 30 global participants in-person. The objective was to share experiences from the Nordic countries on how to estimate consumption-based impacts and gain an understanding of the current state-of-the-art at the national and community level across the globe in terms of the primary barriers and limitations

they face in their efforts to assess and quantify consumption-based emissions.

The information collected through the workshops was also used to verify the findings from the survey and ensure that we had not missed out on any important aspects relating to municipalities current practices as well as opportunities, barriers and needs for understanding and addressing consumption-based impacts at the local level.

## 3 Results from the workshops and survey

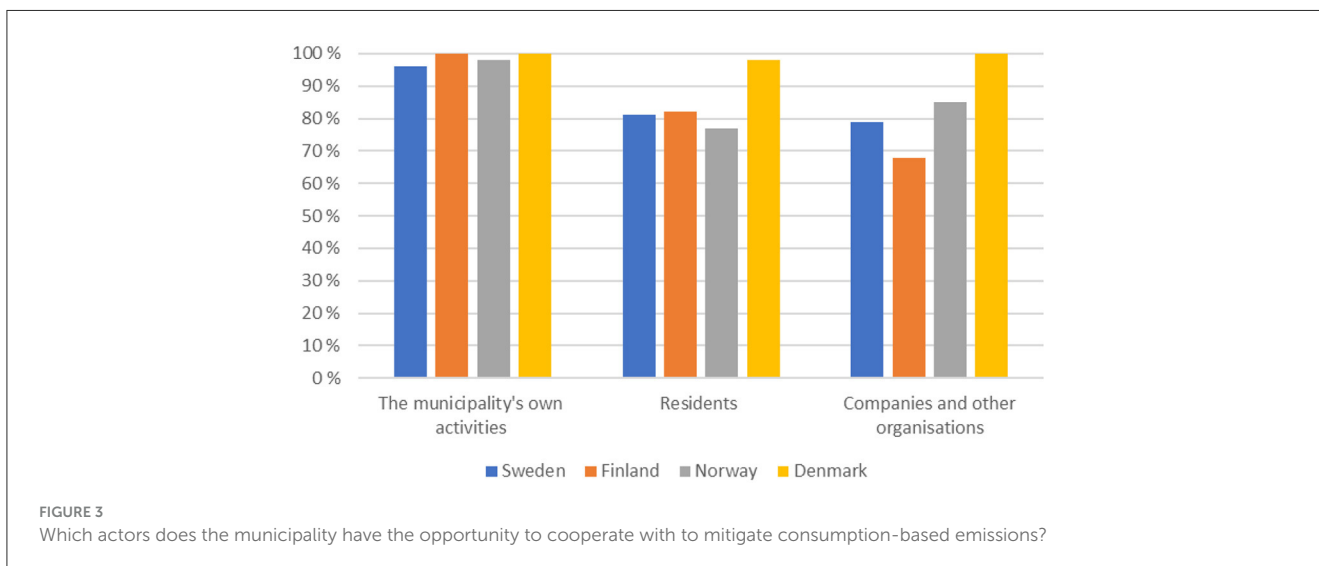
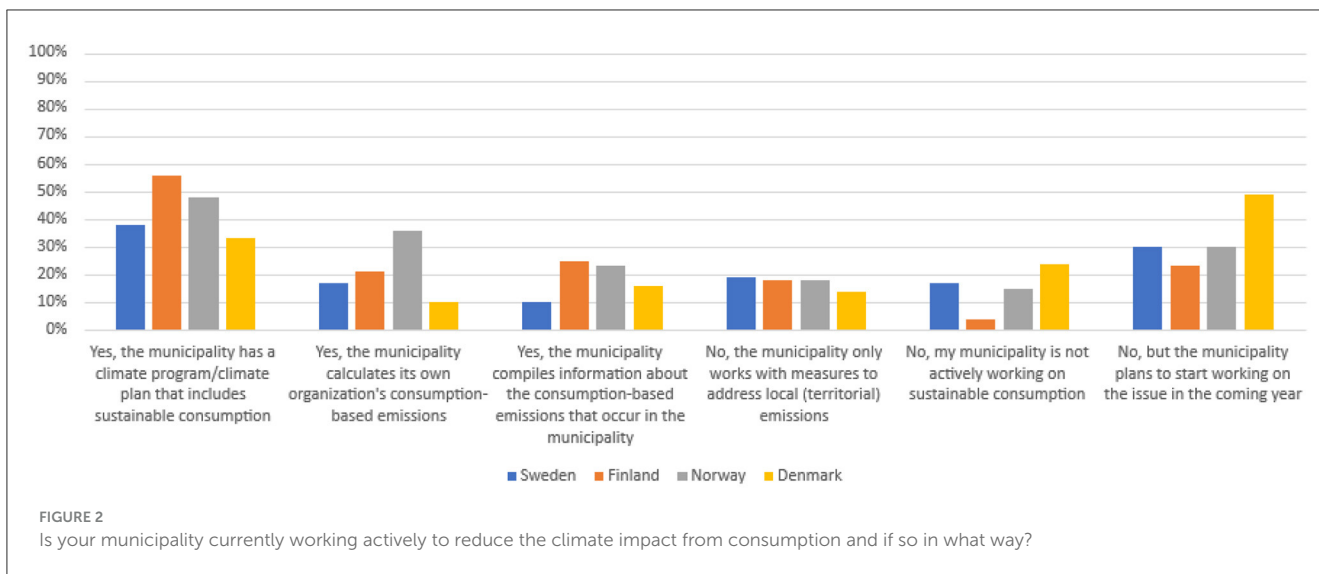
### 3.1 Survey results

The survey provided a quantitative overview of the state of consumption-based climate work in the Nordic countries. Overall, between a third (DK, SW) and half (FI, N) of the Nordic municipalities that responded to the survey in 2022 had a climate program that paid attention to sustainable consumption (Figure 2). Most municipalities (>50%) are not working actively on consumption-based emissions yet. Between 30 and 50% of the responding municipalities planned to initiate further work on reducing climate impact from the consumption in the municipality in the coming years. The survey demonstrated a willingness to explore the use of consumption-based emission data as it becomes available. In Norway progress has been made with more than a third of the municipalities monitoring the consumption-based emissions of their own organization, whereas the share was <20% in the other countries. Depending on the country, currently only 10–25% of the responding municipalities compiled wider consumption-based emissions within the municipality.

Most of the respondents reported that their municipality has opportunities to influence consumption-based emission from the municipality as a society by cooperating with both residents and businesses, in addition to work on the municipality's own activities (68–98% of respondents, see Figure 3). There are some national differences. For example, Danish municipalities responded to a larger extent than the other countries that they will work with both residents and businesses to mitigate consumption-based emissions.

<sup>26</sup> <https://miro.com/>

<sup>27</sup> <https://www.stockholm50.global/>



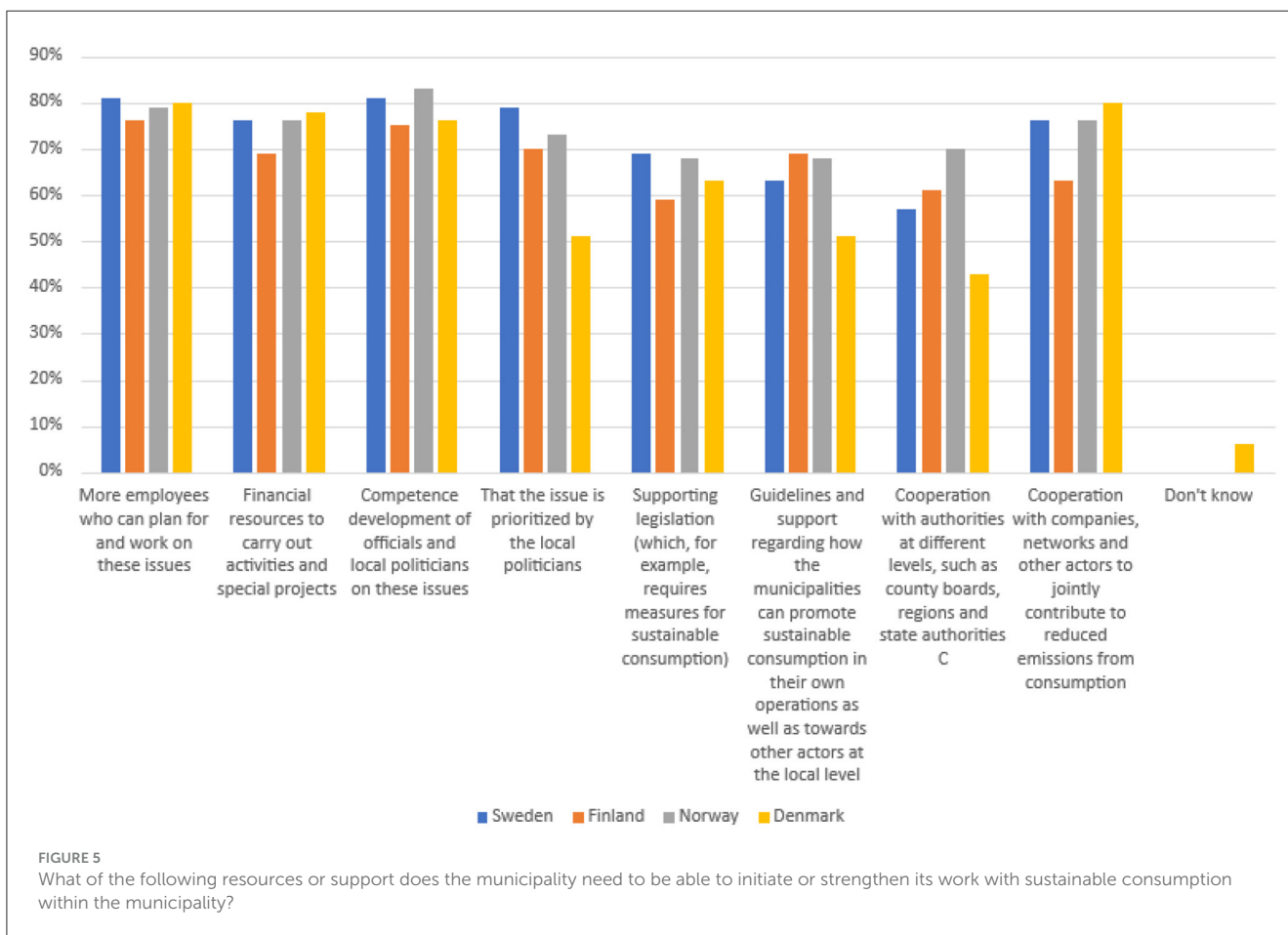
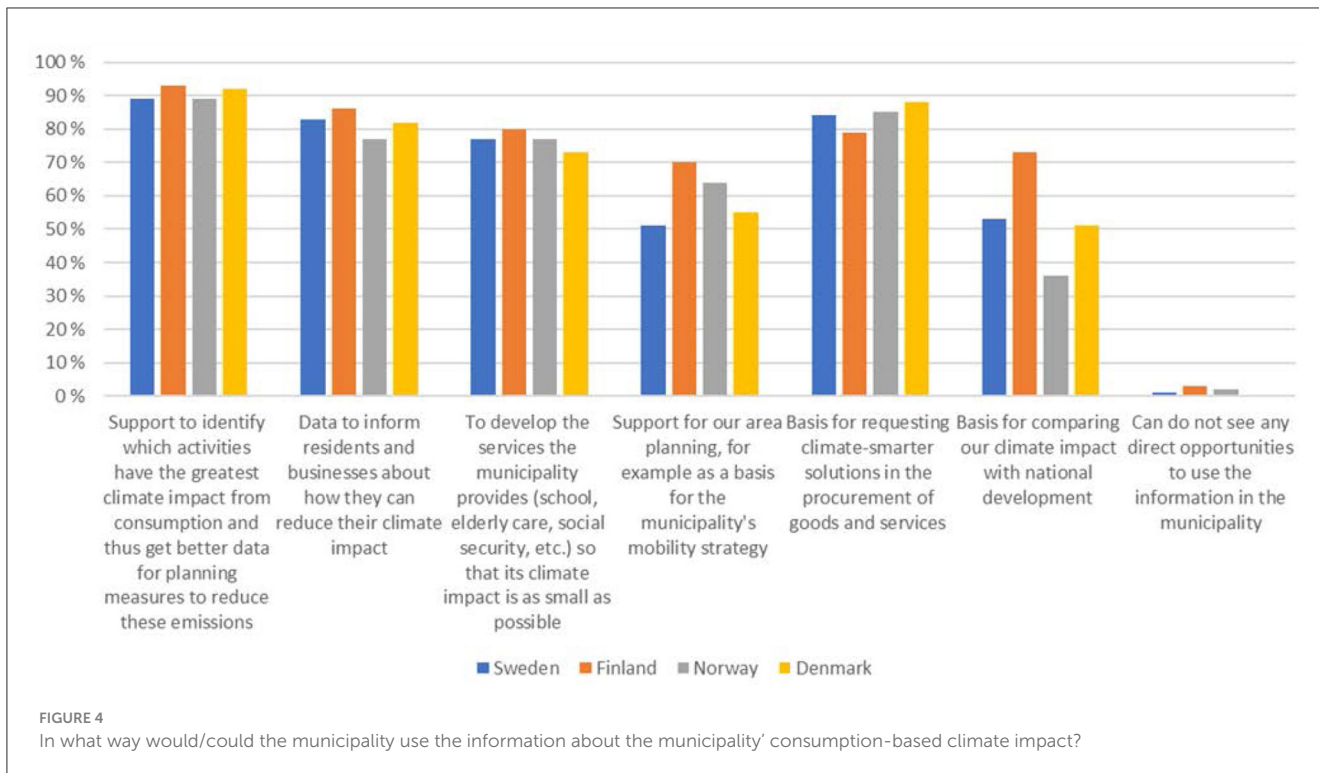
An overwhelming majority (close to 90% across all four countries) of the respondents considered that consumption-based data could potentially be used to identify and prioritize actions to mitigate related emissions (Figure 4). There was also a consensus that the information is relevant and useful to the municipalities. Respondents agreed that the information generated could be used to make better climate plans, optimize their own operations' emission reductions, and help residents and companies to reduce their emissions. Moreover, they saw that this information could be used in their procurement and for bench-marking purposes (Figure 4).

For the municipality to be able to initiate or step-up work on sustainable consumption, the responding municipalities agreed that additional human and financial resources are needed, and competence development was also identified as a key need by 70–80% of respondents (Figure 5). Guidelines and support to focus on sustainable consumption was also seen as a relevant precondition by 60–70% of respondents.

This could include, for example, guidance on procurement. National differences were small but about half of the Danish municipalities felt the need for local politicians to prioritize the issue, while in the other countries a clear majority expressed this need. In Denmark, participants also expressed less need for guidelines and support for sustainable consumption compared to the three other countries, and a lower expressed need for cooperation between authorities at different vertical levels.

### 3.2 Barriers and needs for municipalities working with assessing their consumption-based emissions

The workshops provided explanations for the finding of the survey and additional insight into the challenges and opportunities related to consumption-based climate work.





### 3.2.1 Denmark

The outcome of the Danish workshops was a consensus that municipal procurement needs to incorporate CO<sub>2</sub> emissions. There are different commercial providers for this type of services in Denmark, for example KONSIDO,<sup>28</sup> Viegand and Maagøe<sup>29</sup> and NIRAS.<sup>30</sup> In addition, the public sector data management provider KMD has developed a tool (carbon key) with Viegand and Maagøe targeting municipalities to allow them to assess their inhouse Scope 1, 2, and 3 emissions.<sup>31</sup> These solutions are being considered by most Danish municipalities today. The assessment of the total emissions from the municipality as a society (own plus emissions caused by citizens and businesses) within the municipality remains a challenge for all Danish municipalities. They are as part of their commitment in the DK2020 project 2022/2023 completing their initial assessment of their emissions and are now gearing up to also include societal emissions. The current energy crisis and demand for enhanced circularity and waste reduction has accelerated their planning and management needs and hence also their needs to quantify and reduce societal emissions based on consumption.

They are therefore working with different organizations such as klimaplan.nu<sup>32</sup> where more than 10,000 households have registered across Denmark to self-report on their own household consumption-based emissions. In addition, the municipalities are supporting developing ways to interact with companies in their area by providing training and workshops on assessment and reduction of emissions. This is the first needed step for the municipalities to engage with the companies to help them in reducing their emissions as a measure to both reduce emissions as well as support the companies in the current and ongoing green transition which represents both risks and opportunities to all companies. The association of municipalities supports the efforts of the 98 municipalities in Denmark. The next iteration of the DK2020 programme will include enhanced focus on consumption-based emissions and societal emissions and is being developed.

### 3.2.2 Finland

The workshop on consumption-based emissions was attended by 72 participants from the municipalities. Values and attitudes were seen as the biggest general challenge in reducing the emissions due to consumption. Municipalities found that changing consumption habits is difficult. In addition, it was felt that a municipality has little potential to influence the activities of stakeholders outside the municipal organization. Participants emphasized the need to involve local residents, especially young people, in the climate work. Municipal experts felt that new ways of engaging people are needed. Blaming citizens for climate change was not seen as a good way to influence consumption. Participants provided a lot of support for a suggestion to advance

changing consumption by engaging and putting in place long-lasting communication campaigns for residents, in cooperation with stakeholders and companies. Cost savings and health benefits could also be highlighted together with information on the emission impact of consumption. In addition, services are needed for the transmission, compilation, and production of information. Communication and easily accessible material for communication were also desired from national level representatives. The interviewed municipal officials identified a need for detailed calculators targeted for consumers. These calculators already exist, but better marketing and dissemination is needed among municipal climate experts so that they become used in extension work and awareness campaigns.

Several aspects related to the internal functioning of the municipal organization were raised. The lack of political will was mentioned as one of the challenges in reducing the municipality's emissions. Politicians should be given the message of the necessity for commitment and action. Training officials and decision-makers was also identified as an important activity. Lack of expertise, especially regarding conducting green public procurements, was seen as a challenge in a few municipalities. The best solutions found for accelerating these procurements were guidance and obligations targeted toward the municipalities, as well as procurement guidelines and contracts. According to the municipality representatives attending the workshop, it would be good to get service providers closely involved in the municipality's work.

National policy instruments were highlighted by the interviewed as important tools to make consumption more sustainable in general. To support their work, municipalities need local data, models and tools that can be used to monitor the development of municipal emissions and the effectiveness of the measures taken. Consumption-based estimates at the municipality level provides a more comprehensive picture of the global emissions generated by consumption from the local level and in certain sectors. For example, emissions from construction and food consumption from across the full supply-chain will be better known. A broader knowledge base on emissions improves planning, targeting, and prioritizing the municipal climate action. Consumption-based calculations particularly benefit food services, urban planning (mobility and housing), educational and cultural services and procurement activities in the municipal organization. These sectors typically cause significant emissions also outside the municipal borders. Information about households' consumption-based emissions provides tools for communication toward residents and other stakeholders. It makes household emissions visible and shows the extent of the global emissions impact.

### 3.2.3 Sweden

In Sweden, three municipality specific workshops were arranged to present a new public tool that estimate households' consumption-based impact at the municipality and postcode level (Axelsson et al., 2022) and solicit municipalities feedback on what they perceive as being current barriers and opportunities to use consumption-based data to support a transition to sustainable consumption patterns among households.

28 <http://www.konsido.dk/Home.html>

29 <https://viegandmaagoe.dk/en/>

30 <https://www.niras.dk/sectorer/energi/klimaregnskaber-og-carbon-footprint/>

31 <https://www.kmd.dk/da-DK/loesninger-og-services/loesninger/energi/kmd-carbonkey>

32 <https://klimaplan.nu/klimaplan>

Before the launch of the new tool, lack of local data has been a barrier in municipalities work to address consumption-based emissions. With the new tool available, municipalities still need to build capacity pertaining to the use of the tool as well as policies and measures to mitigate consumption-based impacts among households as well as for the municipality's own consumption. Similar to Finland, several aspects raised in the three municipalities related to how the municipality collaborated across departments and how the work could be better coordinated to strengthen the impacts and where training officials and local politicians were recognized as a key need. However, contrary to Finland, lack of political will was not identified as a major barrier in any of these three municipalities although there was recognition that politicians need clear motivation about the local relevance to be willing to allocate sufficient resources to address consumption-based emissions.

In addition to the three municipality specific workshops, one workshop was arranged about opportunities to link consumption-based estimates to local carbon budgets and held as part of a conference about local carbon budgets in November 2022.

With regards to opportunities identified in municipalities work to include consumption-based emissions in their ambitions to reach net zero emissions at the local level, participants acknowledged that while goals and ambitions exist, practical follow-up and measurement can be challenging. However, informing the public about the municipality's carbon budget and consumption-based emissions were identified as important steps, as these two factors are closely intertwined. By combining territorial and consumption-based emissions from the municipal organization, the municipality get a good basis for establishing mitigation goals and prioritizing actions effectively. It was noted that households' transport often accounts for the largest emissions, but that the municipality may face resource limitations in addressing this issue. Leadership from municipal representatives was considered crucial for guiding citizens regarding their consumption habits. Furthermore, one participant suggested that considering all emissions should not merely be seen as an opportunity, but an obligation for all municipalities. Workshop participants also communicated that they considered it a necessity to raise awareness both among residents and within their own organization about the challenges posed by climate change. To gain a comprehensive understanding, it was suggested that emissions should be collected in a manner that allows for comparison and visualization of the complete picture. Finally, it was proposed that indicators are needed to be able to follow-up on local consumption-based targets. Overall, the workshop participants agreed on the importance of including consumption-based emissions in their efforts toward net zero emissions at the local level.

With regards to measures for addressing consumption hotspots, workshop participants highlighted several interesting initiatives. Transportation and food were identified as significant areas to focus on in efforts to facilitate reductions in households' climate footprint. Improved infrastructure for electric charging stations and improved public transport were some of the proposed measures, including developing apps for carpooling. Investing in local tourism initiatives was also mentioned as an important measure to mitigate air travel abroad. Information campaigns and different kinds of engagement activities were broadly emphasized as

key for creating commitment. The importance of circular economy initiatives and collaboration with businesses were also emphasized.

Lastly, participants expressed a strong need for more support to be able to identify effective policies and measures to mitigate consumption-based emissions and influence changes in consumption behavior that can be applied at the municipality level.

### 3.2.4 Pan-Nordic workshop

In the Pan-Nordic online workshop, opportunities, and challenges for municipalities' work on sustainable consumption and monitoring of emissions were discussed. During the discussions there were differing views on the role of municipalities; some participants emphasized the opportunities of municipalities to cooperate with, and influence citizens consumption patterns as well as the municipality's own procurement practices. Others highlighted that there are many stakeholders which the municipality has a limited influence over. Many participants mentioned the lack of data and methodological issues as barriers. Several participants regarded that they would like to see more standardized methods for GHG inventorying, e.g., at the national level. On the other hand, some participants expressed that detailed monitoring may not be necessary or may not lead to the necessary action, and that there is enough information already about what emissions that need to be mitigated. Several participants also expressed that working with consumption-based emissions is not a political priority in the municipalities. Moreover, some participants felt that there is a lack of knowledge, money and/or other resources in the municipality to work with this topic.

### 3.2.5 International workshop (Stockholm 50+)

In the international event organized in connection with the 2022 UN Conference Stockholm 50+<sup>33</sup> participants emphasized the importance of acknowledging that municipalities have different opportunities and challenges and that transition strategies need to be tailored to the specific needs and circumstances of each location. The importance of national-level encouragement and support for municipal sustainable consumption efforts was highlighted.

When discussing opportunities associated with the engagement of different actors, participants stressed the importance of engaging with both businesses and citizens. With regards to the latter, the potential to use gamification and nudging techniques to support sustainable lifestyles was also discussed. Spatial and city planning was identified as an important means for municipalities to support sustainable choices among the public, particularly relating to transportation and citizens access to welfare services. The importance of reuse and sharing of resources was also highlighted as key and where municipalities were suggested to have good potential to contribute to the establishment of smart reuse and sharing systems.

At the same time, the workshop also recognized the responsibilities of individuals in initiating the necessary changes themselves. Good governance, including provision of education and leading by example, were highlighted as important factors for

<sup>33</sup> <https://www.sei.org/events/sustainable-and-just-consumption-based-carbon-budgeting-for-municipalities/>

encouraging this. With regards to which household consumption-categories to target, participants suggested that transport-related emissions should be addressed as a matter of priority. Looking at municipalities' own consumption, the importance of sustainable public procurement was emphasized as well as sharing best practices between municipalities.

It was clear that lack of tools to estimate, and capacity to address consumption-based emissions, are not only problems experienced by the Nordic municipalities but problems that are shared internationally. Access to comprehensive local data related to the own municipality context was also highlighted by several participants. Existing frameworks such as the C40 climate action framework and the DK2020 were highlighted as valuable resources for municipalities to connect to.

## 4 Discussion

At the time of the data collection of this study, less than half of the municipalities in Denmark, Finland, Norway, and Sweden worked actively on measuring consumption-based emissions. However, our data shows that there is a broad interest and need to further develop GHG inventorying to incorporate both municipalities' own consumption-based emissions as well as those of the municipality as a broader society. Our findings suggests that many municipalities in the Nordics have come to realize that such information is needed to identify just and sustainable measures toward climate neutrality. Both expectations and challenges related to consumption-based inventories are remarkably similar across the four countries. By combining our quantitative survey with findings from qualitative workshops we were able to highlight both expectations and challenges with respect to consumption-based data on emissions in the municipalities. In addition, we have used published studies for reflection. This "triangulation" of the issues provides the base for our discussion.

The general expectation is that more accurate and detailed consumption-based information would strengthen climate friendly economic steering and prioritization. Inventories of emissions of residents and businesses is expected to help municipalities to guide residents and businesses to reach reductions and, thus, support the municipalities on a path toward a responsible, just, and sustainable society. It is, however, also recognized that consumption-based emission inventories are resource intensive to develop.

To progress with consumption-based inventories, it is important that their development and practical applications are supported, encouraged, and evaluated (Balouktsi, 2020). Otherwise, applications may simply add to the "incomplete, inconsistent, inaccurate, and incomparable" reporting that Mia et al. (2019) have found to be a key problem in GHG disclosures of cities. To reduce this challenge, the aim should be to establish harmonized approaches for municipal consumption-based emission estimates in the EU and beyond. Hence, there is a need to develop coherent and transparent models and approaches as noted by several authors (Hsu et al., 2019; Arioli et al., 2020; Mueller et al., 2021). The Global Protocol for Community-Scale Greenhouse Gas Inventories (see text footnote 4; GPC) strives to do this based on emission sources according to selected scope 3 emissions. It sets standards for GHG inventories that fulfill the principles of relevance, completeness,

consistency, transparency, and accuracy. Cities with sufficient resources can develop their own emission inventories, but it would also be important to engage municipalities with limited resources, especially when the aim is to create data that can be aggregated from the municipal level to the national level.

Our results suggest that one way to produce reliable municipal consumption-based information is to support municipalities by nationally compiled and verified data that can be used in developing consumption based GHG emission inventories both for the municipality as an organization and as a broader society. Such nationally available data and guidance would reduce the common challenges related to system boundaries that are encountered especially in emission inventories addressing consumption. The national-level support for inventories should also include a repository for all estimates that have been made, with sufficient metadata to ensure reliability and comparability. This would also facilitate exchange across countries and lead to further co-development of standardized methodologies. The Global Protocol for Community-Scale Greenhouse Gas Inventories has initiated the sector-based approach to Scope 3 emissions. A comprehensive consumption-based accounting would for many municipalities be an important complementary approach as it links emissions directly to the consumption. This would support wider municipal activities to foster sustainable consumption focusing also on other aspects than the GHG-emissions.

Most respondents to our survey and participants in the workshops perceived that they need more resources to be able to initiate or strengthen municipal work with sustainable consumption. This is not surprising as any novelty will require some effort to become adopted. The establishment of an inventory requires personnel and financial resources, and special skills are also needed to interpret the data and plan the appropriate measures accordingly. Our observations echo the conclusions by the IPCC AR6 WG3 which stress that availability of national funding is a fundamental pillar of city actors' capacity to develop mitigation policies (Dubash et al., 2022). Institution building is often constrained by a lack of national support, funding, human resources, coalitions, coordination across old and new organizations, and the ability to create new institutional competences. These were reflected in the survey (Figure 5). The workshops also brought up that climate mitigation can be limited by cultural norms and values of policy actors with varying levels of power and shifting alliances.

Salvia et al. (2021) argue that establishing plans at a regional level or through inter-municipal government cooperation could leverage more resources (council staff, population, and budget) to develop and implement climate strategies. However, if public expenditure is seen as a problem, any new demand for resources may be politically rejected, as demonstrated by the current Finnish Government's plan to discard a legal obligation on municipal climate planning that its predecessor had introduced (Government of Finland, 2023, p. 257). The establishment of consumption-based inventories may also be seen as a symbolic action that populists who doubt the necessity of climate action generally may decide to attack. Struggles over symbolic actions can lead to polarization that does not advance climate action (Pielke, 2017). Therefore, it is relevant to also consider the view voiced by some workshop participants who noted that detailed monitoring at the municipal level may

not be needed for action; they argued that a broad overview of emissions is sufficient to guide the adoption and implementation of policies. Municipalities should thus carefully consider the added value of detailed consumption-based inventories before devoting significant resources to it. One specific issue is the definition of the system boundaries, which is a challenge for municipalities that must deal with a great variety of contributors to the overall consumption, from individual households to businesses. Here pragmatic and transparent solutions are needed to avoid confusion and double counting.

To ensure wider application and use of consumption-based emission data, it is essential to create and maintain services that provide all municipalities access to reliable proxy-data which can be used instead of detailed data collected in the municipality. Comparable and transparent information is key as there is currently a very diverse “market” with a wide range of different emission calculators that are based on various assumptions and limitations (Harangozo and Szigeti, 2017; Hsu et al., 2019; Mulrow et al., 2019). It is essential that municipalities can base their actions on coherent and reliable information on consumption-based emissions. Ultimately, the tracking of results in terms of reduced carbon footprint should be linked to the overall national documentation of emission reductions. This is a challenging step and requires that the inventories include consumption-based emissions from both the municipal organization and the citizens using standardized methods.

Pioneer municipalities are important for demonstrating how to produce and use consumption-based information on emissions. An initial step is often to examine the consumption-based emissions of the municipality’s own activities. This strengthens the capacity to deal with consumption-based data and methodological issues such as the specification system boundaries. It also provides the municipality information that can be used directly to improve procurement and support the management system of the municipality.

There is still need for further research-based support on the models and on the use and role of consumption-based emission data in municipal climate policy. Such studies could, for example, explore how consumption-based information can be, or is used, in specific applications such as procurement or in guiding major sectors such as construction, education, or health care to lower their carbon footprint. This was also highlighted in the IPCC AR6 WG3 report. While there is much literature on urban climate governance, there is still limited understanding of the governance models and regimes that support multi-level decision-making for mitigation of consumption-based emissions and climate action in general (Lwasa et al., 2022).

In this study we have not explored how consumption-based inventories might change climate governance by affecting the view of cost and benefits of mitigation vs. adaptation. The issue is important, but beyond the scope of this paper because we do not have data that would allow such comparison. The findings do, however, suggest that an overview of all emissions is important—but not enough alone to ensure lasting policy changes. In municipalities, there is a need to consider the social dynamics and potential causes of conflicts related to climate policies at the local level. Consumption-based inventories highlight consumption

and thus lifestyles and ethics. Hence, information gathered needs to be used wisely to avoid social tensions and contribute to the acceptance of any novel policies addressing emissions from consumption. For example, emissions from transport can be reduced by policies that support a switch to public transport, and these can be justified by consumption-based data. Conflicting views on economics, value-systems and ethics manifested in political differences among the public and politicians should nevertheless be expected. Therefore, measures to ensure social cohesion within the municipality when communicating and implementing consumption-based inventorying and subsequent measures and policies should protect equality and avoid social backlash locally. Protests against climate measures perceived to be unfair can easily emerge. We recognize the importance of these challenges, but a detailed analysis of these is beyond the scope of this paper.

## 5 Conclusions

There has been a rapid rise in quantification and analysis of urban territorial emissions, but gaps remain in our understanding about the global impact of municipal consumption-based emissions. Standardized frameworks and systematic data are still lacking (Hsu et al., 2019; Long et al., 2020). Ultimately, better municipal data could lead to systematic carbon budgeting and discussions on ways to allocate reduction targets within the municipality so that cities could step up their ambition levels to reach the targets of the Paris agreement (GPC, 2021; Salvia et al., 2021). It could also lead to a deeper discussion on the ways that a municipality can influence consumption. In its own procurements, a municipality can employ specific criteria, but the consumption of citizens can mostly be influenced indirectly, through planning and guidance and engaging residents in different campaigns as suggested in the workshops.

The EU Mission Climate-Neutral and Smart Cities<sup>34</sup> provides opportunities to test how consumption-based inventories can be used in efforts to achieve sustainable and just climate neutrality at the municipal level in these pioneer cities. Participant cities could therefore explore possibilities to use consumption-based approaches further and co-develop these by incorporating requirements regarding comprehensive, just, and sustainable GHG inventorying by participating cities.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

<sup>34</sup> [https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities\\_en](https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en)

## Author contributions

HS: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Project administration, Supervision, Writing – original draft, Writing – review & editing. MH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Validation, Writing – original draft, Writing – review & editing. LS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. KA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing. AP: Formal analysis, Methodology, Validation, Writing – review & editing. BA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fclim.2023.1294296/full#supplementary-material>

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