From Data to Action: Harnessing GHG Inventories for Local Sustainability Initiatives

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Overview

This report presents an overview of the processes, data, and resources required for local governments to produce greenhouse gas (GHG) inventories, which are powerful planning tools in mitigating and adapting to the climate crisis. It is broken into two sections which focus on different aspects of the inventory process.

The first section outlines the development of a GHG inventory, addressing data identification, collection, and inventory calculations. This process is demonstrated using a comparative case study analysis, focusing on the City of Rockford, Michigan, and the City of Grand Haven, Michigan. In the former, ICLEI ClearPath (a membership-only subscription) was used, while the later calculated emissions with the EPA Local Greenhouse Gas Inventory Tool (a no-cost spreadsheet). With an inventory on hand, the second section highlights the importance of processes for continuously updating inventories, possible municipal uses of inventory data, alignment with policy action, and financial resources available to municipalities to pursue GHG inventories.

Key Concepts & Definitions

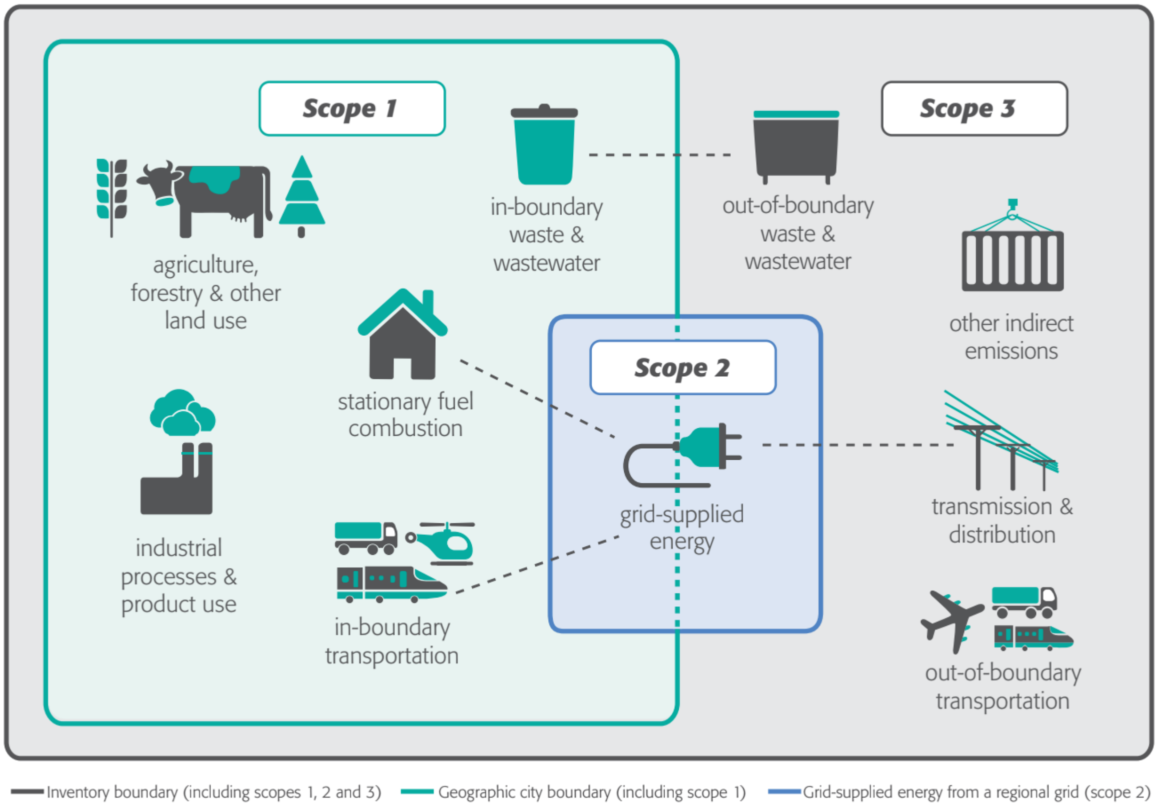
What is a Greenhouse Gas Inventory? A greenhouse gas (GHG) inventory quantifies emissions from residential, commercial, and industrial sources within a jurisdiction, for a given time period. Although several uses exist, local governments often use GHG inventories to identify emission reduction opportunities Inventories offer localities an opportunity to explore the activities contributing the most towards emissions, thus scaling the drivers of the climate crisis to the local context.

What are the two types of inventories? There are two types of inventories: community-level inventories and local government operations (LGO) inventories. On one hand, community-level inventories aim to estimate greenhouse gas emissions from all sources within a specific community or geographic area. These inventories cover emissions from various sectors, including residential, commercial, industrial, transportation, waste management, and agriculture. The goal is to provide a comprehensive picture of the community's overall carbon footprint. On the other hand, LGO inventories focus specifically on estimating greenhouse gas emissions resulting from the internal operations and activities of a local government or municipality. This includes emissions from government-owned facilities, fleet vehicles, street lighting, water treatment plants, and other municipal services. Here, the purpose is to help local governments understand their direct emissions, identify opportunities for reducing their operational carbon footprint, and implement more sustainable practices within their own operations.

Which methodologies exist to produce them? For local governments, two frameworks exist to identify, calculate, and report on GHG emissions. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) is used for community-wide inventories, while the Local Government Operations Protocol (LGOP) is designed for tracking emissions arising from municipal operations (CARB et al. 2010; GHG Protocol n.d.-a).

How are emissions categorized? For inventorying purposes, emissions are categorized into Scope 1, 2, and 3 categories. Scope 1 refers to emissions which arise from sources located within the geographical/operational boundary. For example, residential or commercial natural gas usage. Scope 2 consists of emissions occurring as a result of grid-supplied electricity, heat, steam, and/or cooling within the defined boundary (e.g., residential, commercial, and industrial electricity usage) contributes to this scope. Scope 3 refers to out-of-boundary emissions which result from activities taking place within the boundary. Examples include emissions arising from landfills out-of-boundary which receive waste from within the boundary. Below, Figure 1 presents an overview of the sources and boundaries for municipal GHG emissions.

Figure 1. Scope 1, 2, and 3 Emissions



Source: Greenhouse Gas Protocol 2014b

Inventory Tools

As mentioned above, two tools were used to develop inventories for Rockford and Grand Haven: ICLEI ClearPath and the EPA GHG Tool. Developed by ICLEI, an international organization that provides tools and resources to help local governments and communities address sustainability challenges, ClearPath offers a standardized and user-friendly approach to inventorying GHG emissions. It helps cities collect data, estimate emissions, generates forecasts, and analyze trends across various sectors. The tool covers emissions from sources such as energy use in buildings, transportation, waste management, and industrial processes. Notably, access to ICLEI ClearPath is restricted to ICLEI members, who pay an annual membership of approximately $1,000-$8,000 depending on population size of their municipality (ICLEI n.d.). As a result of ICLEI membership, municipalities also receive access to a technical advisor and working groups, both of which will assist them with data needs and the development of future sustainability priorities.

Meanwhile, the EPA GHG Tool is as a free-for-download solution in the form of an automated Excel spreadsheet (USEPA 2023). Like ClearPath, it provides a framework for estimating GHG emissions based on data from multiple sources, such as energy consumption, waste generation, and transportation activity. However, it does not have some of the technical capabilities of ICLEI's tool, such as forecasting and analyzing trends. Below, Table 1 summarizes the key attributes and trade-offs of using both pieces of software.

Table 1. Tool Comparison

	Form Automation	Technical Support	Working Group	Forecasting	Free to Use
ICLEI ClearPath	X	X	X	X	
EPA GHG Inventory Tool	X				X

Developing an Inventory

The aim of this section is to provide municipalities with a clear methodology to follow when developing their own inventories, establishing what data is required and who to request it from. In general, the process for developing an inventory involves three five steps:

Boundary Setting

Before calculating emissions for community-level or local government operation (LGO) inventories, it is crucial to establish an assessment boundary that identifies the gasses, emitting sources, geographic/operational boundary, and time span relevant to the inventory. If possible, municipalities account for seven gasses: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Emitting sources, which are covered in further detail below, range from stationary combustion, transportation use, electricity, and more.

The geographic boundary used by a community-level inventory will generally align with the administrative jurisdiction of the municipality, although smaller units (e.g., districts) and large units (e.g., metropolitan statistical areas) can also be chosen. Meanwhile, the operational boundary for an LGO inventory will be based on determining what is owned by or controlled by a locality. The time span for an inventory should be 12 months and conform to either a fiscal or calendar year, whichever is used by the municipal government.

For Rockford and Grand Haven, the physical and temporal boundaries for both community-level inventories were defined to municipal borders and the year 2022. In both communities, emissions for CO_2, CH_4, and N_2O were calculated, as data was not available for the other four gases.

Although relatively straightforward and less resource-intensive than other steps, boundary setting is essential to the success of a GHG inventory. By specifying a scope, it is possible to compare a consistent baseline for GHG emissions, thus serving as the foundation for accurate and reliable emission assessments in the future. Without a well-defined boundary, the inventory's credibility and usefulness could be compromised, hindering the overall success of GHG reduction efforts and climate change mitigation strategies.

Data Identification & Collection

The most crucial steps for completing an inventory are data identification and collection. Although using the same methodologies, ICLEI ClearPath and the EPA GHG Tool each require different data inputs. This is because both tools utilize alternative calculations and assumptions. For ICLEI ClearPath, data is inputted directly into an online user-interface. Below, Table 2 outlines the information that should be used to complete a community-level inventory, as well as potential data sourcing options and resources.

Table 2. ICLEI ClearPath Community Data

Topic	Data	Source/Resources
Energy and Fuel		
Electricity Usage	Residential, commercial, industrial electricity usage	Electric utility
Stationary Fuel Combustion	Residential, commercial, industrial usage of natural gas, propane, etc.	Natural gas utility, propane suppliers
District Energy	Commercial electricity usage	District energy provider
Transportation		
On-Road Vehicles	Vehicle miles traveled (VMT), categorized by vehicle type (passenger car, light truck, heavy truck, motorcycles), number of annual passenger trips	County or state transportation agencies, regional planning/development bodies, and/or Google Environmental Insights Explorer (EIE)
Active Transportation	Number of trips, distance traveled, and percentage of all trips in the community that are completed by walking or biking.	Survey of residents and/or Google EIE
Aviation Travel	Fuel type and usage, percentage attributable to local jurisdiction	Local airport, state airport regulator, and/or modeling from FlightAware
Public Transit	Fuel type, vehicle type, annual fuel use, annual revenue miles traveled, number of passengers per year, overall service population	Local public transit system
Rail Transportation	Fuel type and usage, sorted by application (transit system, freight, etc.), for the track distance covered within the city boundary and outside the city	Rail operator
Water Transportation	Fuel type and usage, sorted by application (passenger, freight,	Shipping operators, port facilities, and marinas

	etc.), for distances within and outside the city	
Off- Road Vehicles	Fuel type and usage, sorted by sector and equipment type (utility vehicles, construction vehicles, etc.)	Survey of residents
Solid Waste		
Waste Generation	Quantity of landfill destined waste generated during the year, landfill methane collection scenario, moisture content, and the waste type	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Biologic Treatment of Solid Waste	Quantity of waste composted in the community, and the waste type	Waste disposal unit, municipal utility/public works department, and/or other bodies responsible for municipal composting
Waste Combustion	Annual mass of MSW (short tons), percentage of total combusted MSW generated in-boundary, and the higher heating value of MSW	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Flaring of Landfill Gas	Quantity of landfill gas that is sent to flare	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Combustion of Landfill Gas	Quantity of methane emitted by landfills	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Collection and Transportation Emissions	Quantity of waste collected and/or transported to a disposal site, fuel type used by collection vehicles, and the round-trip miles traveled to disposal site	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Process Emissions	Quantity of waste processed at the site annually, fuel type	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports

Water and Wastewater		
Treatment Energy Use	Electricity and natural gas being used to treat the wastewater generated by the community	Wastewater treatment facility and/or municipal utility/public works department
Energy Use to Supply Drinking Water	Electricity and natural gas being used to supply water to the community	Water supplier and/or municipal utility/public works department
Combustion of Digester Gas	Heat content associated with digester gas utilized for treatment, if applicable	Wastewater treatment facility and/or municipal utility/public works department
Combustion of Biosolids and Sludges	Daily quantity of sludge/biosolids incinerated, energy content of biosolids, and populations served	Wastewater treatment facility and/or municipal utility/public works department
Flaring of Digester Gas	Fraction of methane in digester gas and the destruction efficiency	Wastewater treatment facility and/or municipal utility/public works department
Agriculture, Forestry, and Other Land Use (AFOLU)		
Agricultural Activities	Biogenic carbon dioxide, carbon dioxide, methane, and nitrous oxide emissions	N/A
Removals from Trees Outside of Forests	Canopy area, emissions from tree loss outside forests, carbon dioxide removals	ArcGIS, iTree
Removals from Forests	Land area, net annual carbon flux	ArcGIS, iTree
Process & Fugitive Emissions		
Hydrofluorocarbon & Refrigerant Emissions	Gas type, amount of fugitive gas released	CARB Refrigerant Management Program
Emissions from Oil Systems	Amount of carbon dioxide, methane, and nitrous oxide released	EPA FLIGHT database
Emissions from Mining, Processing, Storage, and Transportation of Coal	Amount of carbon dioxide, methane, and nitrous oxide released	EPA FLIGHT database

Emissions from Natural Gas Distribution	Amount of natural gas usage city-wide	Natural gas utility
Upstream Impacts of Activities		
Upstream Impacts of Electricity Used by the Community	Electricity usage associated with upstream emissions, total upstream emissions	Electric utility
Upstream Impacts of Fuels Used in Stationary Combustion by the Community	Fuel type, usage associated with upstream emissions, total upstream emissions	Natural gas utility, propane provider
Consumption Based		
Food Consumption	Food type, per-capita consumption, population	Statewide averages
Services Consumption	Food type, per-capita consumption, number of households, life cycle emissions	Statewide averages, municipal planning department
Construction Materials Consumption	Material type, amount consumed, life cycle emissions of goods type	Statewide averages, municipal planning or public works department
Goods Consumption	Goods type, per household consumption, number of households, life cycle emissions of goods type	Municipal planning department

For LGO inventories developed in ICLEI ClearPath, similar information as described in Table 2 is required. However, most of the data must be scaled down to encompass only municipal operations. Table 3 highlights the data, sources, and resources to develop an LGO inventory.

Table 3. ICLEI ClearPath LGO Data

Topic	Data	Source/Resources
Buildings and Facilities		
Electricity Usage	Electricity used, daily occupancy, daily operating hours, building square footage	Electric utility (billing receipts or purchase records)

Stationary Fuel Combustion	Fuel type, fuel usage for municipal operations	Natural gas utility, propane suppliers (fuel receipts or purchase records)
District Energy	Amount of district energy used by municipality	District energy provider
Streetlights and Traffic Signals		
Electricity Usage	Number of streetlights and the electricity used for lighting	Electric utility (billing receipts or purchase records)
Stationary Fuel Combustion	Number of streetlights and the natural gas or propane used for lighting	Natural gas utility, propane suppliers (fuel receipts or purchase records)
Vehicle Fleet		
Fleet Vehicle Emissions	Fuel type, annual fuel use, percentage of biofuel in blend, annual miles traveled categorized by percentage of passenger vehicle, light truck, and heavy truck	Municipal departments with vehicles (public works, police, fire, parks)
Emissions from Off-Road Vehicles	Fuel type, annual fuel use for small and large utility vehicles used for local government operations	Municipal departments with vehicles (public works, police, fire, parks)
Transit Fleet		
Transit Vehicle Emissions	Fuel type, vehicle type, annual fuel use, annual revenue miles traveled, number of passengers per year, and the overall service population	Local public transit system
Employee Commute		
Employee Commute	Number of employees, fuel type, employee annual VMT broken down by percentage attributed to passenger cars, light trucks, and heavy trucks	Employee survey
Employee Transit Use	Fuel type, transit type, total employee passenger miles per year	Employee survey
Employee Air Travel	Total employee aviation passenger miles per year	Employee survey
Electric Power Production		

Electric Power Transmission and Distribution Losses	Quantity of electricity lost from purchased electricity which was delivered by municipal utility	Municipal utility
Solid Waste Facilities		
Government-Owned/Operated Landfills	Methane emitted by landfills, total tons of waste in place	Municipal landfills
Waste Generation	Total waste generated, landfill methane collection scenario, moisture content, waste type	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Biologic Treatment of Solid Waste	Quantity of waste composted in the community and the waste type	Waste disposal unit, municipal utility/public works department, and/or other bodies responsible for municipal composting
Waste Combustion	Annual mass of MSW (short tons), percentage of total combusted MSW generated in-boundary, and the higher heating value of MSW	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Flaring of Landfill Gas	Quantity of landfill gas that is sent to flare	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Combustion of Landfill Gas	Quantity of methane emitted by landfills	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Collection and Transportation Emissions	Quantity of waste collected and/or transported to a disposal site, fuel type used by collection vehicles, and the round-trip miles traveled to disposal site	Waste disposal unit, municipal utility/public works department, and/or federal, state, county, or local data reports
Process Emissions	Quantity of waste processed at the site annually, fuel type	Waste disposal unit, municipal utility/public works department, and/or

		federal, state, county, or local data reports
Water and Wastewater Treatment Facilities		
Process N_2O from Effluent Discharge to River, Ocean, or Deep Well Injection	Treatment process used by facility (anaerobic/aerobic), whether effluent is discharged into a body or water, whether the facility is owned by the municipality	Wastewater treatment facility and/or municipal utility/public works department
Process N_2O Emissions from Wastewater Treatment	Biological conversion process used by facility (nitrification/denitrification), whether industrial and commercial discharges are received	Wastewater treatment facility and/or municipal utility/public works department
Process Emissions from Wastewater Treatment Lagoons	Five-day biochemical oxygen demand (BOD5) load generated, whether there are industrial and commercial discharges received	Wastewater treatment facility and/or municipal utility/public works department
Fugitive Emissions from Septic Systems	BOD5 load generated from septic systems	Wastewater treatment facility and/or municipal utility/public works department
Emissions from the Combustion of Digester Gas	Heat content associated with digester gas utilized for treatment	Wastewater treatment facility and/or municipal utility/public works department
Emissions from Flaring of Digester Gas	Fraction of methane in digester gas and the destruction efficiency	Wastewater treatment facility and/or municipal utility/public works department
CO_2 Emissions from the Use of Fossil Fuel Derived Methanol	Daily methanol load and plant treatment type (raw solids, anaerobic, or solids combustion)	Wastewater treatment facility and/or municipal utility/public works department
Emissions from Combustion of Biosolids and Sludges	Daily quantity of sludge/biosolids incinerated, energy content of biosolids, populations served	Wastewater treatment facility and/or municipal utility/public works department
Process and Fugitive Emissions		

Services Consumption	Service type, per government employee consumption, number of government employees, life cycle emissions of service type	Statewide averages or employee survey
Construction Materials Consumption	Material type, amount consumed, life cycle emissions of goods type	Statewide averages, municipal planning, or public works department
Food Consumption	Food type, per-capita consumption, number of government employees	Statewide averages or employee survey
Goods Consumption	Goods type, per government employee consumption, number of government employees, life cycle emissions of goods type	Statewide averages, or employee survey
Upstream Impacts of Fuels Used in Fleet Vehicles	Fuel type, annual fuel use, percentage biofuel in blend, upstream emissions per fuel use	Municipal departments with vehicles (public works, police, fire, parks)
Hydrofluorocarbon & Refrigerant Emissions	Gas type, fugitive gas released	CARB Refrigerant Management Program
Upstream Impacts of Fuels Used in Stationary Combustion	Fuel type, energy use associated with upstream emissions, total upstream emissions	Natural gas utility, propane provider
Fugitive Emissions from Natural Gas Distribution	Quantity of natural gas used	Natural gas utility

Unlike ICLEI ClearPath, data gathered using the EPA GHG Tool is inputted into an interactive Excel spreadsheet. Below, Table 3 dictates the data and sources necessary to produce a community-level inventory using this tool.

Table 4. EPA GHG Tool Community Data

Topic	Data	Source/Resources
Energy and Fuel		
Electricity Usage	Residential, commercial, industrial electricity usage	Electric utility
Stationary Fuel Combustion	Residential, commercial, industrial usage of natural gas, propane, etc.	Natural gas utility, propane suppliers
Mobile Units		

On-Road Vehicles	VMT, categorized by vehicle type (passenger car, light truck, heavy truck, motorcycles), number of annual passenger trips	County or state transportation agencies, regional planning/development bodies, and/or Google EIE
Active Transportation	Number of trips, distance traveled, and percentage of all trips in the community that are completed by walking or biking	Survey of residents and/or Google EIE
Aviation Travel	Fuel type and usage, percentage attributable to local jurisdiction	Local airport, state airport regulator, and/or modeling from FlightAware
Public Transit	Fuel type, vehicle type, annual fuel use, annual revenue miles traveled, number of passengers per year, overall service population	Local public transit system
Rail Transportation	Fuel type and usage, sorted by application (transit system, freight, etc.), for the track distance covered within and outside the city boundary	Rail operator
Water Transportation	Fuel type and usage, sorted by application (passenger, freight, etc.), for distances within and outside the city boundary	Shipping operators, port facilities, and marinas
Off-Road Vehicles	Fuel type and usage, sorted by sector and equipment type (utility vehicles, construction vehicles, etc.)	Survey of residents
Solid Waste		
In-Boundary Landfill	Number of landfills within community, whether collection system (LFG) is comprehensive or partial, methane emissions	Landfill operators, CARB Landfill Emissions Tool
Wastewater		
Anaerobic/Aerobic Treatment	Treatment process used by facility (anaerobic/aerobic), population served by anaerobic/aerobic systems	Wastewater treatment facility and/or municipal utility/public works department
Combustion of Digester Gas	Amount of digester gas produced each day, fraction of methane in biogas	Wastewater treatment facility and/or municipal utility/public works department

BOD5 Values	BOD5 influent in treatment process, amount of BOD5 removed during primary treatment	Wastewater treatment facility and/or municipal utility/public works department
Septic Systems	Number of residential, commercial, and industrial units served by septic systems	Municipal utility/public works department
Nitrogen Loads	Industrial nitrogen load in wastewater treatment system	Wastewater treatment facility and/or municipal utility/public works department
Nitrification/ Denitrification	Biological conversion process used by facility (nitrification/denitrification), whether industrial and commercial discharges are received at the facility, population served by nitrification/denitrification systems	Wastewater treatment facility and/or municipal utility/public works department
Nitrogen Load in Effluent Discharge	Daily N load from effluent discharges, discharge location (river, stream, or ocean)	Wastewater treatment facility and/or municipal utility/public works department
Water		
Water Imports	Percentage of water which is derived from local or imported sources	Water supplier and/or municipal utility/public works department
Water Use	Residential, commercial, and industrial water usage	Water supplier and/or municipal utility/public works department
Agriculture, Land Management, and Urban Forestry		
Agriculture and Land Use	Synthetic, organic, and manure consumption for residential, commercial, and industrial activities	Survey of agricultural activities
Tree Coverage	Amount of municipality's total area taken up by residential, commercial, and industrial properties, as well as the percentage of those areas with tree cover	Municipal planning and zoning department
Waste Production		
Solid Waste Emissions	Waste generation associated with residential, commercial, and industrial	Waste disposal unit, municipal utility/public works department, and/or federal,

	units, categorized by material type (e.g., paper, plastic, organic)	state, county, or local data reports, EPA Waste Reduction Model (WARM)

Once the required data has been identified, it must be collected. Communication must occur between and among a variety of actors, including utilities, waste disposal units, municipal departments, regional planning bodies, and state agencies. In some cases, information will be difficult to obtain (e.g., solid waste), either due to a lack of availability or inconsistencies in reporting. As a result, it may be necessary to make calculations based on aggregate county, state, or national data. For example, when calculating waste generation in Rockford and Grand Haven, it was difficult to retrieve data from waste disposal units in the communities. To compensate for this, waste generation and characterization data from Kent and Ottawa Counties were used to estimate city-specific waste by scaling this information based on residential, commercial, and industrial unit ratios.

Municipalities collecting data for a GHG inventory should be prepared to allocate a significant portion of their resources and efforts to data collection. Coordinating with external units involves engaging with multiple organizations, each with their own reporting systems and data collection processes. This coordination may require extensive communication, data requests, and follow-ups to ensure the timely and accurate submission of data. Additionally, internal calculations can be complex and time-consuming, especially when converting raw data into GHG emissions estimates. This process often involves applying emission factors, accounting for different sectors and activities, and considering various methodologies and protocols. Municipalities must invest considerable time and expertise to ensure accurate calculations and reliable results.

To effectively manage this data-intensive process, municipalities should prioritize developing streamlined data collection procedures, establishing clear communication channels with stakeholders, providing guidance and support to data providers, and employing data management systems that facilitate efficient organization and analysis of collected information. It is recommended to develop a spreadsheet or another tracking system to reflect key information on data requests, including estimated deadlines, inquired information, and the point of contact. Once information is received, what has been provided should be noted in a log for future reference.

For a complete overview of this process of Rockford and Grand Haven, access the summary reports for both in the Appendix.

Inputs & Calculations

Once data has been identified and collected, it must be inputted into ICLEI ClearPath or the EPA GHG Tool to finalize the inventory. For ICLEI ClearPath, this is done by adding calculation inputs to the inventory records. The EPA GHG Tool is similar, with data inputted into color-shaded cells to derive emission values.

However, there are also cases where data may be difficult to ascertain from source holders. For Rockford and Grand Haven, solid waste data was not provided by waste haulers, necessitating estimates based on scaled county-level data based on residential, commercial, and industrial unit ratios and waste characterization reports.

In Grand Haven, residential waste was calculated by taking a per household estimate from the 2021 Kent County Waste Characterization Study (1,325 lbs/household) and multiplying by the number of households in Grand Haven (5,695 households) (Kelly 2022; United States Census Bureau 2022). After converting pounds to tons, this estimate revealed that 3,769.9 tons were generated by residential units in the city. Then, commercial waste was determined by multiplying 4.51 lb/sq ft, the average of commercial generation rates listed by CalRecycle, by 921,885 sq ft, the total square footage of commercial units in Grand Haven (CalRecycle 2019). In total, commercial waste generation was estimated to be 2,080.3 tons. Finally, industrial waste was calculated by multiplying 6 lb/sq ft, the average of industrial generation rates listed by CalRecycle, by 4,029,917 sq ft, the total square footage of industrial units in Grand Haven (CalRecycle 2019). In total, commercial waste generation was estimated to be 12,089.751 tons.

To input the data into EPA WARM, the total of 17,940 tons was apportioned into waste material categories based on a EPA municipal solid waste report (USEPA 2016). This report outlined that municipal solid waste in 2013 consisted of:

- Paper: 27%
- Food: 14.6%
- Yard Trimmings: 13.5%
- Plastic: 12.8%
- Metals: 9.1%
- Rubber, Leather, and Textiles: 9%
- Wood: 6.2%
- Glass: 4.5%
- Other: 3.3%

Table 5 highlights the waste characterization for the City of Grand Haven. With these calculations, waste generation in the city was estimated to produce 2.3% of overall emissions.

Table 5. Solid Waste Data

Material	Metric Tons
Paper	4,843
Glass	807
Metal	1,632
Plastic	2,296
Rubber, Leather, and Textiles	1,614
Wood	1,112
Yard Trimmings	2,421
Food	2,619
Other	592
Total	**17,936**

When estimating unavailable data, it is advised to review the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) and the Local Government Operations Protocol (LGOP) to ensure that the estimation process follows standardized and reliable methods. Replicability is equally important to verification, peer review, and future updates to the inventory, making it essential that each step as meticulously documented.

Utilizing an Inventory

This part presents an overview of post-finalization activities, including updating procedures, alignment with policy action, and financial and technical resources available for municipally led sustainability initiatives.

Updating Procedures

In the realm of future planning, one of the primary considerations revolves around the continuous updating of greenhouse gas (GHG) inventories. It is vital to ensure that these inventories remain current and accurate to support ongoing climate action and decision-making processes effectively. To achieve this, several key steps come into play. Firstly, addressing data gaps becomes a priority. During the initial inventory development, certain data might have been missing or unavailable, limiting the comprehensiveness of the assessment. To rectify this, future planning necessitates concerted efforts to fill in these data gaps.

Refining models and calculations is another crucial aspect. As scientific knowledge evolves and methodologies advance, it becomes essential to improve the precision of emission estimation models. This includes incorporating the latest emission factors, adopting more sophisticated algorithms, and staying up to date with emerging best practices. Such refinements enable more accurate projections and better tracking of progress over time. This relates to another key element, streamlining future data collection. Simplifying the data collection workflow, automating data retrieval, and employing digital tools can enhance efficiency and reduce the burden of data management. Investing in modern technologies and data management systems can significantly contribute to this effort, facilitating seamless data flow and reducing the likelihood of errors in the inventory process.

Additionally, building strong connections with data holders is vital for long-term inventory sustainability. Engaging and fostering relationships with organizations, businesses, and institutions that hold relevant emissions data ensures a steady flow of critical information for future inventories. Clear communication and collaboration between the entity responsible for the inventory and data holders enable a more streamlined and cooperative data-sharing process. Furthermore, in cases where obtaining data was particularly challenging during the initial inventory creation, investing in building and nurturing these relationships becomes even more imperative. By expressing an ongoing interest in receiving the required information every 3-5 years, data holders can better plan and prepare for data submissions, ultimately improving the reliability and completeness of future inventories.

Policy Alignment

Once a comprehensive greenhouse gas (GHG) inventory has been compiled, it serves as a valuable foundation for the development of local sustainability or climate action plans. These plans play a pivotal role in guiding municipalities and communities towards a more sustainable future. Leveraging the information obtained from the inventory, local governments gain valuable insights into the sources and sectors that contribute the most to emissions within their jurisdiction.

Armed with this knowledge, decision-makers can strategically design and implement targeted strategies to address the identified emission hotspots. For example, if the transportation sector emerges as a significant contributor to emissions, a viable plan of action may involve investing in a bike sharing network or improving public transportation infrastructure. Similarly, if energy consumption is a dominant source, supporting energy efficiency measures and encouraging the adoption of renewable energy sources within both municipal operations and the private sector could be key priorities. Additional examples include:

- Promote Energy Efficiency
- Encourage Renewable Energy Adoption
- Install Community and Municipal Solar
- Energy Performance Contracts
- Smart Metering
- Promote Educational Awareness
- Financial Resources
- Green Building Certification
- Collaborations with Utility Companies
- Promote Active Transportation
- Support Electric Vehicle Infrastructure
- Invest in Public Transportation

Local governments interested in pursuing sustainability actions have access to a diverse range of funding sources to support their initiatives. These funding opportunities can significantly bolster the implementation of climate action plans and sustainable projects. Here are some of the key funding sources available to local governments:

1. **Federal Grants:** Various federal agencies offer grants and funding programs specifically geared towards supporting sustainability and environmental initiatives

at the local level. These grants may cover a wide array of projects, including renewable energy installations, energy efficiency upgrades, green infrastructure development, and climate resilience projects.

- Environmental & Climate Justice Thriving Communities Block Grant
- Greenhouse Gas Reduction Fund
- Climate Pollution Reduction Grants

2. **State Grants:** State governments also provide funding opportunities to support local sustainability efforts. These grants may align with state-level environmental goals and priorities, encouraging local governments to implement projects that contribute to broader sustainability objectives.

3. **Utility Rebates and Incentives:** Many utilities offer rebates and financial incentives to encourage energy efficiency and the adoption of renewable energy technologies. Local governments can take advantage of these programs to offset the costs of energy-efficient equipment and renewable energy installations in their own facilities.

4. **Public-Private Partnerships:** Collaboration with private sector entities can lead to public-private partnerships that leverage private investment to support sustainability projects. Local governments can attract private funding for projects that align with corporate social responsibility goals or address mutual sustainability objectives.

5. **Bond Financing:** Issuing bonds can be a means for local governments to secure funds for large-scale sustainability projects over an extended period. Green bonds, in particular, are designed explicitly to finance environmentally beneficial projects.

Conclusion

Developing a greenhouse gas (GHG) inventory is a comprehensive and rigorous process that involves several key steps to identify and collect relevant data. First, boundary setting determines the geographical and temporal scope of the inventory. Then, data is identified and collected from numerous sources, including utilities, water treatment facilities, and government departments. This information can then be inputted into an inventorying tool, such as ICLEI ClearPath or the EPA Local GHG Inventory Tool. Based on available data, these software solutions will provide emission estimates for the sources and sectors involved.

However, the work of an inventory is not complete once it has been conducted. To maximize potential benefits, its results must be used to inform future sustainability efforts in a community. To begin this process, localities are encouraged to develop sufficiently localized climate action plans, which balance emission reduction strategies based upon the needs identified in an inventory with community engagement and other values, such as equity and cost effectiveness.

In summary, true value of an inventory lies in its application. By integrating GHG inventories into proactive sustainability planning, communities can pave the way for a more resilient and sustainable future while combating the global challenge of climate change at a local scale.

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Appendix

Access the inventory reports for the City of Rockford and the City of Grand Haven.