



ACHIEVING HIGH-INTEGRITY VOLUNTARY CLIMATE ACTION

D3.4 - Tested Data Products for Cities

WP3 – Strengthening key design features
and governance frameworks for high-
integrity voluntary climate action



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Summary Requirements

1. Changes with respect to the Description of Action (DoA)

Since we were not able to have full access to the various tools considered in the report, we could not fully test them. Therefore, the report is focussing more on the review part rather than the test part.

2. Dissemination and uptake

The report will be published on the ACHIEVE website and promoted via social media posts (e.g. LinkedIn). It will be taken up in the development of the Cities Roadmap within ACHIEVE.

3. Short summary of results (<250 words)

Traditional greenhouse gas inventory tools remain the most practical option for cities. While these tools differ in data sources, scope, and flexibility, improving transparency and integrating new data sources such as satellite observations, artificial intelligence, and machine learning could enhance their accuracy and comparability. Effective national systems combine centralised coordination with flexibility for local data, reducing administrative burdens while maintaining local relevance.

Emerging emissions tracking platforms, particularly Carbon Monitor Cities, offer more frequent and detailed monitoring than annual inventories. More advanced systems such as EverImpact and ICOS Cities potentially provide highly accurate observations but currently require substantial investment, specialised equipment, and technical expertise. Citizen science complements these approaches by increasing public engagement, supporting behaviour change, and generating locally relevant data.

For most cities, especially those with limited budgets, it is recommended to rely on conventional GHG inventories while joining city networks that provide guidance, training, and access to suitable planning and monitoring tools. More sophisticated monitoring approaches are better suited to larger, well-resourced cities with greater capacity to influence local emissions.

Looking ahead, advances in AI and high-resolution satellite data could significantly improve emissions monitoring and help better link local inventories with national and global climate targets. However, many innovative approaches remain at the pilot stage or are accessible only to a limited number of cities. Given the rapid pace of technological development, city networks are expected to play an increasingly important role in evaluating new tools, sharing knowledge, and supporting cities in implementing effective climate planning.

4. Evidence of accomplishment

This report.

5. Disclosure statement on the use of generative artificial intelligence (AI)

Generative artificial intelligence was not used in the research presented in this report or during the preparation of this report.





Preface

In recent years an unprecedented number of voluntary climate commitments have been made by a wide array of non-state and subnational actors. These voluntary climate actions aim to reduce greenhouse gas emissions and build climate resilience and are crucial for lowering risks of exceeding warming limits. However, the full potential of voluntary climate action can only be realised when integrity-related concerns are overcome. ACHIEVE aims to identify opportunities to strengthen and scale up high-integrity voluntary climate action towards achieving net-zero emissions by mid-century. The project will generate transformative and timely scientific insights on the role, effectiveness and integrity of voluntary climate action including carbon credits; assess the integrity and impacts of such action; analyse how policies and regulations, and high-integrity voluntary climate action can strengthen each other; and use scientific findings to support the scaling up of high-integrity voluntary action. This will be achieved through a highly inter- and transdisciplinary consortium that, from the start, actively engages policymakers and other societal stakeholders in co-creating outcomes that respond to end users' needs. ACHIEVE is aligned with the Work Programme of Cluster 5, Destination 1 "Climate sciences and responses for the transformation towards climate neutrality" as the project directly contributes to advancing knowledge and providing solutions for climate change specifically on high integrity voluntary climate action. ACHIEVE will develop transition pathways to climate neutrality that integrate voluntary climate action by cities, regions and companies; it will develop novel social science insights for climate action; contribute to better understanding sustainability co-benefits and trade-offs; and increase transparency and trust in voluntary climate action by strengthening integrity and making scientific results easily accessible for different stakeholder groups.

RU – Stichting Radboud Universiteit	NL	
NCI – New Climate Institute for Climate Policy and Global Sustainability GGMH	DE	
PBL – Ministerie van Infrastructuur en Waterstaat	NL	
OEKO – Öko-Institut E.V. – Institut für Angewandte Ökologie	DE	
E3M – E3-Modelling AE	EL	
UEF – ITA-Suomen Yliopisto	FI	
CATIE – Centro Agronomico Tropical de Investigacion y Enseñanza Catie	CR	
SU – Stockholms Universitet	SE	
HOL – HOLISTIC IKE	EL	
WWF – Fondo Mundial para la Naturaleza Colombia - WWF Colombia	CO	
CDP – CDP Worldwide (Europe) Gemeinnützige GmbH	DE	
UOXF – The Chancellor, Masters and Scholars of the University of Oxford	GB	





Executive Summary

Cities are both major sources of greenhouse gas (GHG) emissions and key actors in the transition to climate neutrality. Effective climate action requires accurate, timely, and spatially detailed emissions data. This report reviews innovative data products and emerging technologies — including satellite observations, sensor networks, products based on artificial intelligence (AI), and geospatial analytics — that can improve urban GHG emission accounting, tracking, and climate action monitoring. The report also highlights several successful citizen science initiatives. Since the technological developments in this field are on-going and happen at high speed, the report can only provide a snapshot of the current situation.

Emissions accounting tools

The reviewed accounting tools serve different roles in municipal climate planning. While some are tailored to specific national contexts, others offer broader international applicability and more advanced planning capabilities. Future development should focus on greater transparency, stronger integration with national data systems, and support for both baseline emissions assessments and ongoing monitoring.

National practices

The most effective approaches combine nationally coordinated methodologies and databases with flexibility for local adaptation, reducing the workload for cities while maintaining relevance and credibility using local data. National GHG inventory systems face common challenges, particularly regarding Scope 3 emissions, timely data updates, and the integration of external datasets.

Emission tracking tools

Emission tracking tools vary in their emphasis on planning, monitoring, and reporting. Some are particularly useful for scenario modelling and long-term planning, while others focus on tracking progress and communicating results to stakeholders. Greater integration between modelling platforms and reporting systems would improve their effectiveness and usability.

Climate action tracking tools

Climate action tracking platforms support cities in monitoring the implementation and impact of climate measures. They differ in their strengths, ranging from scenario-based planning to progress monitoring and benchmarking. Future improvements could aim to better connect planning, monitoring, and reporting functions while allowing adaptation to different national and regional contexts.

Citizen science

Citizen science initiatives complement formal GHG inventories by engaging citizens in climate action and





generating locally relevant data. Although they do not replace institutional monitoring systems, they can increase transparency, support behavioural change, and improve the connection between climate policies and community engagement.

Conclusion

Cities aim to understand where, when, and how much CO₂ is emitted in order to effectively reduce emissions and achieve climate neutrality. Advances in AI and high-resolution satellite data are bringing this goal closer, complementing conventional carbon accounting methods that remain well suited for annual GHG inventories despite limitations such as time lags and some data uncertainties.

While emerging emission-tracking approaches such as Carbon Monitor Cities show promise, their coverage remains limited, and more advanced systems like EverImpact and ICOS Cities still need to demonstrate their effectiveness beyond city pilot projects. Questions also remain about the costs, technical requirements, and expertise needed to operate such systems.

Given the rapid pace of development and the limited resources available to most cities, city networks can and should play an important role in monitoring developments, sharing knowledge, and providing common tools and services to support their members. Cities that are not already part of such a city network are strongly encouraged to sign up and benefit from the knowledge, advice and training provided.





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1 Introduction, background and motivation

Cities and urban areas are at the forefront of the climate crisis. Although they occupy only a small fraction of the Earth's surface, they are responsible for a substantial share of global greenhouse gas (GHG) emissions due to concentrated energy consumption, transport activity, industrial production, and building-related emissions. At the same time, cities are increasingly recognised as critical actors in the transition towards GHG neutrality. Ideally, robust urban climate policy is based on the availability of accurate, timely, and spatially explicit emissions data capable of supporting evidence-based decision-making, policy design, and monitoring of mitigation progress.

Current urban GHG monitoring approaches, however, face several limitations. Existing inventories are often based on aggregated statistical datasets, emission factors, and periodic reporting mechanisms that may lack temporal granularity, spatial resolution, or methodological consistency across cities. In many cases, urban GHG emissions assessments rely on data that are outdated, incomplete, or insufficiently harmonised, thereby constraining the ability of local authorities and stakeholders to evaluate the effectiveness of climate actions and monitor GHG emissions “closer-to” real time.

Recent advances in Earth observation, remote sensing, sensor networks, digital twins, geospatial analytics, artificial intelligence, and big-data processing offer new opportunities to enhance urban emissions monitoring systems. Innovative data products derived from satellite observations, mobility datasets, smart infrastructure, atmospheric measurements, and integrated modelling approaches have the potential to improve the accuracy, consistency, and operational value of urban GHG assessments.

This deliverable contributes to the development of enhanced methodologies and data ecosystems for urban GHG monitoring. It focuses on the identification, assessment, and review of innovative data products for cities that can support (1) emission accounting, (2) emission tracking, (3) climate action tracking, and (4) presents examples of successful citizen science emissions initiatives. By systematically reviewing these tools following a pre-defined set of criteria (see section 2 below) and evaluating their applicability within urban climate governance contexts, the deliverable aims to strengthen the scientific as well as operational basis for monitoring progress towards GHG neutrality targets at city level. At the same time, the author acknowledges





that this is an extremely fast-moving field with current and on-going advances in AI-technology and developments in satellite- as well as ground-based sensors. These advances may make existing products/methods outdated within months. Therefore, this deliverable presents but a snapshot in time, which will hopefully prove useful for those looking for an introduction into the field.

The report is structured as follows: First, we explain our methodology (section 2). Second, we present a general overview of different types of data tools and products used by cities (cf. section 3). Third, we look in detail into the three main categories of tools reviewed for this report, comparing and contrasting them along different criteria: section **Error! Reference source not found.** on emission accounting tools and national practises, section 5 on emission tracking tools, and section 6 on climate action tracking tools. Additionally we present different citizen science initiatives in section 7. We conclude the report with a synthesis section (section 8) offering a summary of our findings as well as recommendations for cities and their representatives. Finally, there is an extensive annex with factsheets providing further details on the different tools and initiatives considered.





2 Methodology

In order to gather information on the plethora of different tools and data products available for cities regarding GHG emissions accounting and tracking, we first started with desktop research to get an overview by accessing web-based descriptions. City-network platforms (Covenant of Mayors, NetZeroCities, C40 Cities, Energy Cities), as well as websites for individual tools proved the most relevant sources.

Additionally, we tried to engage stakeholders and participate in various online events that promoted the different tools available. Stakeholders contacted were those that Oeko-Institut works with from other national and international research organisations (e.g. ifeu Institute, Holistic, Klimabündnis) and city representatives (e.g. from Munich, Freiburg, Budapest), and representatives of companies offering different services and tools for municipal use. For that purpose, we participated in the Barcelona Smart City World Expo Congress¹ in November 2025, which is an international event bringing together several thousand city representatives, country representatives and company representatives as well as researchers and other interested parties to discuss current trends in the wide field of “smart” cities. City representatives that we talked to included those from Barcelona, Munich, Stockholm, Milan, or Tübingen. Company representatives contacted included those from big companies such as Google, Microsoft or ESRI, as well as those from smaller, more specialised outfits, e.g. Latitudo40, Gartner, DKRS, Caeli, Acri ST or RealityMaps. Moreover, we talked to other researchers involved in European research projects (e.g. ASCEND, SAVE+, ESCALATE) as well as representatives from city networks or facilities such as NetZeroCities, Eurocities, Energy Cities, the European City Facility and the German federal energy agency (dena). Online events attended included a Space4Cities webinar on how different types of satellite data can be used by cities.

Since there is such a multitude of tools and datasets on the market, it became clear that we had to narrow our attention down to a subset of what is on the market. We therefore focused on tools that address GHG emissions in cities (for inventory and tracking purposes) as well as tools providing features such as climate action tracking. The latter tools typically indicate / track the progress a city is making towards net zero emissions by monitoring the climate protection

¹ See <https://www.smartcityexpo.com/>





measures taken. Additionally, we investigated a number of citizen science approaches. When we began carrying out the reviews of those data products and tools, we soon realised that it is difficult to get proper and full access to the tools. Many of the reviews are therefore based on the tool descriptions we found on the internet as well as our own assessment based on the Oeko-Institut's expert knowledge in the field.

For emission accounting tools, emission tracking tools and climate action tracking tools the following categories were assessed – see Table 1 below.

Table 1: Categories and descriptions used for assessing emission accounting and climate action tracking tools

Category	Description
Developer / provider	Platform or company that developed and or provides the tool
Purpose / functionality	The tool's basic purpose und functionality
How it works	The methodology behind the tool
Sectors covered	Sectors may include stationary energy use, transport, industry, different GPC scopes
Access	Free access, different types of restricted access (registration needed, payment needed, location-specific)
Geographic scope	Local, regional, national, global
Languages available	Different languages (if available)
Platform type	Typically web-based or stand-alone spreadsheet
Strengths	Key strengths of the tool considered
Limitations	Key limitations of the tool considered
Example users	Selection of example cities, if mentioned
Website	Website



3 General overview of data tools and products

Urban greenhouse gas (GHG) monitoring and climate governance are already, and will for the foreseeable future, be affected by transformations driven by advances in digital technologies, Earth observation systems, data analytics, and integrated modelling approaches. Cities increasingly require robust, transparent, and timely emissions information in order to design, implement, and monitor climate mitigation strategies. Innovative data tools and products have the potential to be central to enabling evidence-based urban climate action and supporting the transition toward GHG-neutral cities.

Emissions inventories have historically relied on aggregated statistical data and standardised accounting methodologies, mostly with a temporal resolution of one year. While these approaches remain essential for reporting consistency and comparability, they often lack the spatial detail, temporal frequency, and operational flexibility needed for “dynamic” climate policy and “closer-to” real-time evaluation of measures. Emerging data tools and products integrating analytical methods based on newly available data sources (e.g. satellite- as well as ground-based sensors) and technology (e.g. artificial intelligence, machine learning) therefore offer opportunities to complement and enhance existing monitoring systems (cf. sections 4, 5 and 6 below).

This section provides an overview of the main components that characterise contemporary urban GHG and climate action monitoring. First, we address potential areas of application in which the resulting tools and products support urban climate policy. Second, we investigate the methods and analytical approaches underlying these tools. And third, we discuss the various data sources and datasets used to generate emissions-related information, which, in turn, are the basis for the analytical approaches.

3.1 Areas of application

There is a growing range of applications within urban climate governance and emissions monitoring systems². This report focuses particularly on three major applications: emission

² The main GHG gas considered is CO₂; some tools also include GHGs other than CO₂ and present their results in CO₂-equivalents.





accounting tools, emission tracking tools and climate action tracking tools. Additionally, section 0 shows a few positive examples of how citizen science initiatives can contribute to better knowledge of emissions in selected areas of interest.

3.1.1 Emissions accounting tools

Emissions accounting tools are designed to quantify greenhouse gas emissions across sectors and territorial boundaries. These systems form the basis for official climate reporting and target setting. Typical applications include city-wide emissions inventories, often combined with sectoral emissions accounting. These may be used for compliance reporting and may or may not be aligned with national and international reporting frameworks. Innovative data products can enhance accounting systems by improving spatial resolution, temporal frequency, and data completeness.

3.1.2 Emissions tracking tools

Emissions tracking tools focus on monitoring changes in emissions over time on timescales shorter than one year (which is the typical resolution of standard GHG accounting tools). These tools may in the future support “close-to” real-time emissions monitoring. They allow for trend analyses and dynamic visualisations in emissions dashboards as well as monitoring of mitigation pathways. Tracking tools increasingly rely on automated data integration and digital analytics platforms capable of supporting continuous monitoring (cf. section 3.2 below).

3.1.3 Climate action tracking tools

Climate action tracking tools aim to connect emissions trends with policy implementation and mitigation measures. These tools may support and include aspects such as monitoring the implementation of climate action plans, assessing the effectiveness of mitigation measures/policy impacts, and, finally, support evidence-based urban climate governance. Climate action tracking tools extend beyond emissions quantification by incorporating governance, planning, and intervention monitoring dimensions.

3.2 Methods and analytical approaches

The tools discussed above require a range of analytical and modelling techniques. Different methods are applied depending on monitoring requirements, data availability, spatial scale, and policy objectives. As yet there is no single standard method to monitor city-scale GHG emissions,





which makes comparing results between cities difficult (e.g. Satt Arioli et al. (2020)).

3.2.1 Standard emissions accounting approaches

Conventional emissions accounting approaches remain the methodological backbone of urban GHG inventories and climate reporting systems. These approaches typically rely on the combination of activity data and emission factors, which may or may not be sector specific, as well as suitable statistical aggregation procedures.

Standardised accounting frameworks, such as the Greenhouse Gas Protocol (2021), provide transparency and comparability across cities and countries. They are essential for official reporting and policy alignment, but may face limitations regarding timeliness, spatial detail, and responsiveness to rapidly changing urban dynamics (e.g. in the mobility sector).

3.2.2 GIS-based approaches

Geographic Information Systems (GIS) play a central role in spatially explicit urban emissions analysis. GIS-based methodologies enable the integration, visualisation, and analysis of geographically referenced datasets from multiple domains. Applications include, for example:

- Spatial allocation of emissions
- Infrastructure mapping
- Land-use modelling
- Spatial scenario analysis
- Climate vulnerability assessments.

GIS approaches are particularly important for translating emissions information into locally actionable planning and policy insights.

3.2.3 Artificial intelligence and machine learning

Artificial intelligence (AI) and machine learning (ML) approaches are increasingly applied to large and complex urban datasets. These methods support automated analysis, predictive modelling, and pattern recognition across multiple data streams. Potential applications may include the estimation of building energy demand, the detection of land-use changes, the modelling of mobility and transport emissions as well as forecasting emissions trajectories. Furthermore, ML approaches can support automated classification of satellite imagery and make plausible suggestions to fill data gaps. AI-based approaches can improve scalability and analytical





efficiency, particularly in contexts involving large Earth observation datasets and high-frequency sensor data. Since AI-tools as well as ML-approaches often come across as black boxes, methodological transparency, reproducibility, and explainability remain important considerations in policy-oriented applications potentially limiting the range of their use.

3.2.4 Hybrid and integrated approaches

Increasingly, urban climate monitoring systems combine multiple methodological approaches in order to improve robustness and reduce uncertainty. Hybrid approaches range from combining statistical inventories with satellite observations to integrating ML outputs into GIS-based models. Furthermore, they can be used for coupling atmospheric monitoring with bottom-up accounting approaches, or link sensor-based monitoring with policy evaluation frameworks. Such integrated approaches are particularly relevant for urban systems, where emissions processes may be interconnected and dynamic. Hybrid methodologies can improve both scientific accuracy and operational applicability (see, for instance, section 5.3 below).

3.3 Data sources for urban GHG monitoring

Urban emissions monitoring increasingly depends on the integration of heterogeneous datasets originating from multiple sources, technologies, and governance levels. Different data sources provide complementary information with varying spatial coverage, temporal resolution, and thematic specificity.

3.3.1 Official statistical and administrative data

Official statistical and administrative datasets remain the basis for emissions accounting and climate reporting frameworks. Such data are typically collected and maintained by national statistical offices, municipal administrations, and public agencies. Besides population and socio-economic statistics, these typically include building registries and cadastral data. Additionally, they may include energy consumption records, if available, as well as transport and mobility statistics.

These datasets are widely used in conventional bottom-up emissions inventories because they provide sector-specific information aligned with established accounting methodologies. Administrative data are particularly important for ensuring consistency with national reporting obligations and international standards such as the Global Protocol for Community-Scale





Greenhouse Gas Emission Inventories (Greenhouse Gas Protocol, 2021).

3.3.2 Utility and infrastructure data

Utilities and infrastructure operators increasingly generate detailed operational datasets relevant to urban emissions monitoring. Typical data sources include data on fixed infrastructure networks (electricity, gas and district heating), renewable energy generation records, data on public transport operations as well as water and waste management information.

These datasets can significantly improve the granularity and accuracy of emissions estimates, especially when integrated with spatial and temporal analytics. However, access to utility data may be restricted due to privacy concerns, commercial sensitivity, or institutional barriers.

3.3.3 Satellite and earth observation data

Satellite-based Earth observation systems provide large-scale and spatially consistent information that can support urban emissions analysis and environmental monitoring. These datasets are particularly valuable for assessing urban morphology, land-use dynamics, energy-related indicators, and environmental conditions across broad geographic areas. Relevant satellite-derived data include:

- Optical imagery for land-use and land-cover classification, urban expansion analysis, and vegetation monitoring,
- Thermal imagery for analysing urban heat islands, building energy performance, and industrial heat emissions,
- Atmospheric observations for measuring concentrations of air pollutants and greenhouse gases.

Earth observation data offer advantages in terms of scalability, repeatability, and harmonisation across regions. However, they often require integration with ground-based and administrative datasets to improve interpretation and validation. As yet there is no possibility of measuring CO₂-levels in the atmosphere via satellites on a spatial resolution that would enable cities to accurately track their CO₂-emissions in real-time (Hammerling et al., 2012; Pan et al., 2021).

3.3.4 Ground sensors and IoT-based data

The increasing deployment of sensor technologies within urban environments provides new opportunities for near real-time environmental monitoring and emissions tracking. Ground-based and Internet of Things (IoT)-generated datasets may include air-quality monitoring





stations, traffic and mobility sensors, smart building systems or energy monitoring devices.

These data streams provide high temporal granularity and can support dynamic monitoring applications, including short-term emissions estimation and behavioural analyses. Smart-city infrastructures and IoT-technologies are therefore becoming important components of urban climate monitoring systems. At the same time, challenges related to data interoperability, quality assurance, cybersecurity, and long-term operational maintenance remain significant.

3.3.5 Multi-source data integration

No single data source is sufficient to comprehensively capture the complexity of urban emissions. Urban monitoring approaches therefore increasingly rely on multi-source integration frameworks that combine administrative records, and operational infrastructure datasets with Earth observation data and sensor networks. This kind of integration enables cross-validation of emissions estimates (which reduces uncertainty) as well as improved spatial and temporal resolution.





4 Emissions accounting tools and national practises

This section focuses on digital tools that support cities and municipalities in compiling standardised GHG inventories. These tools are primarily used for baseline emissions accounting and periodic reporting, based on activity data and emissions factors. In the first subsection, we present a set of accounting tools that are being used in different cities, starting with an example from Germany (Klimaschutz-Planer) and broadening the scope to internationally available tools. Further tool details can be found in the annex. The second subsection (section 4.3) looks at how different countries approach carbon accounting in cities with a more or less centralised approach. The tools used are mostly country-specific and therefore geographically restricted. Nonetheless, they provide interesting insights into how important the centralised provision of certain GHG emission indicators can be.

4.1 Summary of key tools for municipal GHG inventory development

The following table presents an overview of a set of emissions accounting tools used by cities in Europe and beyond. These tools enable local governments to quantify GHG emissions across different sectors by combining local activity data with standardised emissions factors. All listed tools are designed to support structured, policy-aligned GHG inventories, although their availability, data requirements, and geographic applicability vary. The tools included here represent a mix of national, international, and independent systems, each with specific strengths and limitations based on the user type, sectoral scope, and integration with existing planning frameworks.





Table 2: Overview of key emissions accounting tools used by municipalities for GHG inventory development

Tool Name	User Type	Core Function / Scope	Sectors Covered	Global Availability	Access Type
Klimaschutz-Planer (Klimaschutz Planer (<i>Klima-Bündnis der europäischen Städte mit indigenen Völkern der Regenwälder Services GmbH, n.d.</i>))	Government / Official Use	Accounting emissions based on inventory updates for municipalities using BSKO datasets and German standards.	Covers energy use in private households, industry, municipal infrastructure, commerce, and transport.	No, only in Germany	Restricted to German municipalities
ECOREgion (<i>ECOSPEED</i>)	Government / Official Use	GHG accounting and scenario modelling tool that helps visualise and simulate the impact of various local policies.	Covers similar sectors as BSKO: energy, buildings, transport, etc.	No, Germany, Italy, Luxembourg, Switzerland	Restricted to selected municipalities
CIRIS (C40) (<i>Global Covenant of Mayors, 2024</i>)	Government / Official Use	Standardised Excel-based GHG inventory	Stationary energy, transportation, waste, industrial processes	Yes, Global	Registration required
ClearPath (ICLEI) (<i>ICLEI USA, 2025</i>)	Government / Official Use	Manage inventories, forecast emissions, monitor progress against climate targets.	Stationary energy, transportation, waste, industrial processes	Yes, available worldwide via ICLEI membership	Restricted to ICLEI member cities
Google EIE (<i>Google</i>)	Independent	Provides modelled estimates of citywide CO ₂ emissions using satellite	Buildings, road transport	No, only selected cities	Public access



		imagery and traffic activity.			
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4.2 Comparative review of emissions accounting tools

The following comparison of the tools shown above draws on different criteria such as usability, adaptability, data handling, innovation, and how well each tool meets municipal needs.

Usability and accessibility

The tools vary considerably in terms of ease of access and user interface design. Klimaschutz-Planer and ECORegion are well integrated into national or regional frameworks. They offer guided, municipality-focused interfaces but are only accessible to German municipalities or members of specific alliances. ClearPath is also easy to use and includes built-in support features, although access is limited to ICLEI members. CIRIS, on the other hand, is globally available at no cost, but since it operates through Excel, users need a certain level of technical knowledge. Google EIE requires the least effort to access, as it provides automatic emissions data for selected cities. However, it does not support any form of user input or customisation. Google EIE may still be used to fill certain emission data gaps, e.g. in the transportation sector.

Adaptability to different municipal contexts

Adaptability refers to how easily a tool can be applied across various countries, city sizes, and governance systems. CIRIS and ClearPath perform well in this category. CIRIS is compatible with the GPC framework, which supports use in different global contexts. ClearPath enables scenario modelling and target setting, making it useful for municipalities at different stages of climate planning. By contrast, Klimaschutz-Planer and ECORegion are closely linked with national-level methods and data structures. This connection limits their usefulness outside their respective countries. Google EIE offers consistent data outputs for many urban areas but is only beneficial for cities already included in its dataset (mostly big cities).

Data input and output transparency

Klimaschutz-Planer and ECORegion follow a combined model that uses both local activity data and national default values for calculating city emissions inventories. This approach ensures consistency with policy frameworks such as BSKO or IPCC and eases the data input burden. CIRIS and ClearPath rely entirely on data entered by the user. This supports full transparency and ensures that municipalities retain full control of their inventories. In contrast, Google EIE generates emissions data automatically based on satellite and mobility data. Although this allows for quick assessments, the assumptions and methods used are not fully disclosed, and cities have





no way to verify or adjust the results.

Innovation and future relevance

From an innovation standpoint, Google EIE offers a new approach by using automation and satellite-based estimates. This model is especially helpful in areas with limited access to emissions data, or otherwise hard-to-come-by data such as from the transportation sector. ClearPath is notable for its integrated planning capabilities, allowing municipalities to project and evaluate climate strategies. Klimaschutz-Planer is updated regularly to reflect changes in German policy but still focuses primarily on static inventory creation. ECORegion includes basic tools for scenario modelling. CIRIS does not feature advanced functions or automation.

Summary

Each tool occupies a specific role in the landscape of municipal climate planning. Klimaschutz-Planer and ECORegion are well suited for their national settings but are not designed for use across Europe. CIRIS and ClearPath are more versatile, with global relevance. ClearPath also offers more advanced planning functions. Google EIE is highly accessible and technically forward-looking, but its best role as of now is as a benchmarking tool and provider of specific data (e.g. in the mobility sector). In the future, development of emissions accounting tools should emphasise better transparency, closer integration with national data systems, and features that support both baseline assessment and continuous monitoring.

4.3 National and local municipal GHG accounting systems: country profiles

Cities' GHG inventories play a key role in supporting local climate policy. They allow cities to assess the status-quo, define achievable goals, and monitor their performance. Even though the desired outcomes are reliable, i.e. usable local emissions data, the systems used to generate these inventories differ significantly from one country to another. These differences can be seen in institutional arrangements, data flows, methods used, and technical infrastructure.

This section provides profiles of selected European countries, focusing on how they handle municipal GHG accounting in practise. For each country, the following aspects are addressed:

- Tools and platforms used: the primary systems or templates municipalities rely on for GHG inventory preparation





- Methodological approach: how emissions are calculated, the scopes included, and the sectors addressed
- Data sources and data providers: details on data origin, access, and institutional coordination
- Strengths and limitations: key benefits and constraints associated with the respective national approaches.

4.3.1 Denmark

Tools and platforms used

Denmark's primary platform for municipal GHG inventories is the Energy and CO₂ Accounts (Energi- og CO₂-regnskabet), which is managed by the Danish Energy Agency and available through the national energy efficiency site SparEnergi.dk (Danish Energy Agency). This centralised platform compiles annual greenhouse gas inventories for all 98 Danish municipalities using national datasets that cover sectors including energy, transport, buildings, agriculture, and waste (Center Denmark; Danish Energy Agency).

Municipalities are not required to collect baseline data manually. Instead, the system pre-fills inventories with national emissions data, allowing municipalities to review and confirm the figures on an annual basis (State of Green). They can adapt the pre-filled data with more precise local sources, such as utility records or traffic counts. The platform also allows municipalities to visualise emissions by sector through dashboards and to use scenario modelling for assessing policy impacts (Center Denmark; Viegand Maagøe, 2025).

Methodological approach

The Energy and CO₂ Accounts system uses a generic data model that translates national datasets into a unified calculation framework. Activity data such as energy usage, vehicle numbers, and livestock quantities are converted into CO₂ equivalents by applying emission factors that are nationally approved and consistent with IPCC guidelines (Center Denmark; State of Green).

The platform accounts for Scope 1 emissions from energy, transport, agriculture, and waste. It includes Scope 2 emissions from purchased electricity and heat. Generally, Scope 3 emissions are excluded (Center Denmark; State of Green). The sectors addressed are energy supply, buildings, transport, agriculture, and waste (State of Green).



Data sources and providers

The Energy and CO₂ Accounts system collects data from a variety of national and sector-specific databases. Statistics Denmark contributes energy, population, and vehicle data. The National Building Register (BBR) provides information about buildings and heating systems. Utility providers and Energinet supply electricity and gas consumption data. The Danish Transport Authority, DSB, and Banedanmark contribute data on rail transport energy usage. Public transportation operators provide fuel usage statistics. The Danish Centre for Environment (DCE) supplies agricultural and land use data, and the Environment Ministry offers information for the waste sector (Center Denmark; Viegand Maagøe, 2025).

Strengths and limitations

There are multiple strengths to the Energy and CO₂ Accounts platform. Its pre-filled inventories reduce the workload for municipalities (State of Green). Its use of a common methodology ensures comparability between different local authorities (Center Denmark). The platform also supports adjustments with local data and offers scenario modelling tools that increase its usefulness (Viegand Maagøe, 2025). Plans are in place to include real-time data through integration with smart meters and utility systems (Center Denmark).

Some limitations do exist. The system does not cover Scope 3 emissions (State of Green). Since data updates occur annually, rapid local developments may not be reflected unless municipalities update them manually. Smaller municipalities may also lack the capacity to make full use of the system's customisation features (Viegand Maagøe, 2025).

4.3.2 The Netherlands

Tools and platforms used

In the Netherlands, the main system used for energy and GHG data at the municipal level is the Regionale Klimaatmonitor³ (Regional Climate Monitor). This centralised national platform is developed and maintained by the Netherlands Enterprise Agency (RVO). The Klimaatmonitor provides yearly data on GHG emissions and energy use for all municipalities, provinces, and regions. Municipalities have direct access to processed statistics, which are broken down by

³ <https://data.overheid.nl/community/application/klimaatmonitor>



sector, e.g. transport, residential energy use, or industry. In some cases, data is available at the neighbourhood level (Data Overheid). Although some cities produce separate reports in line with frameworks like the Covenant of Mayors or the C40 protocol, they mainly use Klimaatmonitor data as the official foundation for these reports (Man, 2023).

Methodological approach

The Klimaatmonitor uses a bottom-up approach. Actual activity data is collected by national agencies and grid operators, including electricity and gas consumption figures. These are combined with standardised emission factors to estimate annual CO₂ emissions by sector (Data Overheid). The structure of the data follows the IPCC sector categories. However, the system does not explicitly apply the GPC scope terminology. Scope 1 emissions, which refer to direct emissions from fuel use, and Scope 2 emissions from electricity consumption are covered. Scope 3 emissions are generally not included. Data is updated once per year, usually with a one-year delay (Man, 2023).

Data sources and providers

Several key sources contribute data to the Klimaatmonitor. Statistics Netherlands (CBS) provides sector-specific energy consumption data, transport statistics, and demographic indicators. The Netherlands Enterprise Agency (RVO) contributes data on renewable energy projects and subsidies. Industrial emissions are included from Emissieregistratie (official emissions registry). Utility companies supply metered electricity and gas use. Road authorities and Statistics Netherlands contribute figures on fuel consumption and vehicle distance travelled. These combined sources ensure consistency and comparability across all municipalities (Data Overheid).

Strengths and limitations

The Klimaatmonitor offers municipalities standardised and reliable data, which supports comparisons between cities. The platform is publicly available, connects to local dashboards, and relies on high-quality national datasets that are updated regularly (Data Overheid).

At the same time, there are limitations. The platform is primarily focused on CO₂ emissions from energy sources, so other greenhouse gases like methane or nitrous oxide are less thoroughly represented. The system assumes that locally generated renewable energy is consumed locally, which can lead to inaccuracies in cases where a municipality is a net importer or exporter of energy. In addition, municipalities have limited flexibility to add unique local data or adjust





calculation methods (Man, 2023).

4.3.3 Poland

Tools and platforms used

When it comes to GHG inventories, municipalities in Poland either use the Covenant of Mayors (CoM) emission inventories methods and templates or they rely on spreadsheets or databases developed by consultants or regional energy agencies. Those that are part of the CoM network follow the official CoM Excel templates for Baseline Emission Inventories (BEIs) and Monitoring Emission Inventories (MEIs). BEIs are prepared when a municipality joins, and MEIs are submitted every two to four years to monitor progress on SECAP targets. The Polish Network Energie Cités (PNEC⁴) offers guidance and support to local authorities through this process (Stowarzyszenie Gmin Polska Sieć „Energie Cités”, 2025).

Municipalities that are not affiliated with CoM typically supplement their inventory data with national data made available by KOBiZE⁵, which is the National Centre for Emissions Balancing and Management. KOBiZE provides standardised emission factors, methodology instructions, and aggregated emissions data that municipalities can scale down to the local level (The National Centre for Emissions Management; UNFCCC, 2024).

Methodological approach

The approach used for municipal greenhouse gas inventories in Poland generally follows international standards, including the Local Government Operations Protocol (LGOP) developed by ICLEI, the IPCC Guidelines, or the GPC. These inventories usually include Scope 1 emissions that occur directly within municipal boundaries, Scope 2 emissions from electricity and heat that are purchased, and, in some cases, selected Scope 3 emissions. The method of calculation is based on multiplying activity data by relevant emission factors, in line with both national and international practices (LIFE REMY Project, 2023; UNFCCC, 2024).

Data sources and providers

Key sources of data include utility companies that provide figures for electricity, gas, and district

⁴ <https://www.pnec.org.pl/en/>

⁵ <https://www.kobize.pl/en/page/id/409/about-us>





heating. Transport authorities contribute vehicle registration data and traffic count statistics. Waste companies offer information related to treatment and disposal. Additional data comes from Statistics Poland (GUS⁶), which supplies demographic figures and energy consumption indicators. KOBiZE supports the process by providing nationally consistent emission factors, detailed methodologies, and information about emissions from large facilities (The National Centre for Emissions Management; UNFCCC, 2024).

Strengths and limitations

Poland's approach benefits from strong alignment with international standards, and KOBiZE ensures a consistent methodological foundation. Regional energy agencies also provide valuable assistance, especially to smaller municipalities that may have limited technical capacity.

Limitations include the fact that there is no dedicated national platform specifically for municipal GHG accounting. As a result, most municipalities rely on spreadsheets or tools created by consultants. Scope 3 emissions are generally not included in the inventories. Furthermore, many municipalities only update their inventories every two to four years as part of the CoM reporting cycle, which limits their ability to track progress on an ongoing basis (LIFE REMY Project, 2023).

4.3.4 Slovenia

Tools and platforms used

In Slovenia, municipalities typically use one of two main methods to prepare their GHG inventories. Municipalities that are part of the Covenant of Mayors (CoM) follow the official CoM Excel templates to complete both Baseline Emission Inventories (BEI) and Monitoring Emission Inventories (MEI). These templates are consistent with the GPC and the IPCC framework. BEIs are submitted when municipalities join the initiative, while MEIs are submitted every two to four years to track progress toward targets under the Sustainable Energy and Climate Action Plan (SECAP) (Envirodual, 2024; Neves et al., 2016).

Municipalities that are not CoM members usually take a different approach. They often use national or sector-specific data from the Slovenian Environment Agency (ARSO) accessed through

⁶ <https://new.stat.gov.pl/en>





the Okoljski Kazalci portal⁷. Some municipalities use tools developed by consultants or as part of EU-funded projects. In Ljubljana's case, a fully automated digital emissions platform is in use (Envirodual, 2024; Slovenian Environment Agency, 2024).

Methodological approach

Slovenian GHG inventories mostly follow the methodologies of the IPCC and GPC. They include Scope 1 emissions generated within the municipal boundary and Scope 2 emissions from purchased electricity and heat. In some cases, certain Scope 3 emissions, such as waste-related emissions, are also included (Republic of Slovenia, Ministry of the Environment and Spatial Planning, 2018). The main sectors covered are stationary energy, transport, waste and wastewater, industrial processes, and agriculture, forestry, and land use (Slovenian Environment Agency, 2024).

In smaller municipalities, it is common to estimate emissions using per capita or GDP-based national data from ARSO. This reflects a top-down estimation approach rather than a bottom-up method based on detailed local figures (Interreg Europe, 2022).

Data sources and providers

Municipal GHG inventories are built using data from multiple providers. These include electricity, gas, and district heating utilities. The Statistical Office of Slovenia supplies demographic data and information about types of heating used. National GHG statistics come from ARSO. The National Pollution Registry provides emissions from major sources. Transport authorities contribute data on vehicle registrations and traffic counts (Interreg Europe, 2022; Slovenian Environment Agency, 2024).

Strengths and limitations

The GHG inventory process in Slovenia has several advantages. It aligns with international standards such as IPCC and GPC. The system is flexible enough to accommodate municipalities of different sizes. Capacity-building efforts are supported through EU and regional programmes (Interreg Europe, 2022).

On the other hand, there are also challenges. The country does not have a single national

⁷ <https://kazalci.arso.gov.si/en>





platform for municipal GHG accounting, which results in variations between methods used. The process can be time-consuming and manual. Scope 3 emissions are not thoroughly included. Inventories are often only updated every few years, which can limit their usefulness (Interreg Europe, 2022; Slovenian Environment Agency, 2024).

Ljubljana's digital monitoring system

The City of Ljubljana has introduced a fully digital, real-time platform for monitoring GHG emissions. This tool was developed in cooperation with Envirodual⁸. It brings together data from energy providers, transport counts, waste systems, and energy logs from both public and private buildings. The system automatically processes this activity data into CO₂ equivalents using embedded emission factors. It updates results immediately when new data is integrated. The platform also replaces traditional spreadsheet reports with a centralised dashboard. In addition, it allows for scenario modelling to evaluate policies like electric bus rollouts or district heating network expansions (Envirodual, 2024)

4.3.5 Sweden

Tools and platforms used

In Sweden, the official municipal-level GHG inventories are provided through the National Emission Database⁹, which is managed by the Swedish Meteorological and Hydrological Institute (SMHI) on behalf of the Swedish Environmental Protection Agency. These inventories are based on Sweden's national reporting under the UNFCCC and are distributed geographically using a 1 by 1 kilometre grid. This grid is developed using proxy data and national models (SMHI, 2024; Swedish Environmental Protection Agency). Each grid cell includes pre-calculated emissions data that are broken down by sector: transport, heating, agriculture, and waste. Municipalities can either download full reports or select grid cells corresponding to their geographic area through an online portal. Many municipalities also use additional tools such as Climate View (cf. factsheet 11.1) or Futureproofed Cities (factsheet 11.2) to support climate action planning and scenario modelling. These external platforms often import data from SMHI and combine it with local data

⁸ <https://www.envirodual.com/services/ghg-emissions-inventory%2C-ecological-footprint%2C-reporting>

⁹ <https://www.smhi.se/en/services/air-quality---consulting-assignments/emission-inventories>



(CDP, 2024).

Methodological approach

Sweden uses a mixed approach that combines top-down and bottom-up methods. National-level inventories are compiled first and then disaggregated into municipal-level estimates using local proxy indicators. These proxies include information such as traffic volumes, land use in agriculture, population density, and facility-level industrial data. This spatial breakdown is performed by the Svenska Miljöemissionsdata (SMED) consortium (Berthling, 2024). Some of the larger municipalities review and enhance the modelled data with their own local figures. Most inventories focus on Scope 1 emissions, with Scope 2 emissions added where appropriate. Scope 3 emissions are not systematically included. The methodologies used follow IPCC and GPC guidelines (Swedish Environmental Protection Agency, 2024).

Data sources and providers

Data coordination is handled by the SMED consortium, which is also responsible for data collection, model development, and overall compilation of the inventories. The Swedish Environmental Protection Agency reviews and validates the data before it is submitted to the UNFCCC. The inventory uses multiple data types, including national fuel consumption figures, heating statistics, transport activity, building data, industrial emissions, and figures related to agriculture and waste (SMHI, 2024; Swedish Environmental Protection Agency).

Strengths and limitations

The Swedish system is known for its consistency and high quality. All inventories are developed using the same national methodology that supports the country's UNFCCC reporting, which ensures strong comparability across municipalities. The use of a 1 by 1 kilometre grid provides fine spatial detail. The involvement of SMED offers a robust quality assurance process (Berthling, 2024). Additionally, the system can be linked with external planning tools such as Climate View, allowing municipalities to integrate inventory data into their climate strategies (CDP, 2024).

Despite these strengths, some limitations remain. There is often a delay of 12 to 18 months before data is published. Municipalities also need to perform their own data aggregation because there is no specific national platform for local inventory generation. Scope 3 emissions are not systematically addressed, which limits the overall completeness of the inventories (Swedish Environmental Protection Agency, 2024).



4.3.6 United Kingdom

Tools and platforms used

In the United Kingdom, two main tools are used for municipal GHG emissions accounting. The first is the Local Authority GHG Emissions Statistics, which is published each year by the Department for Energy Security and Net Zero (DESNZ¹⁰). These statistics break down national greenhouse gas totals to the level of local authorities, using sector-specific data for areas such as buildings, transport, agriculture, waste, and industry. The data includes emissions of carbon dioxide, methane, and nitrous oxide (Department for Energy Security and Net Zero, 2023).

The second tool is SCATTER (cf. factsheet 11.3), which stands for Setting City Area Targets and Trajectories for Emissions Reduction. It is a free web-based platform created by Anthesis in partnership with DESNZ, Nottingham City Council, Greater Manchester Combined Authority, and the Tyndall Centre. SCATTER provides inventories aligned with the GPC framework and includes carbon budgets and emissions reduction scenarios. More than 300 local authorities currently use SCATTER to support their climate strategies and reporting (Forrest, 2025; SCATTER).

Methodological approach

The Local Authority Statistics are based on the National Atmospheric Emissions Inventory (NAEI¹¹), which is developed by Ricardo Energy and Environment under contract to the UK government. The NAEI follows IPCC guidelines to compile emissions data for sectors such as energy, transport, agriculture, industry, and waste. Ricardo is responsible for data gathering, modelling, and aggregation (Ricardo, 2022). DESNZ uses the data from the NAEI to distribute emissions across local authorities using proxy indicators like energy consumption, traffic patterns, population data, and land use. The results are published each year but usually with a delay of about 18 months (Department for Energy Security and Net Zero, 2023).

SCATTER builds on the government's local statistics by importing them and converting the data into Scope 1, 2, and 3 categories in line with the GPC framework. Local authorities can improve the results by adding local datasets, such as building-specific energy use or vehicle traffic counts.

¹⁰ <https://www.gov.uk/government/organisations/department-for-energy-security-and-net-zero>

¹¹ <https://naei.energysecurity.gov.uk/>



SCATTER also provides tools for modelling future emissions reduction scenarios¹².

Data sources and providers

The main data sources for GHG accounting are DESNZ and the NAEI, operated by Ricardo. These sources offer both national totals and disaggregated inventories at the local authority level. Additional data comes from the Department for Transport, which supplies transport-related emissions. The Environment Agency contributes industrial facility data. Agricultural sources and the Centre for Ecology and Hydrology provide land use and farming information. Local councils also add their own data when refining inventories within SCATTER (Department for Energy Security and Net Zero, 2025; Ricardo, 2022).

Strengths and limitations

The UK system combines the reliability of official government data with the flexibility offered by SCATTER for local updates. It covers multiple greenhouse gases including CO₂, methane, and nitrous oxides. It is aligned with international frameworks like the GPC and the CDP. SCATTER also allows for forward-looking analysis through its scenario modelling tools (Forrest, 2025; SCATTER).

There are still a few limitations. The publication of official data is delayed by around 18 months. Since much of the data is based on top-down methods, it may not capture rapid local changes. Scope 3 emissions are not comprehensively included. Smaller councils may also lack the resources or expertise to make full use of SCATTER's features (Department for Energy Security and Net Zero, 2023; Ricardo, 2022).

4.3.7 Insights from national practises

National practises reveal different approaches to organising and supporting municipal GHG inventories. While institutional structures vary, several patterns emerge that could inform system design elsewhere.

Top-down with local refinement

Denmark's Energy and CO₂ Accounts follows a top-down approach where the national authority

¹² <https://scattercities.com>



prepares baseline inventories, and municipalities can refine these figures if they have accurate local data. The United Kingdom's National Atmospheric Emissions Inventory is used by the Department for Energy Security and Net Zero (DESNZ) to generate local authority GHG statistics by allocating national totals to local areas using proxies such as energy consumption, traffic volumes, population, and land use. While most municipalities rely on these centrally produced datasets, some enhance them using tools like SCATTER, which offers additional flexibility for scenario analysis and sector-specific detail.

Central databases with local inventory responsibility

Sweden, Slovenia, and Poland maintain national or regional databases that provide sector-level emissions data. In Sweden, the gridded dataset using one by one-kilometre cells is provided by national agencies. Cities select the grid cells within their boundaries and sum sector-specific values to compile results. In Ljubljana (Slovenia), using the ARSO database, and in Poland with the KOBIZE database, the national data serves as a starting point. Cities are still responsible for preparing their own inventories using the figures drawn from these databases.

Bottom-up via centralised service provision

The Netherlands uses the Klimaatmonitor tool in a bottom-up approach where the central statistical agency compiles full inventories on behalf of all municipalities. This ensures consistency, reduces administrative burden, and guarantees full coverage. However, it requires strong central capacity and continuous data-sharing agreements with local actors.

Integration with planning tools

Systems that link inventory data directly to scenario analysis or planning platforms increase their value for climate action. For example, the United Kingdom's SCATTER and Ljubljana's climate planning tool both enable municipalities to model the impacts of different mitigation measures directly from inventory outputs (cf. also section 6 on climate action tracking tools).

Common challenges across different approaches

Regardless of the approach, most systems face challenges in Scope 3 coverage, timeliness of data updates, and integration with external datasets such as utility consumption records. Addressing these issues could enhance both accuracy and responsiveness.

While no single model can be applied universally, the reviewed approaches show that the most





effective systems combine consistency from national coordination with flexibility for local adaptation. Centralised tools and databases can greatly reduce the workload for cities and enable the comparability of cities due to the same methodologies used. But allowing space for local refinement, particularly where high-quality local data exists, ensures that GHG inventories remain credible and relevant for guiding climate action at a local level.





5 Emissions tracking tools

This section provides an overview of different emission tracking approaches and associated tools. The first two subsections focus on platforms that achieve emission tracking through remote sensing technologies, combined with open datasets. The last subsection (section 5.3) presents two examples of a more complex combined approach: besides satellite-based data, these rely also on ground-based sensors, that need to be installed in the cities concerned. This approach has only recently been piloted and it is yet to be seen if and how it can move beyond pilot projects. All tools are presented in more detail in annex factsheets section.

5.1 Publicly available remote-sensing platforms for emissions tracking

Publicly available remote-sensing platforms provide independent, globally consistent GHG emissions data derived primarily from satellite observations, combined with modelling and open datasets. Unlike municipal accounting tools, which often rely on locally reported activity data, these platforms operate largely independently of local authorities and make their results freely accessible through online dashboards or datasets. Their outputs are particularly valuable for cross-city comparisons, rapid trend detection, and verification of self-reported inventories. While spatial and temporal resolutions vary between platforms, they generally cover multiple sectors, from energy and transport to agriculture and waste, and can serve as complementary resources for both researchers and policymakers.





Table 3: Overview of publicly available remote-sensing platforms

Tool	Developer / lead organisation	Geographic coverage	Resolution & update frequency	Data sources & methodology	Sectors covered	Access & usability
Carbon Monitor Cities (Carbon Monitor)	Tsinghua University, University of California, other research partners	~150 major cities worldwide	Daily to monthly updates; data typically available with a short time lag	Combines near-real-time activity data (e.g., electricity generation, industrial production, traffic, flight activity) with emission factors; downscaled to city boundaries using population and economic data	Power, Industry, Ground Transport, Aviation, Residential & Commercial Buildings	Fully public; interactive dashboard and downloadable datasets; requires familiarity with interpreting scientific datasets
Climate TRACE (Climate TRACE)	Global coalition of NGOs, tech companies, and research organisations	Global (all countries; ~500+ subnational regions and selected cities)	Annual updates (some sectors more frequent)	Uses satellite remote sensing, AI, and other geospatial datasets to detect and quantify emissions from individual facilities and activities; aggregates to regional/city levels	Power, Industry, Oil & Gas, Transport (road, aviation, shipping), Agriculture, Waste	Fully public; open-data portal with facility-level search; requires understanding of geospatial datasets for advanced use



5.2 Comparative review of remote-sensing platforms for emissions tracking

This section compares the two remote-sensing-based emissions platforms considered in the overview table. The focus lies on spatial coverage, update frequency, methodological transparency, and how relevant each tool is to municipal emissions tracking. While both platforms offer valuable emissions data from independent sources, their technical design, spatial resolution, and intended users differ.

Geographic and spatial relevance

Each platform varies in how it handles geographic and spatial detail. Carbon Monitor Cities is designed specifically with cities in mind and delivers near-real-time emissions estimates for a limited number of approximately 150 cities across the globe. In comparison, Climate TRACE provides global coverage and can zoom in to the facility level in certain sectors. However, not all cities are represented equally. Many urban areas are only captured through broader regional estimates.

Update frequency and timeliness

The platforms also differ in how often they update their data. Carbon Monitor Cities provides the most frequent updates, ranging from daily to monthly. This level of detail makes it particularly effective for monitoring short-term changes, whether due to seasonal patterns or the introduction of new policies. Climate TRACE typically updates its data once a year, although some sectors, such as power generation, are updated at a higher frequency.

Methodological transparency and accessibility

In terms of transparency and access, both Carbon Monitor Cities and Climate TRACE provide detailed methodologies and raw data that are openly available for download. This allows for independent verification and the potential for custom analysis, although users do need a certain level of technical expertise to fully engage with the data. Both platforms are free to use and openly accessible, supporting transparency. Their ease of use, however, varies depending on the technical background of the user.

Municipal emissions tracking and decision-making relevance

Carbon Monitor Cities is the most clearly aligned with city needs, thanks to its direct focus on urban emissions and its high-frequency updates. This allows cities to monitor trends with a high





level of detail. Climate TRACE can also be useful for cities, especially those with large industrial sites or major infrastructure. It can identify and track emissions from specific facilities. However, its broader regional estimates may not be as useful for smaller cities.

Summary observations

Remote-sensing platforms offer valuable opportunities for consistent and independent emissions tracking, but their usefulness for local climate planning depends largely on their spatial resolution, how frequently data is updated, and how many sectors are covered. Among the two platforms, Carbon Monitor Cities stands out for its clear relevance to cities. Climate TRACE provides unique insight into large emission sources at the facility level, though interpretation for city-level planning must be done more carefully.

5.3 Locally integrated measurement systems for emissions tracking

Locally integrated measurement systems for emissions tracking represent a new generation of approaching city-scale GHG inventories. These systems combine satellite-based data with ground-level sensor measurements and incorporate local datasets through direct collaboration with cities. Unlike broader global or national datasets, these systems are designed for high spatial and temporal resolution. They capture real-time emissions data, utilise detailed infrastructure inputs, and apply location-specific modelling. This level of integration makes them particularly interesting for operational decisions and municipal climate policymaking.

5.3.1 Everimpact

EverImpact supports cities in measuring and reporting GHG emissions. It does this by combining satellite observations, Internet of Things (IoT) ground sensors, and AI-supported climate data processing¹³. The platform integrates satellite data with high-frequency readings from ground sensors to deliver both broad area coverage and detailed local insights. This approach allows for tracking emission trends, identifying hotspots within specific sectors, and validating emission inventory results. The company works directly with city administrations to adapt its services to local needs. Its tools are compatible with the GPC, helping improve the accuracy of official

¹³ <https://www.everimpact.com/technology>





reporting (EverImpact).

The ground sensors deployed by EverImpact measure CO₂ concentrations in the air at specific locations at high temporal resolution (e.g., every 30 seconds). Even though this provides valuable information when deployed at various locations within the city, the sensors cannot determine where the CO₂ originated or directly quantify total citywide emissions (EverImpact). However, ground sensors are complemented by satellite observations. EverImpact incorporates CO₂ concentration data from multiple satellite sources such as the OCO-2 and OCO-3 modules (and most likely also the upcoming and more advanced CO2M module) to complement the measurements gathered by ground sensors, that also measure CO₂. Additionally, the Sentinel-2 based optical imagery for classifying surface types allows for the analysis of land use patterns, whereas Sentinel-1 data (SAR-based 3D urban structure) is valuable for airflow/dispersal analysis and modelling (EverImpact).





Table 4 lists the different steps taken by EverImpact to track GHG emissions in cities.

Step	Description
1. CO ₂ concentration data	Ground sensors measure CO ₂ at a specific location every few seconds. Satellites (e.g., OCO-2, OCO-3) also provide atmospheric CO ₂ concentration across a wider area.
2. City context data	Satellites like Sentinel-2 provide land use patterns (e.g., industrial zones, roads, green areas). Sentinel-1 gives building heights and surface structure.
3. Create digital twin of city	A digital 3D model of the city is built using satellite data (land use and building structure).
4. Run CFD models	Computational fluid dynamics (CFD) simulations are run on the city's digital twin to model airflow patterns. This helps visualise how air and CO ₂ move through the urban environment
5. Emissions are estimated using measured CO ₂ concentrations (inverse modelling)	Using CO ₂ levels measured by ground sensors and satellites, the system works backwards to figure out how much CO ₂ was released and from which locations. It uses airflow patterns from CFD models and wind data from satellites to help trace the emissions back to their sources. This process is called inverse modelling and helps identify the main sources of emissions in the city.
6. Emissions are traced to sectors using AI	Artificial intelligence analyses the estimated emissions and identifies their likely source sectors such as mobility, industry, or waste.

Table 4: EverImpact step-by-step process for citywide emissions tracking (cf. Forum Virium Helsinki (2025))

EverImpact has been used by different major cities in Europe, including Madrid (Spain), Manchester (UK), Dijon (France), Porto (Portugal) or Herning (Denmark)¹⁴. Even though EverImpact seems promising for delivering closer to real-time data on cities' GHG emissions, deploying and maintaining the sensors, handling all the different data types as wells as running the various models requires highly specialised knowledge.

5.3.2 ICOS Cities

The Integrated Carbon Observation System, or ICOS, is a pan-European research infrastructure

¹⁴ <https://www.everimpact.com/clients>



dedicated to the precise measurement of greenhouse gases such as CO₂ and methane. One of its key initiatives, ICOS Cities, was launched under the PAUL Project (Pilot Applications in Urban Landscapes, 2021–2025) with funding from the European Commission through the Horizon 2020 programme. This initiative focuses on developing high-resolution urban GHG observatories specifically designed for cities. The goal is to provide consistent and scientifically robust measurements that complement and enhance local GHG inventories. By supplying continuous, high-precision emissions data, the initiators hope that the system helps cities verify their reported emissions, improve the accuracy of their conventional climate reporting (Integrated Carbon Observation System), and by providing close-to real-time data support climate policymaking and climate action at city level.

ICOS Cities has been piloted in three major European cities (starting in 2021): Paris, Munich and Zurich. In each city the full instrumentation (different sets of ground-based sensors across the cities) has been deployed, complemented by modelling efforts, and cross-verification with the conventional GHG inventory methods. The pilot cities are to be followed by a network of twelve additional cities with a planned roll-out starting in 2026: Antwerp, Athens, Barcelona, Basel, Brno, Copenhagen, Heidelberg, Helsinki, Krakow, Porto, Rome and Rotterdam.

ICOS Cities uses seven scientific methods to monitor urban GHG emissions, which are detailed in Table 5.

Table 5: Key observation methods in ICOS Cities: Parameters measured and operating principles (Integrated Carbon Observation System)

No.	Method	What it measures	How it works
1	High-precision tall tower concentrations	CO ₂ /CH ₄ levels at higher altitudes over time (city-wide background)	Tall towers (e.g., 100+ meters) equipped with precise gas analysers measure urban greenhouse gases continuously.
2	Roof- and street-level sensor networks	Local CO ₂ /CH ₄ concentrations in neighbourhoods, streets, or building clusters	Mid- and low-cost sensors are deployed on rooftops or light poles to monitor spatial distribution of emissions across the city.





3	Ground-based total column (Fourier Transform Infrared Spectroscopy, FTIR)	Vertical column of CO ₂ /CH ₄ from the surface to the upper atmosphere	FTIR spectrometers measure how sunlight is absorbed by gases, giving a full "column" reading of GHGs. Helps validate satellite or surface data.
4	Tall eddy covariance towers	Net CO ₂ flux (amount of gas absorbed or released by surfaces like buildings or vegetation). If a tall eddy covariance tower is installed in a building, it measures the amount of CO ₂ absorbed or released by the surrounding area of the building.	These towers measure vertical wind movement and gas exchange, used to calculate how much CO ₂ is being emitted or taken up locally.
5	Biogenic process observations	CO ₂ from natural sources like trees, soils, and vegetation	Sensors track biological processes (e.g., plant photosynthesis, soil respiration) to distinguish natural vs human emissions.
6	Ground-based wind and meteorology	Wind speed/direction, temperature, pressure, turbulence, boundary layer height	Standard meteorological instruments provide data used in models to simulate how emissions move through the air.
7	Satellite total column observations	CO ₂ /CH ₄ levels from space over cities (for external comparison)	Satellites like OCO-2 or Sentinel observe CO ₂ columns from orbit. ICOS uses these to cross-check and extend ground-based observations.

ICOS Cities case study: Zurich

Overview





Zurich is one of the pilot sites selected for the ICOS Cities project, where a sophisticated observation and modelling system is used to track carbon dioxide emissions in real time. The effort is led by Empa, the Swiss Federal Laboratories for Materials Science and Technology. The pilot has been running for two years and is expected to conclude in December 2025 (Integrated Carbon Observation System).

Observation network

Zurich's system combines multiple types of sensors installed across different elevations and locations to monitor atmospheric CO₂ and related variables.

- High-precision tall tower analysers collect CO₂ data and meteorological measurements at several heights.
- Rooftop-level, mid-cost sensors known as ZiCOS-M are installed to improve spatial coverage above the street level.
- Low-cost sensors called ZiCOS-L are placed at pedestrian height to track localised CO₂ variations at the street level.
- Meteorological stations supply essential weather and wind data needed for dispersion modelling.
- Eddy covariance flux towers are used to directly measure the exchange of CO₂ between the surface and the atmosphere (Grange et al., 2025).

Modelling approach

Once the atmospheric CO₂ data is gathered, Zurich uses a multi-step computational modelling system to trace emissions back to their sources.

- GRAMM, or GroßRAUM-Modell, simulates large-scale, three-dimensional wind flows over Zurich at a resolution of roughly 100 metres. It includes terrain and weather factors to produce wind field inputs for further analysis.
- GRAL, short for Grenzschicht Atmosphärisches Lagrange-Modell (Lagrangian atmospheric boundary layer model), models how CO₂ disperses through the urban landscape at a finer scale, with a resolution of around 10 metres. It uses detailed maps of building layouts and streets to simulate emissions spreading across the city.
- Lagrangian particle dispersion modelling follows the path of air parcels backward in time using atmospheric inversion techniques. This step helps identify the source of





emissions and allows for estimating the contribution of specific sectors (Brunner et al., 2025).

Outcomes and relevance

Preliminary findings from the Zurich pilot suggest that the city's official CO₂ inventory may be overestimated by as much as 20 percent. These results, however, need to be verified. The approach nonetheless offers the opportunity to challenge and validate reported emissions with direct observations.

5.3.3 Comparison of observation-based urban GHG tracking methods

Both EverImpact and ICOS Cities go beyond conventional GHG inventory methods based on activity data by integrating atmospheric measurements, remote sensing technologies, and advanced modelling techniques. These approaches offer a new way of tracking, verifying, and presenting urban GHG emissions.

Hybrid measurement approaches

EverImpact combines satellite-derived CO₂ concentration data with Internet of Things (IoT) sensors placed across a city and 3D mapping of urban infrastructure. This combination enables the platform to generate emissions estimates in near real-time. In contrast, ICOS Cities relies on a coordinated network of high-precision ground instruments such as FTIR spectrometers, tall atmospheric towers, and eddy covariance systems. These measurements are supported by meteorological models and satellite data to ensure accurate tracking and attribution of emissions at the urban scale.

Improved accuracy and verification

During the Space 4 Cities webinar (Forum Virium Helsinki, 2025), EverImpact reported that its methodology could deliver emissions data with up to 50 percent greater accuracy compared to traditional inventory methods. In the case of ICOS Cities, findings from the Zurich pilot showed that official inventories may overstate emissions levels by about 20 percent. These results have yet to be verified though. Nonetheless direct (satellite-based) observation may play a role in improving data quality and/ or challenging assumptions in classical GHG inventories.

Cost considerations

EverImpact's service is offered at a subscription rate of around €2,500 per month. According to the company, this is significantly less than the typical cost of outsourced inventory services, which are estimated at between €6,000 and €8,000 per month. On the other hand, ICOS Cities employs





a scientific infrastructure that requires investment in specialised instruments, long-term operational support, and expert analysis.

Policy and finance opportunities

EverImpact claims that cities using its system may find it easier to qualify for carbon tax schemes, green financing, climate-related loans, and other financial instruments. This is largely due to the credibility and granularity of the data provided. Observation-based systems, therefore, are not only useful for tracking progress but can also enhance a city's ability to access climate finance and policy incentives.

Wider implications

Using observational data can help identify emission sources that might be missed by self-reported inventories, such as emissions from unregulated industries or minor sources scattered throughout a city. These systems also support more detailed policy development, help evaluate co-benefits like improved air quality, and offer a more concrete way to communicate with the public through data that is tied to real locations and timeframes.

Summary

Although implementing high-precision observational systems can involve higher upfront or ongoing costs, their ability to improve the accuracy, transparency, and reliability of climate reporting makes them a strong complement to conventional inventory methods. Their strategic use in high-impact sectors or areas of uncertainty can deliver meaningful benefits. Furthermore, if proven to work reliably, the credibility these systems potentially provide may open new doors for climate finance, helping cities turn better data into greater climate action.





6 Climate action tracking tools

Climate action tracking tools support municipalities in planning, monitoring, and communicating progress towards emission reduction goals. These platforms typically combine GHG inventory data with scenario modelling, action tracking, and stakeholder engagement features. By providing visualisations, benchmarks, and progress indicators, they help local governments evaluate the effectiveness of climate strategies, identify gaps, and adjust actions to stay on track towards net zero targets.

6.1 Overview of climate action tracking tools

The table below summarises key characteristics of five widely used tools, highlighting their core functions, coverage, and access models. The overview presented in the following sections is based on information from the individual tool websites as well as the “Greenhouse Gas Emissions Tools and Datasets for Cities” report by CDP (2024). Detailed factsheets for each tool can be found in the annex of this report.





Table 6: Overview of climate action tracking tools

Tool name	Developer / lead organisation	Core function / purpose	Geographic coverage	Key features	Access type
ClimateView (ClimateView)	ClimateView AB	Scenario modelling and monitoring tool for cities to plan and track emissions reduction measures	Global (main uptake in Europe & North America)	Integrates GPC-aligned inventories with sectoral pathways; visualises emissions and co-benefits; supports dynamic climate action planning	Subscription-based
Futureproofed (Futureproofed)	Sweco	Collaborative platform for municipalities to track climate action implementation and engage stakeholders	Primarily Europe	Dashboards for emissions and actions; facilitates peer learning; tracks co-benefits like air quality and cost savings	Subscription-based
SCATTER (SCATTER)	Anthesis (UK)	Scenario modelling and reporting tool for local authorities	United Kingdom	Offers pathway modelling to net zero; provides GPC-aligned outputs; supports policy scenario comparisons	Free for UK local authorities
Kausal (Watch + Paths) (Kausal)	Kausal Ltd.	Planning and progress-tracking tool for climate strategies	Global	Links actions to targets; monitors KPIs; open-data friendly; supports cross-sectoral action mapping	Subscription-based



CDP-ICLEI Track (CDP)	CDP & ICLEI	Global platform for self-reported climate action data, aligned with GPC	Global	Collects and standardises city inventories; enables benchmarking; supports reporting to multiple frameworks	Free (requires registration)
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6.2 Comparative review of climate action tracking tools

This section offers an interpretive review of the climate action tracking tools listed in the overview table. Although no tools were tested directly, the comparison is based on several criteria, including usability, adaptability, functionality, integration with inventories, and their relevance to municipal needs.

Accessibility

The tools differ significantly when it comes to how easy they are to access and use. SCATTER is available at no cost to local authorities in the United Kingdom and features a clear, step-by-step interface. However, its use is geographically limited to the UK. CDP-ICLEI Track is globally accessible and provides a simple reporting interface, though users must register, and the platform depends on the accuracy of self-reported data. ClimateView, Futureproofed, and Kausal offer smooth, well-designed user interfaces but operate on a subscription basis. This cost requirement may present a challenge for smaller municipalities that have limited financial resources.

Adaptability to different municipal contexts

In this context, adaptability refers to how well each tool can function across different countries, planning systems, and stages of climate action. ClimateView and Kausal are both designed to be flexible, using sector-based frameworks that follow the Global Protocol for Community-Scale Greenhouse Gas Inventories. They can also be adjusted to reflect local priorities. Futureproofed is mostly used within Europe but can be applied in other areas when language support and guidance are available. SCATTER is closely designed around UK policy and datasets, which makes it less useful in other regions. CDP-ICLEI Track has global reach but serves mainly as a reporting and benchmarking platform rather than a planning or modelling system.

Integration with inventories and scenario modelling

One of the key functions of climate action tracking tools is their ability to connect greenhouse gas inventories with action planning and forecasting. ClimateView and SCATTER both integrate inventories that follow the GPC structure with features for scenario modelling, enabling cities to explore various decarbonisation options. Kausal is structured to link climate actions directly with performance indicators and targets, allowing for continuous tracking. Futureproofed combines action tracking with reporting on co-benefits such as cost reductions and improvements in air





quality. CDP-ICLEI Track mainly serves as a data collection and comparison platform, and it does not offer significant tools for integrated scenario modelling.

Stakeholder engagement and collaboration features

Some of the tools place a strong focus on enabling collaboration and public involvement. Futureproofed stands out with its peer-to-peer learning features and public dashboards that support openness. Kausal promotes the publication of open data, making municipal plans visible and accessible to the public. ClimateView includes tools designed to support visual communication with both policymakers and community members. SCATTER allows its outputs to be downloaded for use in public consultations, though it offers fewer built-in features for engagement. CDP-ICLEI Track promotes information sharing and benchmarking between cities but is more oriented toward data exchange than direct public participation.

Summary observations and considerations

Each climate action tracking tool places different levels of focus on planning, monitoring, or reporting. ClimateView and SCATTER are especially useful where scenario modelling plays a central role in the planning process. Kausal and Futureproofed are more focused on tracking progress over time and improving communication with stakeholders. CDP-ICLEI Track is particularly valuable to help municipalities understand the quality of the climate action they are currently doing and, potentially, what other municipalities are doing to learn from it. Future improvements to these systems could include better integration between modelling platforms and reporting databases, along with increased flexibility to adapt to different national and regional contexts.





7 Citizen science emissions initiatives

In Europe, municipal greenhouse gas (GHG) inventories are primarily based on institutional data sources such as utilities, transport agencies, and waste management services. Citizens do not normally contribute data directly to these official inventories. However, a growing number of citizen science initiatives involve individuals in collecting or providing data on their activities, energy use, and mobility behaviour to estimate associated emissions. While these datasets remain separate from formal inventories, they serve as powerful tools for public engagement, behavioural change, and policy experimentation.

7.1.1 Overview of initiatives

The following section reviews six such initiatives: COMPAIR, Nos Gestes Climat, Svalna, CitiCAP, CLAiR-City, and AURORA highlighting their methodologies, scope, and contributions to climate action. Factsheets on each of these initiatives are provided in the annex of this report.





Table 7: Overview of citizen science initiatives

Initiative	Location / scope	Participants	Initiative design	Methodology	Key outcomes
COMPAIR (European Citizen Science Platform)	Pilots in Greece, Germany, Bulgaria, Belgium (2021–2024)	Several hundred	Combines low-cost air quality sensors with a CO ₂ -tracker app for neighbourhood-scale emissions data	In COMPAIR, citizens contribute in three main ways: they use SODAQ portable sensors to measure particulate matter (PM) and nitrogen dioxide (NO ₂) levels; install Telraam traffic counters to record different types of road users; and log daily activities such as transport and energy use in a CO ₂ -tracker app to estimate their personal carbon footprint. The air quality and traffic data are calibrated against official reference stations, while the footprint data is calculated using standard emission factors. These datasets are then combined to identify pollution hotspots, mobility patterns, and individual contributions to emissions.	Produces high-resolution maps of pollution exposure; empowers citizens and supports targeted air-quality and mobility measures
Nos Gestes Climat (Nos Gestes Climat)	France (international beta versions)	> 2 million	Web-based questionnaire tool for personal carbon footprint	Users answer lifestyle questions covering transport, housing, food, and consumption. Uses ADEME (Agence de la transition écologique – France’s ecological transition agency) emission factors and the MicMac model (open-source carbon accounting framework by Avenir Climatique & TaCa) to calculate footprints in CO ₂ e (carbon dioxide equivalent – a standard metric for all greenhouse gases).	Average footprint in France ~9.1 t CO ₂ e/year; widely used by individuals, schools, companies, and municipalities for awareness campaigns





Svalna (Svalna)	Sweden	~16,000	Transaction-based calculator linking financial data to emissions	Citizens securely link bank accounts or credit cards. Purchases are categorised and assigned emission factors from EXIOBASE (global multi-regional input-output database linking spending to environmental impacts) and Statistics Sweden's Environmental Accounts (national sector-level emissions data). Direct activity data (e.g. kWh, flights) can override spending-based estimates.	Provides automated, continuous footprints; used in research and corporate reporting; motivates behaviour change
CitiCAP (City of Lahti; Urban Innovative Actions, 2021)	Lahti, Finland (2018–2020)	~3,000 downloads (350 active weekly)	Europe's first city-wide personal carbon trading scheme for mobility.	GPS and sensors detect travel mode; distances are linked to mode-specific emission factors (g CO ₂ /km). Users have a personal carbon budget; staying under budget earns tradable "carbon credits" redeemable for rewards.	36% of users reduced mobility emissions; city gained detailed transport data influencing its mobility plan and cycling infrastructure
CLAiR-City (Trinomics B.V., 2019; University of the West of England Bristol).	Six European regions (NL, UK, SI, PL, PT, IT; 2016–2020)	8,300 direct, ~800,000 outreach	Large-scale participatory project linking citizen visions to emissions and air quality scenarios	Citizens report habits and propose measures via surveys, workshops, and games. Data is integrated into air quality dispersion models (predict pollutant spread) and GHG projection models to 2050, comparing "citizen scenarios" with "business-as-usual" trends.	Citizens often favoured stronger reductions than policy targets; results informed Clean Air Plans (e.g., Bristol) and provided educational tools
AURORA (CORDIS, 2021; European Citizen	Aarhus (DK), Forest of Dean (UK), Évora (PT), Ljubljana (SI),	~7,000	Combines personal footprint tracking with community-	Citizens log household energy and transport use; CO ₂ footprints are calculated using standard emission factors. Participants can invest in local solar PV plants (~1 MW each), with generated electricity credited as	Expected 13–20% household emission cuts; ~5 MW solar capacity built; 150 "energy ambassadors" trained



Science Platform).	Madrid (ES) (2021–2025)		owned solar PV projects	avoided emissions. Activities include thermal camera home audits and DIY sensor building.	
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7.1.2 Interpretation – lessons learned and policy relevance

Citizen science initiatives are proving to be an effective complement to institutional climate efforts. By offering detailed, behaviour-linked data and strengthening public engagement, they provide both practical and cultural value. These efforts not only enrich local datasets but also help cultivate a sense of shared responsibility for emissions reductions.

Empowerment through measurement

Initiatives like Nos Gestes Climat and Svalna show that when individuals are able to see the direct climate impact of their daily choices, they are more likely to adjust their behaviour. Providing a clear link between personal actions and emissions outcomes makes climate responsibility more relatable. COMPAIR's air quality maps take this further by making pollution visible at the street level. This visibility turns what is often seen as an abstract, distant issue into something people can observe and respond to in their immediate surroundings.

Behaviour change potential

Efforts to change behaviour through incentives and community engagement have also shown promise. The CitiCAP project, for example, encourages individuals to reduce their emissions by offering carbon credits. Meanwhile, AURORA's model of involving citizens in community solar planning fosters a stronger emotional and social investment in sustainable energy transitions. CLAiR-City adds another layer by using participatory scenario modelling, which has shown that citizens may be open to more ambitious policy measures than those currently being considered by elected officials.

Data for policy innovation

Citizen science doesn't just benefit individuals, it also helps cities to plan better. Municipalities gain access to localised datasets that can be used to improve transportation planning, air quality policies, and broader climate action plans. COMPAIR and CLAiR-City, for instance, go beyond data collection by offering analytical tools and policy-ready outputs that strengthen the technical basis for local decision-making.

Methodological diversity for different contexts

The range of available tools, from simple online platforms to advanced modelling frameworks, allows these initiatives to be tailored to a variety of community settings and policy goals. This flexibility makes it possible to reach both highly resourced cities and smaller communities with limited capacity. Still, integration with formal greenhouse gas inventories remains limited. That gap represents a missed opportunity to align community-based data collection with official reporting and monitoring systems.





Overall Relevance

While citizen science initiatives are not designed to replace institutional greenhouse gas inventories, they serve an essential supporting role. By creating momentum for behaviour change, building public ownership of climate targets, and generating place-based data, these projects help bridge the gap between government-led climate policy and everyday citizen engagement. With proper support and integration, they can improve policy relevance, boost transparency, and help unlock new forms of climate finance and innovation.





8 Synthesis and conclusion: What does this mean for cities?

This synthesis draws on, and summarises, the sections above before answering the question of what the insights gathered mean for cities given their limited resources.

Traditional **emissions accounting tools** are well established and in widespread use. They differ only in the details of how data is provided, the extent to which cities can include their own data and override national averages, or the scopes covered. Some of them have been developed further to include planning elements, bringing them closer to the needs of cities. Transparency is still an issue, which we encourage the tool designers to address in order to achieve higher comparability in between tool outcomes. The ways in which more specialised data can be included in the accounting tools should also be further looked into: new methods of gathering additional information based on satellite measurements and / or advanced computational methods such as AI and ML look promising and may help to advance accounting reliability. All this is the basis for better policy planning for, and better comparisons between, cities.

The look into different **national practises** showed an interesting range of solutions. While no single approach can be applied universally, the most effective systems combine consistency from national coordination with flexibility for local adaptation. Centralised tools and databases can greatly reduce the workload for cities. But allowing space for local refinement, particularly where higher quality local data exists, ensures that GHG inventories are relevant for supporting climate policy at the local level.

Emission tracking tools that monitor CO₂ emissions at a higher than annual frequency have the potential to advance cities' monitoring methods to the next level. Mostly based on remote sensing, these platforms offer valuable opportunities for consistent and independent emissions tracking, but their usefulness for local climate planning depends largely on their spatial resolution, how frequently data is updated, and how many sectors are covered. Carbon Monitor Cities (see factsheet 10.1) seems the most promising based on our review.

The most advanced **locally integrated approaches** of EverImpact and ICOS Cities are high-precision observational systems that currently involve high upfront and ongoing costs due to specialised kit on the ground as well as complicated modelling and data processing requirements. Their ability to improve the accuracy and reliability of climate reporting may make them a strong complement to conventional inventory methods in the future.

Citizen science initiatives serve an essential supporting role for addressing GHG-neutrality in cities. By creating momentum for behaviour change, building public ownership of climate targets, and generating place-based data, these projects help bridge the gap between government-led climate policy and everyday





citizen engagement. With proper support and integration, they can improve policy relevance, boost transparency, and help unlock creativity and innovation. Wherever possible cities should try to support citizen-led initiatives, not just because of the actual data gathered, but especially for creating support and ownership of climate policy within the city community.

What does this mean for cities?

The national practises analysed in this report show, that many cities in many countries already have one way or another to establish an annual GHG inventory and therefore are able to assess their GHG emissions and start planning on how to reduce them. Tools for tracking that kind of climate action are also available for cities, but are not provided centrally at national level. Therefore, cities need to decide which tool(s) to use. This is where city networks could play an important role: they could provide information and advice on what tool is suitable for individual cities' needs. Additionally, they may provide training for city representatives to learn how to use the tools and implement them within the city administration. Of course, in order to benefit from this kind of service by city networks, cities would need to join a city network.

Cities with smaller budgets should focus on traditional GHG inventory methods combined with a membership in a city network, that allows them to benefit from the concentrated knowledge available on these network platforms.

The more advanced ways of tracking emissions in more detail than annual GHG inventories can (Carbon Monitor Cities, EverImpact, ICOS Cities), are probably more suited for cities with greater pre-existing knowledge and the resources to actually be able to invest into these platforms. These approaches are more relevant for cities that can actually influence emissions at the local level, which is probably more the case for bigger cities.

Outlook

In an ideal world, cities would be able to know exactly where, when and how much CO₂ is being emitted so they can introduce and implement climate protection measures that lead them towards a GHG-neutral state. In that world, city GHG inventories and city plans would be easily linked to national and global inventories, policies and targets (e.g. the Paris Agreement goals). The recent technological drive, mainly in artificial intelligence, and the increasing availability of high-resolution satellite data open the door for moving closer to that ideal world. Conventional methods of carbon accounting always had a few drawbacks such as time lags, uncertainty in some data points (e.g. non-pipe-based fuels like heating oil, coal or solid biomass), and different methods to estimate emissions reductions. Nonetheless, they were (and are) well suited in most circumstances when it comes to establishing a city's annual GHG inventory.

At the time of writing this report, some of the newly developed emission tracking methods such as Carbon





Monitor Cities or Climate TRACE show promising results but may only be available to a restricted number of global cities / regions. The most advanced approaches to emission tracking, EverImpact and the ICOS Cities project, still have to prove they actually deliver what they promise beyond the pilot stage. And even if they succeed, the question remains if all the necessary kit plus its maintenance (ground sensors etc.), and specialised knowledge and software (data processing, inverse atmospheric modelling) are worth the closer to real-time GHG monitoring, and who can or is willing to actually pay for it.

Since the whole field of tools and new data products is so fast-moving, for individual cities it is difficult to keep track of the developments, as they do not have the resources. Therefore, it seems most sensible for city networks to do the job of gathering information and providing it to its network members. Or even develop tools that can be used by network cities directly (as is already the case for some, e.g. the NetZeroCities planner, which is in turn based on Kausal Paths (cf. factsheet 11.4)).





ANNEX





9 Factsheets: Emissions accounting tools

The following factsheets provide detailed information on each of the emissions accounting tools examined in Section 4. These are intended for readers who wish to explore the functionality, access conditions, and usability aspects of each tool in greater depth. Information is based on publicly available documentation.





9.1 Klimaschutz-Planer

Tool	Klimaschutz-Planer
Developer / provider	Climate Alliance & partners
Purpose / functionality	Designed for German municipalities, the tool supports accounting of local greenhouse gas emissions using BSKO-compliant methods. It facilitates structured emissions reporting in alignment with national and municipal climate goals
How it works	Municipalities input local activity data. The tool combines this with official emission factors and default values to generate standardised results across key sectors
Sectors covered	Private households, industry/manufacturing, municipal infrastructure, commerce/trade/services, and transport – as defined under the BSKO framework
Access	Free for German municipalities participating in the Climate Alliance or the "Kommunaler Klimapakt"; restricted to municipalities within Germany
Geographic scope	Only available in Germany
Languages available	German
Platform type	Restricted, web-based
Strengths	Standardised and policy-aligned structure; user-friendly interface; ensures compatibility with national reporting obligations
Limitations	Requires significant manual data entry and updates; limited Scope 3 coverage; applicability restricted to German municipalities
Example users	Can be used by all German municipalities that are part of the Climate Alliance or the Kommunaler Klimapakt. Widely adopted across municipalities in Germany for BSKO-aligned emissions accounting
Website	https://www.klimaschutz-planer.de/





9.2 ECORegion

Tool	ECORegion
Developer / provider	Ecospeed AG
Purpose / functionality	A GHG accounting and scenario modeling tool used by municipalities to calculate and project local emissions over time
How it works	Municipalities can either use preloaded national default datasets or enter their own data. The platform allows adjusting key assumptions and simulating future emission pathways
Sectors covered	Energy, buildings, transport, industry, and waste – following BSKO-compliant sector structure
Access	Free for municipalities in selected Climate Alliance countries; restricted to eligible municipalities within Germany, Italy, Luxembourg, Switzerland
Geographic scope	Regionally limited
Languages available	German
Platform type	Restricted, web-based
Strengths	Compliant with IPCC guidelines; allows future scenario modelling and supports climate action planning
Limitations	Subscription costs may deter smaller municipalities; accuracy depends on detailed local data availability; limited integration of real-time data streams
Example users	Available to municipalities in Germany, Luxembourg, Switzerland, and Italy, particularly those affiliated with the Climate Alliance. Used for local emissions accounting and scenario modelling in multiple EU regions
Website	https://www.ecospeed.eu/





9.3 CIRIS (C40)

Tool	CIRIS
Developer / provider	C40 Cities
Purpose / functionality	Excel-based GHG inventory tool aligned with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)
How it works	Users manually input local data into structured Excel templates. Emissions are calculated sector-wise using GPC methods and emission factors
Sectors covered	Stationary energy, transportation, waste, industrial processes
Access	Free download, available to local authorities worldwide with registration
Geographic scope	Global availability
Languages available	English, Spanish, French
Platform type	Non-web-based (Excel format)
Strengths	Open and flexible; widely used in international city networks such as the Covenant of Mayors; allows traceability of calculations
Limitations	Spreadsheet-based format can be cumbersome for large datasets; no automatic integration with national databases; limited built-in visualisation and reporting features
Example users	Used by more than 90 cities within the C40 Cities network. Also commonly applied by cities participating in the Covenant of Mayors for developing GPC-aligned emissions inventories
Website	https://www.globalcovenantofmayors.org/resource/city-inventory-reporting-and-information-system-ciris/





9.4 ClearPath (ICLEI)

Tool	ClearPath
Developer / provider	ICLEI
Purpose / functionality	An online platform for emissions accounting, forecasting, and climate action planning. Especially targeted at local governments in the ICLEI network
How it works	Users enter local activity data. The platform includes built-in calculation engines, target tracking, and scenario planning for emission reductions
Sectors covered	Stationary energy, transportation, waste, industrial processes
Access	Free for ICLEI members (membership required)
Geographic scope	Globally available via ICLEI
Languages available	English
Platform type	Restricted, web-based
Strengths	Combines inventory creation with integrated scenario planning and monitoring tools; robust user support
Limitations	Subscription fees can be prohibitive; designed primarily for North American contexts requiring adaptation for EU data; manual data collection and input limit automation
Example users	Provided to ICLEI member cities as a benefit of paid membership. Used by a large number of local governments in North America, Europe, and Asia, primarily for GHG inventorying and climate planning
Website	https://icleiusa.org/clearpath/





9.5 Google Environmental Insights Explorer (EIE)

Tool	Environmental Insights Explorer
Developer / provider	Google
Purpose / functionality	Provides automated, model-based estimates of city-level CO ₂ emissions from buildings and transport, as well as rooftop solar potential
How it works	Uses satellite imagery, Google Maps data, traffic activity, and standard emissions factors to estimate sectoral emissions. Cities cannot input data themselves
Sectors covered	Buildings and road transport
Access	Free, but only available to pre-selected cities included in Google's database (official registration required for detailed data access)
Geographic scope	Only available for a defined list of cities
Languages available	English
Platform type	Open web-based
Strengths	Fully automated, visually engaging, and fast; helps data-poor cities understand their emission profile
Limitations	Does not fully align with all GPC scopes, particularly Scope 3; building emissions estimates rely on modelled data that may lack local accuracy; limited transparency on model assumptions
Example users	Available to cities and regions already included in Google's EIE database (approx. 8,800 in Europe), providing modeled estimates without requiring local data uploads
Website	https://insights.sustainability.google/





10 Factsheets: Emissions tracking tools

This section presents detailed factsheets for two publicly available remote sensing platforms that provide greenhouse gas (GHG) emissions data at varying spatial and temporal scales. These platforms, Carbon Monitor Cities and Climate TRACE, leverage satellite observations, modelling, and complementary datasets to estimate emissions across different sectors and geographies. The factsheets summarise each tool's purpose, methodology, coverage, and practical relevance, providing a reference for their potential application in municipal climate monitoring.





10.1 Carbon Monitor Cities

Tool	Carbon Monitor Cities
Developer / provider	Developed by an international research team led by Tsinghua University, University of California, Berkeley, and other academic partners
Purpose / functionality	Carbon Monitor Cities provides near-real-time estimates of CO ₂ emissions for major cities worldwide, focusing on daily and sectoral trends. The platform aims to fill the gap between annual inventories and dynamic emissions monitoring, supporting research, policy-making, and public awareness
How it works	• Combines multiple datasets: activity data (e.g., energy use, traffic, industrial output) with satellite observations where available • Uses near-real-time proxies such as power plant operations, traffic congestion indices, and heating/cooling degree days • Applies emission factors consistent with IPCC guidelines • City-level data is produced through downscaling of national datasets combined with local activity indicators
Sectors covered	Power generation; Residential & commercial buildings; Ground transport; Industry; Aviation (partial, where relevant)
Data Update Frequency	Daily or near-daily updates; aggregated into monthly and annual summaries
Access / Licensing	Freely available to the public via an online dashboard and data download interface.
Geographic scope	Global coverage, with a focus on selected major cities on all continents
Languages available	English
Integration with municipal processes	Primarily research-oriented; municipal integration is indirect and depends on local authorities' adoption of the datasets
Strengths	• Provides high-frequency (daily) emissions data • Transparent methodology with open-access datasets • Supports rapid response and trend analysis
Limitations	• Limited city list – only large, high-profile cities are included • May rely on proxy indicators rather than direct measurements, potentially affecting accuracy for smaller sectors • Not interactive for user data input or scenario modelling
Example users	Available to cities and regions already included in Google's EIE database (approx. 8,800 in Europe), providing modelled estimates without requiring local data uploads
Website	https://carbonmonitor.org/





10.2 Climate TRACE

Tool	Climate TRACE
Developer / provider	A global coalition of NGOs, tech companies, and research organisations, supported by Al Gore and partners such as WattTime, TransitionZero, and Hypervine
Purpose / functionality	Climate TRACE offers independent, high-resolution GHG emissions data globally, combining satellite imagery, remote sensing, and artificial intelligence. The goal is to increase transparency in emissions monitoring and to cover all sectors and geographies comprehensively
How it works	• Utilises satellite observations, aerial imagery, and ground-based data sources • AI-based algorithms identify emissions from specific facilities (e.g., power plants, steel mills) and land-use changes • Produces estimates for over 70,000 individual sources worldwide • Aligns with IPCC categories and covers nearly all emitting sectors
Sectors covered	Energy production (electricity, heat, oil & gas); Industry (cement, steel, manufacturing); Agriculture; Waste; Land use, land-use change, and forestry (LULUCF); Transport (road, aviation, shipping)
Data Update Frequency	Annual updates, with some sectors refreshed more frequently depending on data availability
Access / Licensing	Open-access platform; data can be explored online and downloaded
Geographic scope	Global – including countries, regions, and specific facilities
Languages available	English
Integration with municipal processes	Not municipally tailored, but cities can use sector-level or facility-level data to cross-check local inventories or identify major sources
Strengths	• Covers a very wide range of sectors and sources globally • Independent verification using diverse data streams • Open-access and transparent methodology
Limitations	• Not designed specifically for municipal-scale reporting; data may need downscaling • Annual refresh means it is not suitable for near-real-time monitoring in all sectors • Complex methodology may be challenging for non-technical users
Example users	Available to cities and regions already included in Google's EIE database (approx. 8,800 in Europe), providing modelled estimates without requiring local data uploads
Website	https://climatetrace.org/





11 Factsheets: Climate action tracking tools

The following factsheets provide detailed information on each of the climate action tracking tools examined in Section 6. These are intended for readers who wish to explore the functionality, access conditions, and usability aspects of each tool in greater depth.





11.1 ClimateView

Tool	ClimateView
Developer / provider	ClimateView AB, Sweden
Purpose / functionality	ClimateView is an integrated climate planning and monitoring platform enabling cities to model, implement, and track climate action plans. It visualises sectoral “transition pathways” and quantifies their impact on emissions over time, integrating co-benefits such as health, air quality, and economic savings
How it works	Users import or create a GPC-aligned baseline inventory, then select or customise measures from a library of predefined actions. The tool models emission reductions, costs, and co-benefits, displaying results in an interactive dashboard. Scenario comparisons show progress towards targets and highlight policy gaps
Sectors covered	Energy supply, transport, buildings, waste, industry, agriculture and land use
Access	Subscription-based (commercial license; pricing scales with city size and selected features)
Geographic scope	Available globally
Languages available	English (with growing multilingual support)
Platform type	Web-based
Strengths	• Combines emissions tracking with co-benefits analysis • Visual interface for both internal use and public communication
Limitations	• Requires strong baseline data for accurate modelling • Subscription cost may be prohibitive for smaller municipalities
Example users	Cities such as Helsingborg (Sweden) and Nottingham (UK) use ClimateView for integrated climate planning and performance tracking
Website	https://www.climateview.global/en/platform





11.2 Futureproofed (Sweco)

Tool	Futureproofed
Developer / provider	Sweco, Belgium
Purpose / functionality	Futureproofed helps municipalities monitor climate actions, estimate GHG reductions, and communicate progress internally and publicly. It supports both mitigation and adaptation planning and includes peer learning functions
How it works	Municipalities upload actions, projects, and baseline inventories into the system. Each measure is assigned estimated GHG reduction, cost, and co-benefits. Progress is tracked over time, with results displayed in a public-facing dashboard if desired
Sectors covered	Transport, energy supply, buildings, waste, land use, and nature-based solutions
Access	Subscription-based (commercial license)
Geographic scope	primarily Europe but available internationally
Languages available	English, Dutch, French
Platform type	Web-based
Strengths	• Peer-learning network connects municipalities for knowledge exchange • Public dashboards enhance transparency and citizen engagement • Cost and co-benefits included for each measure
Limitations	• Dependent on user-provided data for accuracy • Subscription costs may limit uptake in small municipalities
Example users	Used by over 200 European cities, including Leuven (Belgium) and Bruges (Belgium), for climate action monitoring and stakeholder engagement
Website	https://www.futureproofed.com





11.3 SCATTER

Tool	SCATTER
Developer / provider	Anthesis Group, United Kingdom
Purpose / functionality	SCATTER provides UK local authorities with a free, standardised way to produce GPC-aligned GHG inventories and model decarbonisation pathways to net zero
How it works	The tool uses national datasets pre-processed for each local authority, combined with optional local data, to generate baseline inventories. Built-in pathway modelling allows scenario development and comparison. Outputs can be downloaded for integration into climate action plans
Sectors covered	Stationary energy, transport, waste, industrial processes, agriculture and land use
Access	Free for UK local authorities, but also restricted to UK
Geographic scope	limited to the UK
Languages available	English
Platform type	Web-based
Strengths	• Free and standardised across the UK, ensuring comparability • Provides both baseline inventories and decarbonisation pathways • Supports reporting to frameworks like CDP
Limitations	• Restricted to UK use • Scenarios use generic assumptions which may require local refinement
Example users	Over 300 UK local authorities, including Manchester City Council and Bristol City Council, use SCATTER for inventorying and action planning
Website	https://kb.goodhomes.org.uk/tool/scatter/





11.4 Kausal

Tool	Kausal
Developer / provider	Kausal Oy, Finland
Purpose / functionality	Kausal offers two linked modules – <i>Watch</i> for public transparency of climate actions, and <i>Paths</i> for internal project management. It connects actions to targets, monitors key performance indicators (KPIs), and enables open-data publishing
How it works	Users enter actions, milestones, and performance indicators into the system. Progress is monitored via KPIs linked to GHG reduction targets. <i>Watch</i> publishes data to a public website, while <i>Paths</i> supports internal coordination
Sectors covered	Energy, transport, buildings, waste, land use, cross-sectoral actions
Access	Subscription-based (commercial license)
Geographic scope	Available globally
Languages available	English, Finnish, German, Portuguese (others on request)
Platform type	Web-based
Strengths	• Balances internal management with public transparency • Supports KPI tracking alongside GHG targets • Flexible and customisable to local contexts
Limitations	• Dependent on completeness and quality of local data. • Requires ongoing updates from staff to remain current
Example users	Cities like Espoo and Turku (both in Finland) use Kausal for structured action tracking and reporting
Website	https://www.kausal.tech





11.5 CDP-ICLEI Track

Tool	CDP-ICLEI Track
Developer / provider	CDP & ICLEI
Purpose / functionality	A global self-reporting platform for cities, states, and regions to submit climate action data, track progress, and benchmark against peers
How it works	Registered cities complete annual questionnaires covering GHG inventories, targets, and actions. Data is published in a public portal and can be linked to frameworks such as the GPC
Sectors covered	Energy, transport, waste, industrial processes, agriculture and forestry
Access	Free, but registration required
Geographic scope	Available globally
Languages available	English (submission templates may be translated by users)
Platform type	Web-based
Strengths	• Largest global dataset of self-reported municipal climate action • Alignment with multiple international frameworks • Public portal for transparency and benchmarking
Limitations	• Relies on self-reported data, which can vary in quality and completeness • No built-in modelling or scenario tools
Example users	Used by over 1,100 cities globally, including Barcelona (Spain) and Cape Town (South Africa), for climate action reporting and benchmarking
Website	https://www.c40knowledgehub.org/s/article/CDP-ICLEI-Track-A-climate-reporting-tool?language=en_US https://www.cdp.net





12 Factsheets: Citizen science initiatives

This section presents several factsheets for different citizen science initiatives showing some interesting approaches across European countries to involving citizens directly in climate-related “science”.





12.1 COMPAIR

Citizen Initiative	COMPAIR
Timeline & geographic scope	COMPAIR (2021–2024) is a European pilot project implemented in Athens (Greece), Berlin (Germany), Sofia and Plovdiv (Bulgaria), and the Flanders region of Belgium
Purpose & context	COMPAIR was designed to actively involve citizens in monitoring urban air quality and estimating their carbon footprints. The initiative aimed to generate reliable, high-resolution environmental data that could fill gaps in municipal monitoring systems and support more informed policy decisions
How it works	Participants used SODAQ sensors (portable air quality devices) attached to bicycles or placed in homes to measure particulate matter (PM) and nitrogen dioxide (NO ₂) concentrations. These pollutants are closely linked to urban traffic and fossil fuel use. To capture mobility patterns, residents installed Telraam traffic counters, compact devices placed in windows that use cameras and AI to count different types of road users (cars, bicycles, pedestrians). Alongside this, participants logged their daily transport choices and household energy consumption in a CO ₂ -tracker app
Data processing & methodology	Sensor data was automatically transmitted to a central platform and calibrated against readings from official reference stations to ensure accuracy. Traffic data was correlated with air quality measurements to identify pollution hotspots. Personal activity logs were converted into carbon footprints using sector-specific emission factors (e.g., per kilometre driven or per kilowatt-hour consumed)
Impact & relevance	COMPAIR directly engaged several hundred citizens. The high-resolution pollution maps produced enabled policymakers to simulate potential interventions such as traffic restrictions. The project demonstrated that community-led sensing can complement institutional monitoring, support cleaner mobility policies, and empower citizens with actionable environmental insights
Website	https://www.wecompair.eu/





12.2 Nos Gestes Climat

Citizen Initiative	Nos Gestes Climat
Timeline & geographic scope	Launched in France in 2020 by ADEME (Agence de la transition écologique – France’s public agency for ecological transition) and the Association Bilan Carbone, Nos Gestes Climat is primarily targeted at French residents but is expected to expand internationally
Purpose & context	The initiative addresses the challenge of making personal carbon accounting accessible to the public. Its goal is to help individuals understand the climate impact of their lifestyles and guide them toward low-carbon living consistent with the Paris aligned CO ₂ budget of ~1,5 tonnes CO ₂ e per person per year
How it works	The platform is a web-based calculator that enables users to estimate their annual carbon footprint in about ten minutes. It covers multiple lifestyle domains including transport, housing, diet, and consumption habits
Data processing & methodology	User responses are processed through the MicMac model, an open-source carbon accounting framework developed by the climate advocacy groups <i>Avenir Climatique</i> and <i>TaCa</i> . This model converts lifestyle data into emissions using ADEME’s national emission factors, which specify greenhouse gas emissions per unit of activity (e.g., grams CO ₂ e per kilometre driven, per kWh of electricity, or per euro spent). The tool also incorporates a water footprint estimate for added environmental context
Impact & relevance	With over 2 million users, Nos Gestes Climat has become France’s most widely used personal footprint calculator. It is employed by individuals, municipalities, schools, and companies for awareness campaigns. Average results (~9.1 t CO ₂ e/year) highlight the urgency of deep reductions, and the personalised reduction tips offer an entry point for behavioural change
Website	https://nosgestesclimat.fr/





12.3 Svalna

Citizen Initiative	Svalna
Timeline & geographic scope	Developed in Sweden, Svalna originated as a research project in Gothenburg and has grown into a publicly available platform for both individuals and organisations
Purpose & context	Svalna aims to automate carbon accounting by linking people's financial transactions directly to emissions data, making footprint tracking as routine as checking a bank statement
How it works	Users connect their bank accounts or credit cards to the app through secure channels. Each transaction is automatically categorised (e.g., food, transport, energy) based on merchant information
Data processing & methodology	Each spending category is assigned an emission factor from EXIOBASE, a detailed, global multi-regional input-output database that links monetary spending to environmental impacts, including greenhouse gas emissions. For example, EXIOBASE might determine that 1 Swedish krona spent on clothing corresponds to 0.05 kg CO ₂ e. National-level environmental accounts from Statistics Sweden are integrated to ensure the factors are representative of the Swedish context. Users can override estimates by entering specific quantities (e.g., kWh used, kilometres flown) for greater accuracy
Impact & relevance	By 2019, approximately 16,000 users had registered. Svalna has been used in academic studies, corporate climate challenges, and organisational reporting. Its transaction-based model demonstrates how digital finance tools can normalise emissions tracking in everyday life
Website	https://svalna.se





12.4 CitiCAP

Citizen Initiative	CitiCAP
Timeline & geographic scope	Implemented in Lahti, Finland (2018–2020) under the EU’s Urban Innovative Actions programme
Purpose & context	CitiCAP sought to reduce transport-related emissions by introducing Europe’s first personal carbon trading scheme for mobility
How it works	A dedicated smartphone app automatically tracked users’ travel modes using GPS and onboard sensors. Each mode — walking, cycling, bus, or car — was assigned an emission factor (e.g., grams CO ₂ /km)
Data processing & methodology	The app calculated weekly transport emissions for each participant and compared them with a personal carbon budget. Staying under the budget earned “carbon credits” that could be exchanged for rewards such as bus tickets or bicycle repairs
Impact & relevance	About 3,000 people downloaded the app, with 350 active weekly users. During the pilot, 36% of participants reduced their mobility emissions. The city also gained detailed mobility data to inform its Sustainable Urban Mobility Plan and invested in infrastructure such as cycling highways
Website	https://uia.urban-initiative.eu/en/uia-cities/lahti





12.5 CLAiR-City

Citizen Initiative	CLAiR-City
Timeline & geographic scope	A four-year EU-funded project (2016–2020) across six European regions: Amsterdam (Netherlands), Bristol (UK), Ljubljana (Slovenia), Sosnowiec (Poland), Aveiro (Portugal), and Liguria (Italy)
Purpose & context	CLAiR-City aimed to put citizen perspectives at the heart of climate and air quality planning by replacing top-down technical modelling with participatory approaches
How it works	The project engaged over 8,300 citizens directly through surveys, workshops, and interactive games. Participants described their current behaviours (e.g., commuting patterns, home energy use) and proposed future measures like car-free zones or renewable energy adoption.
Data processing & methodology	Baseline city inventories of CO ₂ and air pollutants were combined with the citizen-proposed measures in air quality dispersion models and long-term GHG projection models up to 2050. These “citizen scenarios” were compared with “business-as-usual” plans to highlight potential environmental and health gains.
Impact & relevance	Results showed that citizens often supported more ambitious emissions reductions than existing policies proposed. In Bristol, findings informed the city’s Clean Air Plan, and educational materials from the project continue to be used to raise awareness
Website	https://www.claircity.eu/





12.6 AURORA

Citizen Initiative	AURORA
Timeline & geographic scope	Active from 2021 to 2025 in Aarhus (Denmark), Forest of Dean (UK), Évora (Portugal), Ljubljana (Slovenia), and Madrid (Spain)
Purpose & context	AURORA combines personal carbon footprint tracking with community renewable energy generation, encouraging both individual and collective action
How it works	Participants use an app to record household electricity and heating consumption, as well as transport activity. The app calculates personal CO ₂ footprints using relevant emission factors
Data processing & methodology	Participants can invest in community-owned solar power plants (~1 MW each). The energy generated is credited to them as avoided emissions. Engagement activities include “energy loss contests” using thermal cameras and DIY sensor-building workshops to help households detect and fix inefficiencies
Impact & relevance	With ~7,000 participants, AURORA expects household emission reductions of 13–20%. The project has added about 5 MW of new solar capacity across its sites and trained 150 “energy ambassadors” to promote the model in other communities
Website	https://www.aurora-h2020.eu/





13 Abbreviations

Abbreviation	
ADEME	Agence de la transition écologique (France)
AI	Artificial intelligence
ARSO	Slovenian Environment Agency
BEIs	Baseline Emission Inventories
BISKO	Bilanzierungssystematik Kommunal
CDP	Carbon Disclosure Project
CFD	Computational fluid dynamics
CO2M	Satellite module measuring CO ₂
CoM	Covenant of Mayors
DESNZ	Department for Energy Security and Net Zero (UK)
FTIR	Fourier Transform Infrared Spectroscopy
GHG	Greenhouse gas(es)
GIS	Geographic Information Systems
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
IoT	Internet of Things
KOBIZE	Polish National Centre for Emissions Balancing and Management
KPI	Key performance indicator
LGOP	Local Government Operations Protocol
MEIs	Monitoring Emissions Inventories
ML	Machine learning
NAEI	National Atmospheric Emissions Inventory (UK)
OCO-2	Satellite module measuring CO ₂
OCO-3	Satellite module measuring CO ₂
PAUL Project	Pilot Applications in Urban Landscapes Project
SECAP	Sustainable Energy and Climate Action Plan
SMHI	Swedish Meteorological and Hydrological Institute
SMED	Svenska Miljöemissionsdata (Sweden)
UNFCCC	United Nations Framework Convention on Climate Change





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