



# Consumption Based Emissions Larimer County

Julia Newman, Managing Director

Tom Herrod, Managing Director

Nick Russell, Senior Associate





# Agenda

- Overview of Inventories & Consumption Based Emissions Inventories
- Scope of Larimer CBEI
- Data and Results
- Applications
- Next Steps
- Questions/Discussion

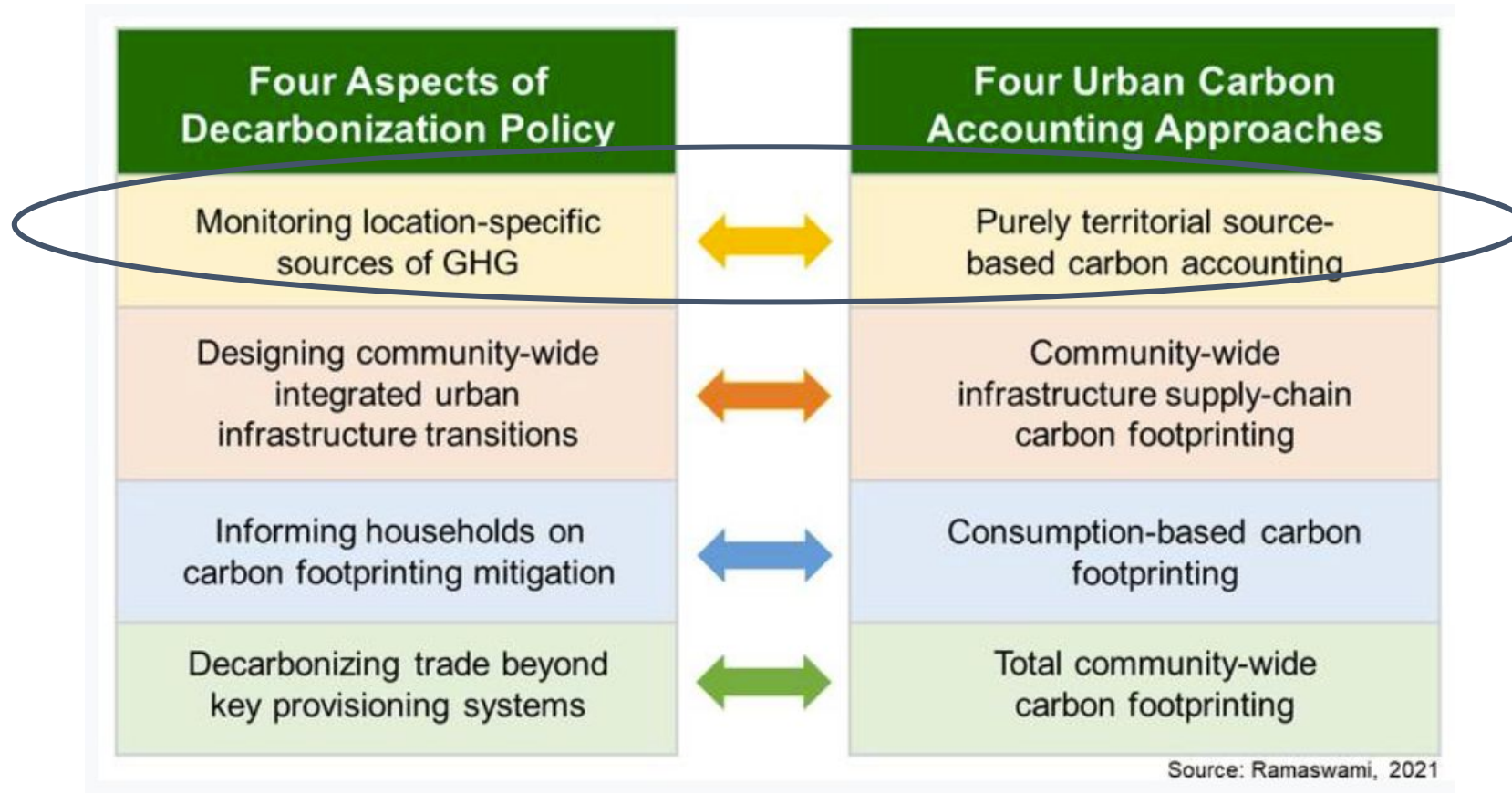


# What are Greenhouse Gas Inventories?

- An accounting of the emission activities and sources that contribute to global climate change.
- Include a spatial and temporal boundary.
- Include the major GHGs: CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, & HFCs.

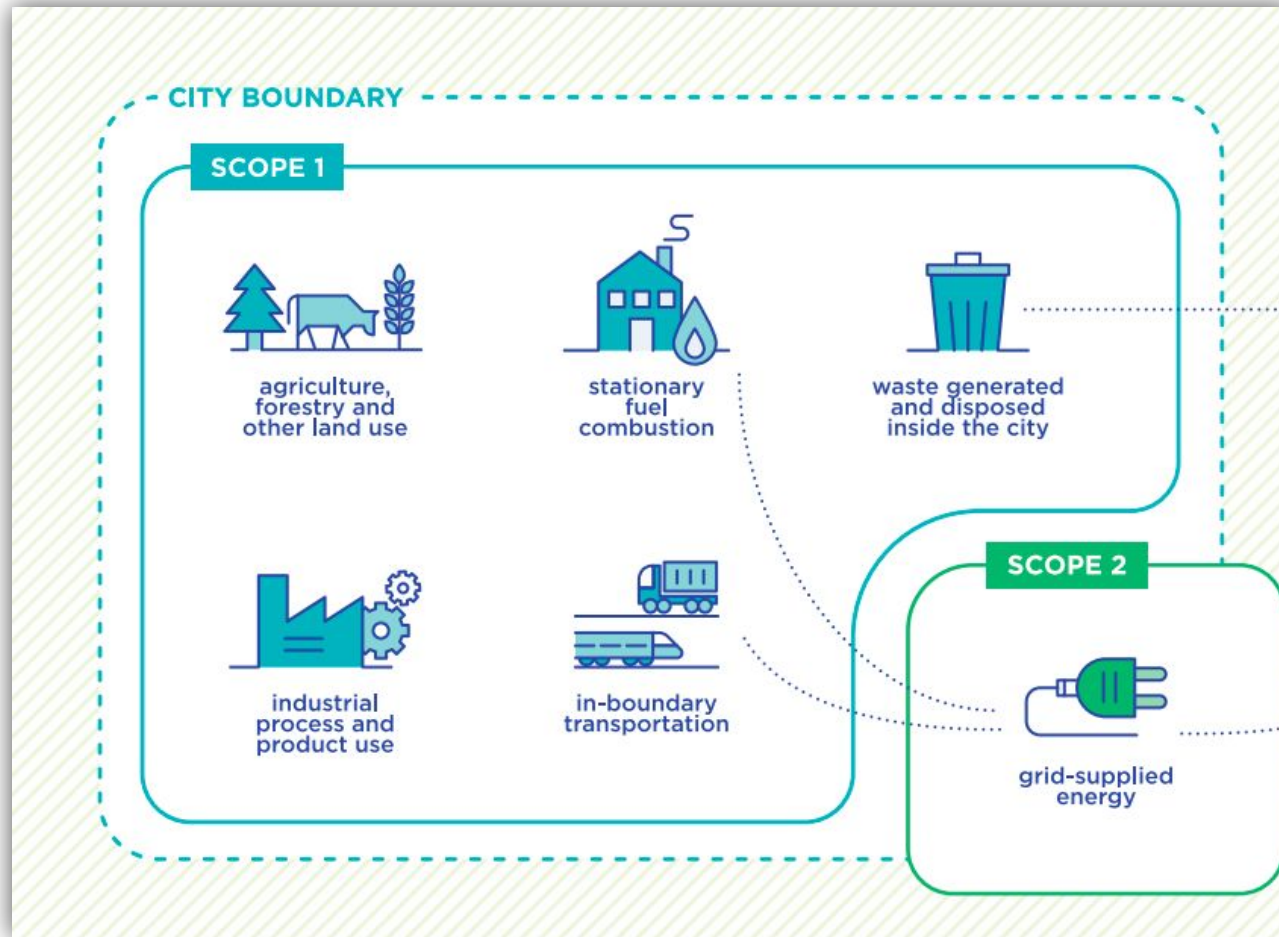


# Major Types of Inventories

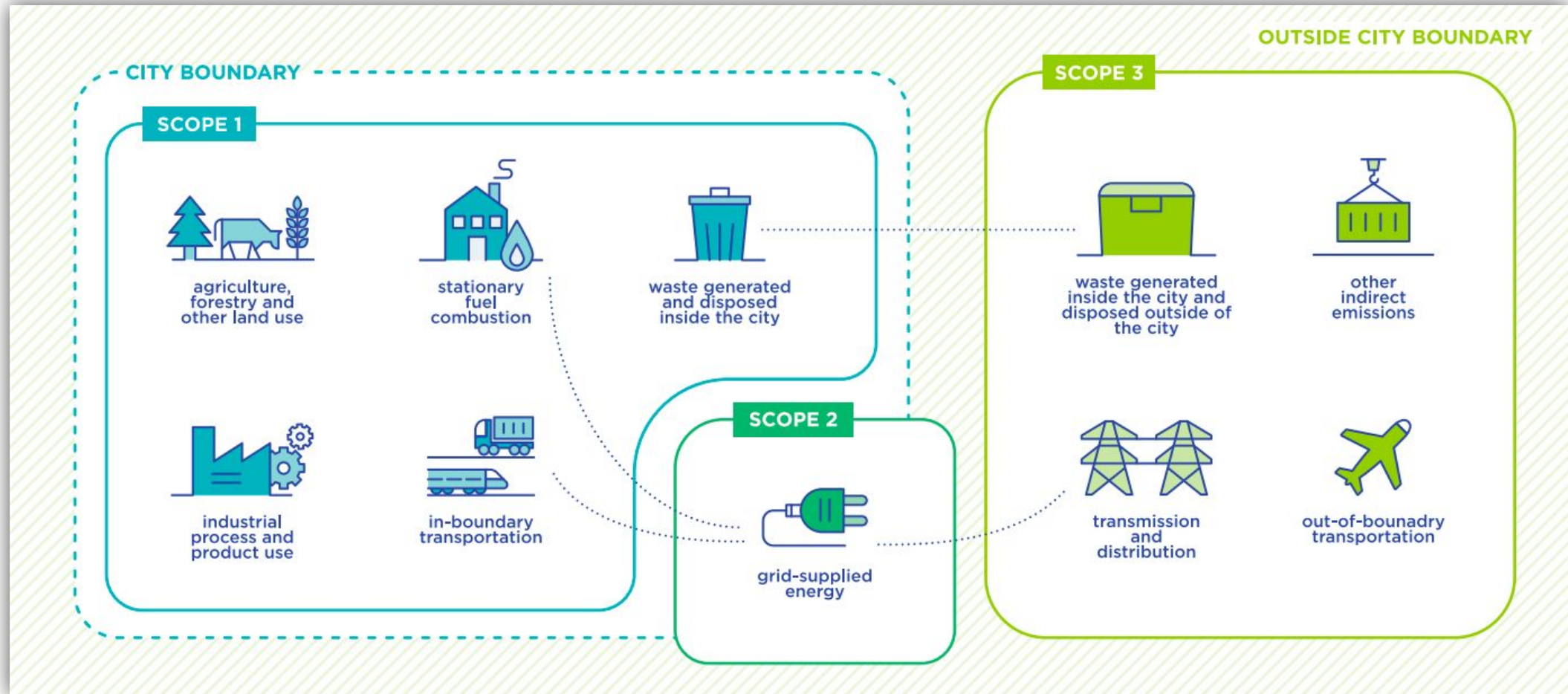




# Community: Territorial Inventories



# Community: Traditional Inventories+





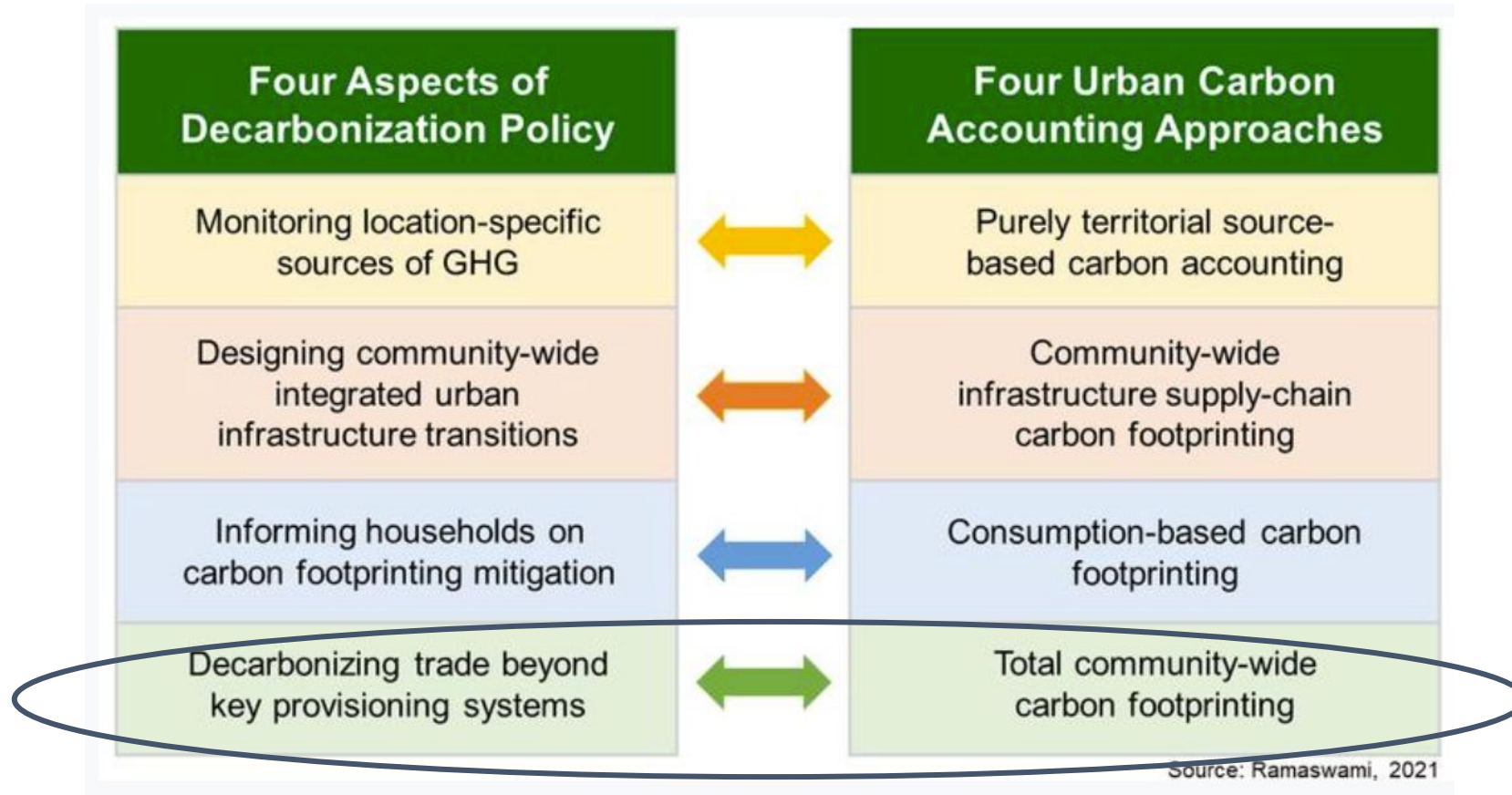
# County Community-Wide Inventory Results

## All Emissions by Sector

Sector	2022 Emissions (mtCO <sub>2</sub> e)	% of Total
Building Energy	2,758,547	65%
Oil Wells	79,150	2%
Transportation	1,137,445	27%
Industrial Processes & Product Use	115,780	3%
Waste	67,189	2%
Wastewater Treatment	1,507	0%
Agriculture	71,244	2%
<b>Total</b>	<b>4,230,863</b>	<b>100%</b>

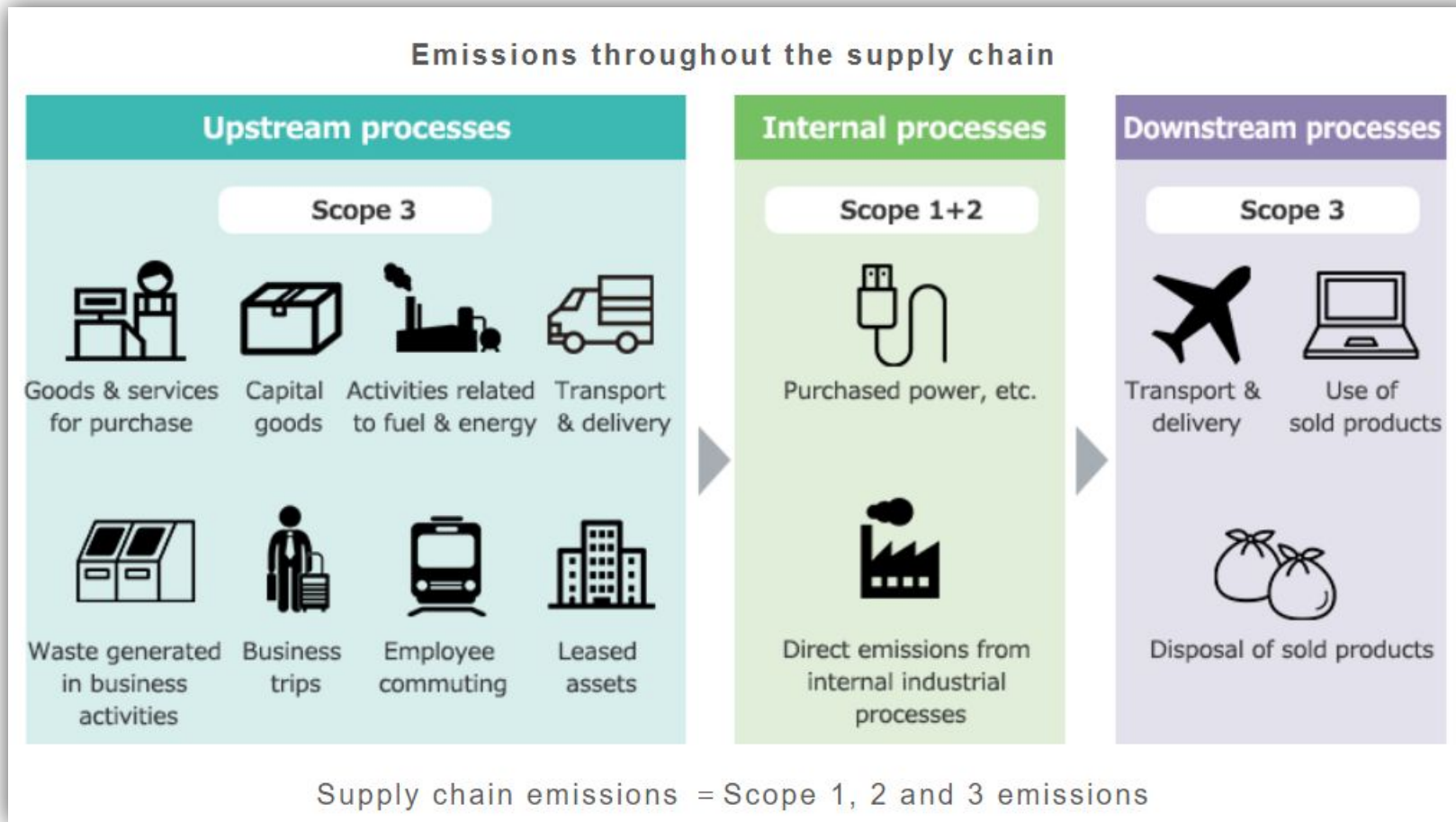


# Major Types of Inventories





# Supply Chain Inventory





# County Organizational Inventory Results

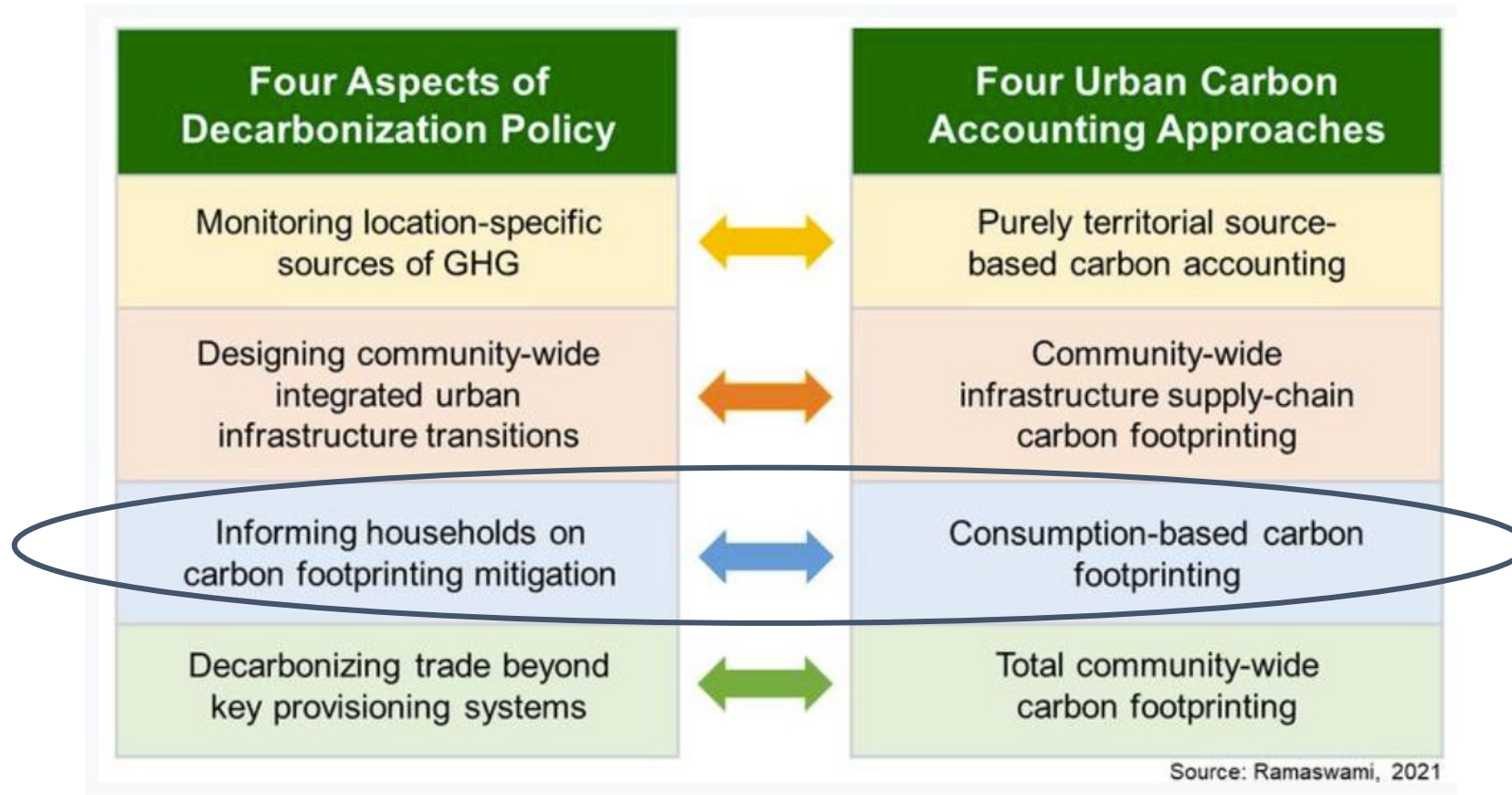
## All Emissions by Sector

Emission Sector	Emissions (mt CO <sub>2</sub> e)	% of Total
Stationary Energy	9,203	8%
Fleet & Equipment	5,538	5%
Employee Commuting	3,181	3%
Business Travel	293	0.3%
Waste	84,175	73%
Refrigerants	25	0.02%
Consumption - Based	12,114	11%
<b>Total Emissions without Consumption-Based Sources</b>	<b>102,415</b>	
<b>Total Emissions with Consumption-Based Sources</b>	<b>114,530</b>	<b>100%</b>





# Major Types of Inventories





# Household Consumption Emissions Inventory

**EPA** United States Environmental Protection Agency

Learn the Issues | Science & Technology | Laws & Regulations | About EPA

Carbon Footprint Calculator

Household Carbon Footprint Calculator

Home Energy | Transportation | Waste

**Home Energy**

**[ - ] Your Current Emissions from Home Energy**

Heating: What is your household's primary heating source?

Utility: Enter your average monthly bill or other data for each source of energy your household uses. Click the icons, ⓘ below for each U.S. average.

Natural Gas ⓘ  Dollars

Electricity ⓘ  Dollars

Fuel Oil ⓘ  Dollars

Propane ⓘ  Dollars

**Your Carbon Footprint**

Annual CO<sub>2</sub> emissions (lbs.) ⓘ

Your Current Total: 0

New Total After Your Planned Actions: 0

U.S. Average\*: 0

\*For a household of 4 people in Zip Code 80524

[Start Over](#) [View Your Report](#)

**CoolClimateNetwork**

Get Started | Travel | Home | Food | Shopping | Take Action

**START WITH A QUICK CARBON FOOTPRINT ESTIMATE**

1. Where do you live?

2. How many people live in your household?  
 2.5 (avg.) | 1 | 2 | 3 | 4 | 5+

3. What is your gross annual household income?  
 Avg | <10k | 10k | 20k | 30k | 40k | 50k | 60k | 80k | 100k | 120k+

[REFINE YOUR ESTIMATE](#)

**Your footprint** | Leaderboard | Settings | Login

50 tons CO<sub>2</sub>e/year

0 % Same as Average

Household tons CO<sub>2</sub>e/year

Travel: Air Travel, Car MFG, Car Fuel

Home: Construction, Water, Other, Natural Gas, Electricity

Food: Other, Meat

Goods: Other, Furniture, Clothing

Services: All

0% same | 0% same | 0% same | 0% same | 0% same

Compared to households with same size and income in United States.

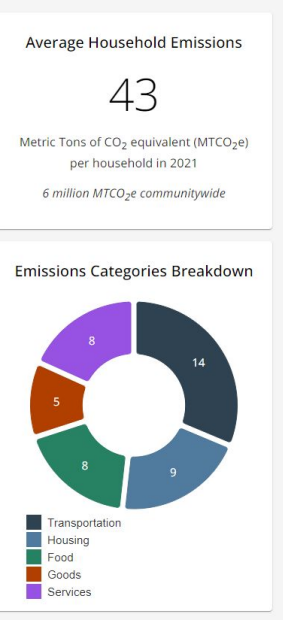
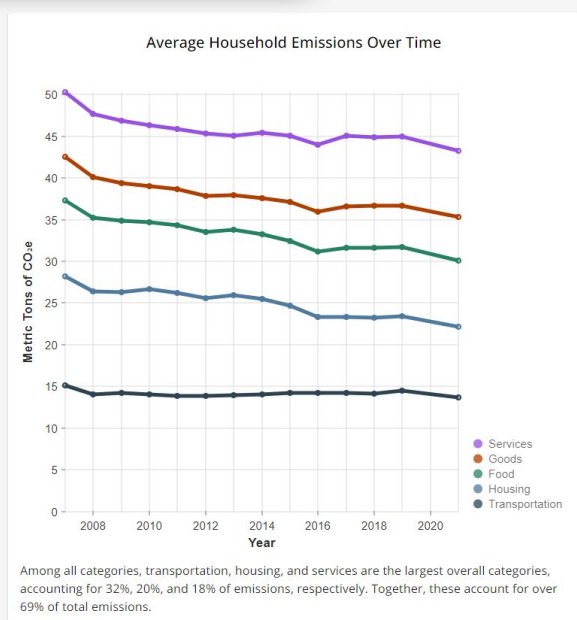
powered by CoolClimate • terms of use • documentation

## Household Emissions Dashboard: Boulder County

This is an estimate of the greenhouse gas emissions associated with the activity of all residents of Boulder County, except calculated for all households in a jurisdiction.

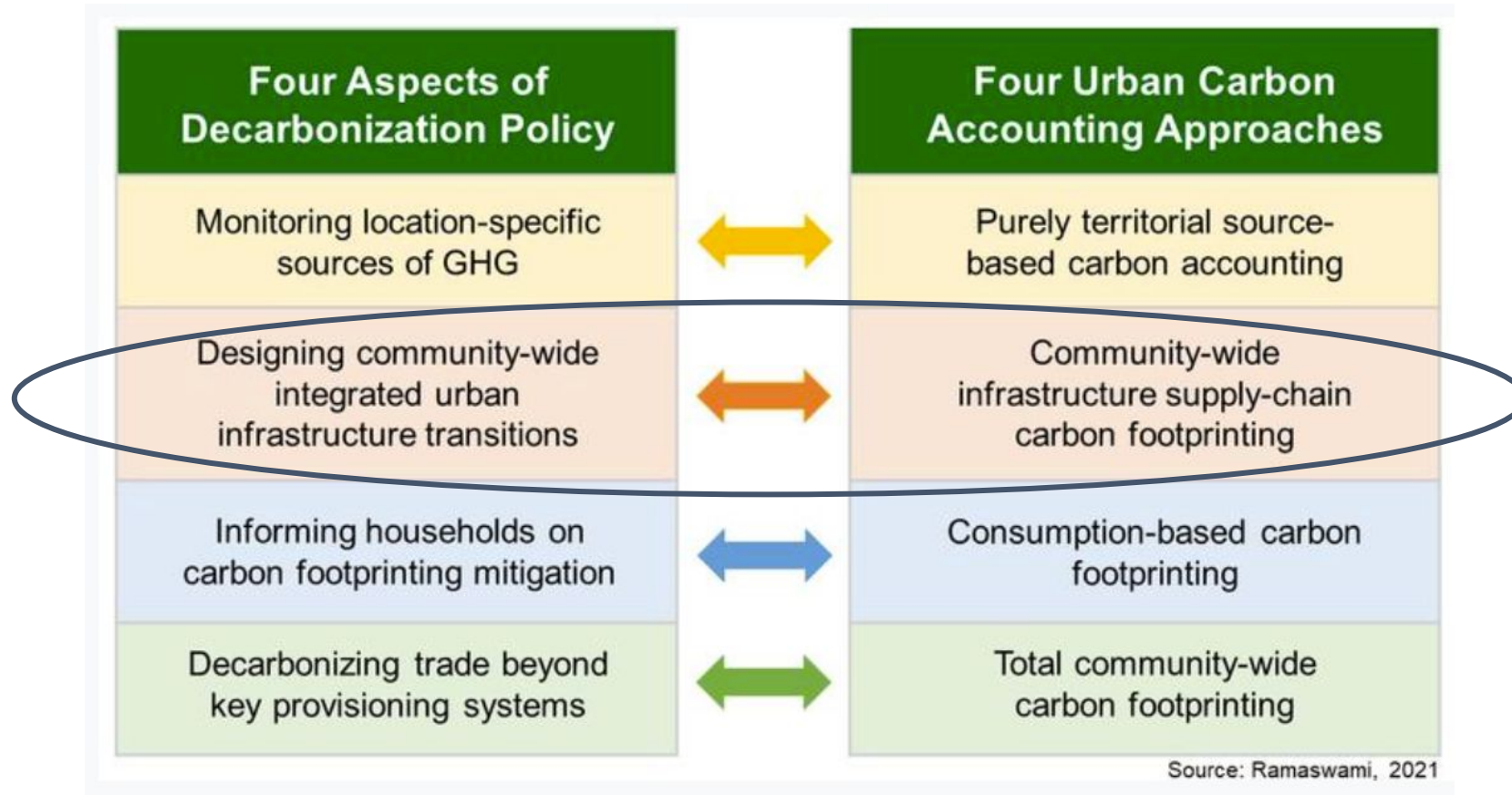
In traditional inventories, a county would look at all emissions that may occur anywhere in the world, but only those emissions that are residents of the county. Emissions associated with businesses that do not serve residents are not included.

Boulder County's 2021 CBEI.

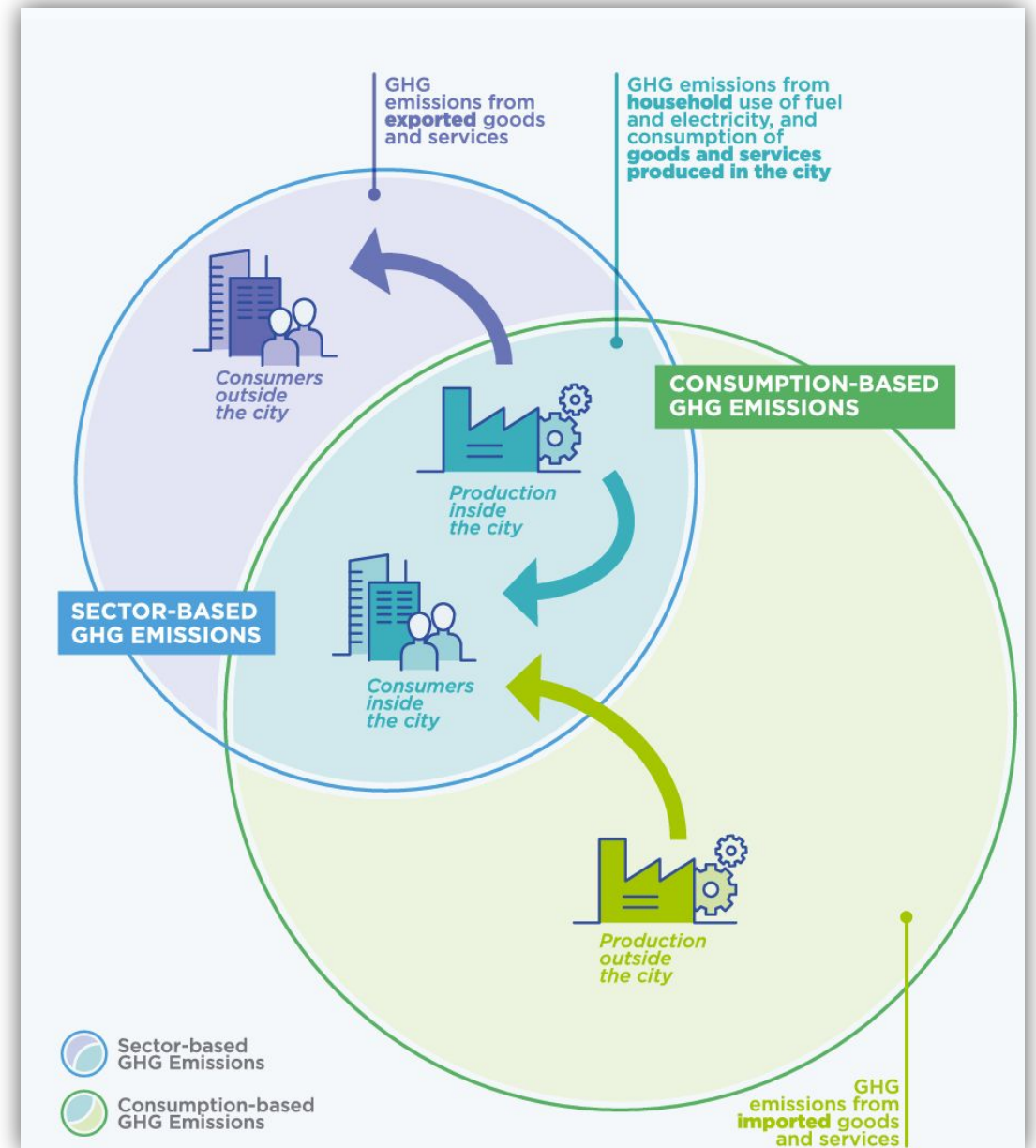




# Major Types of Inventories



# Consumption Based Emissions Inventories

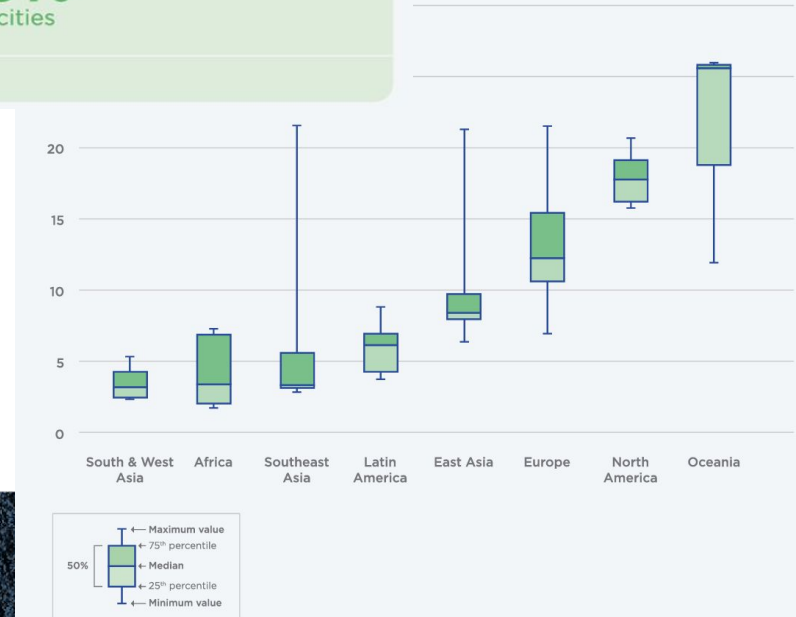




# Protocols & Guidance

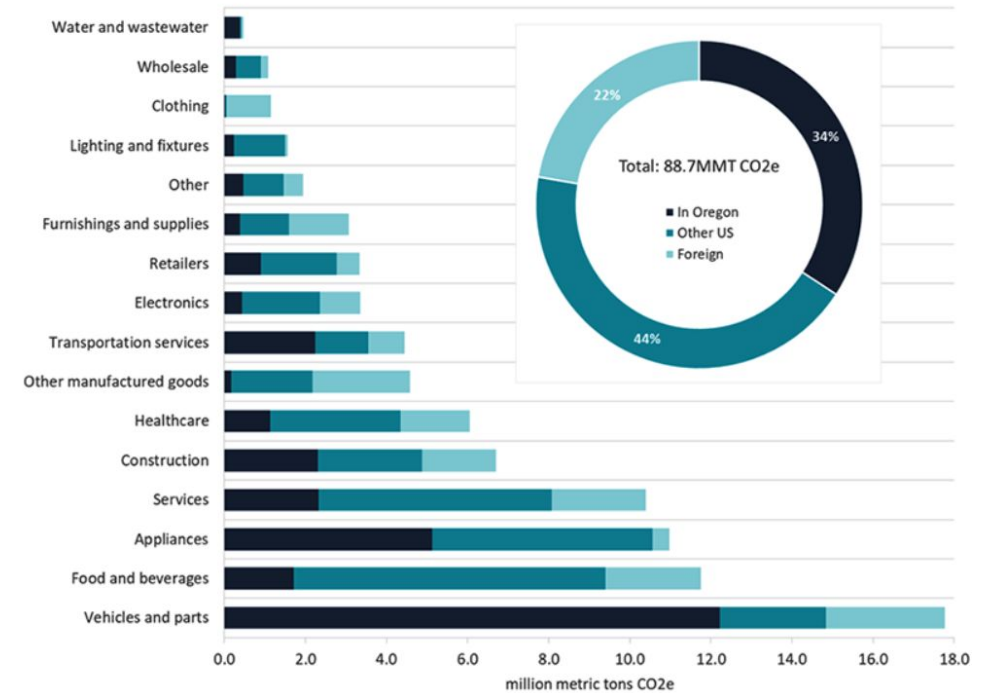
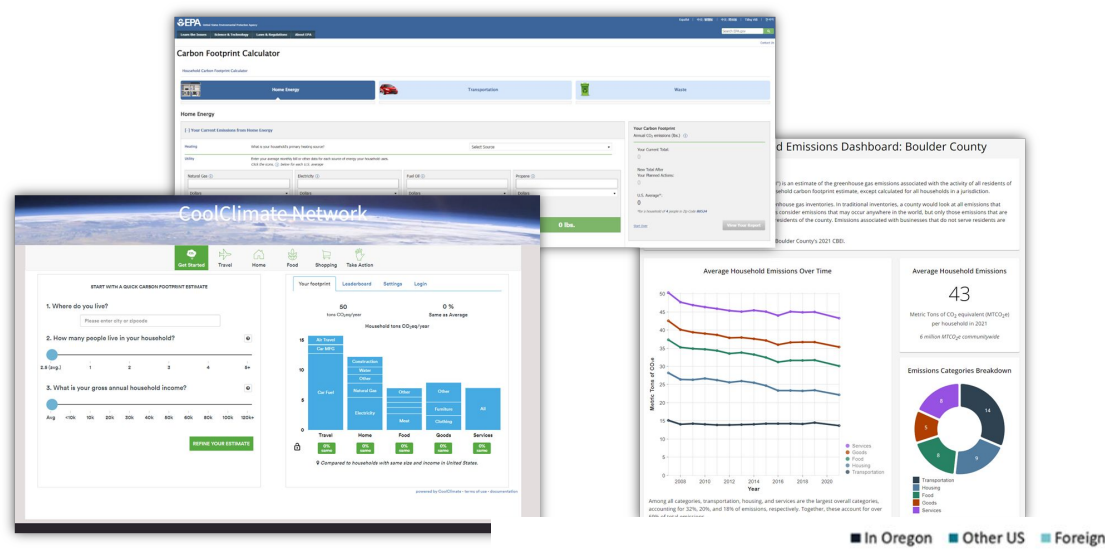
- C40 Cities

- Based on large global cities
- Top-down approach
- 79 cities
- Concluded: *further research is needed to improve the evidence base, and better understand the mechanisms by which cities can influence transboundary supply chains GHG emissions*



# Protocols & Guidance

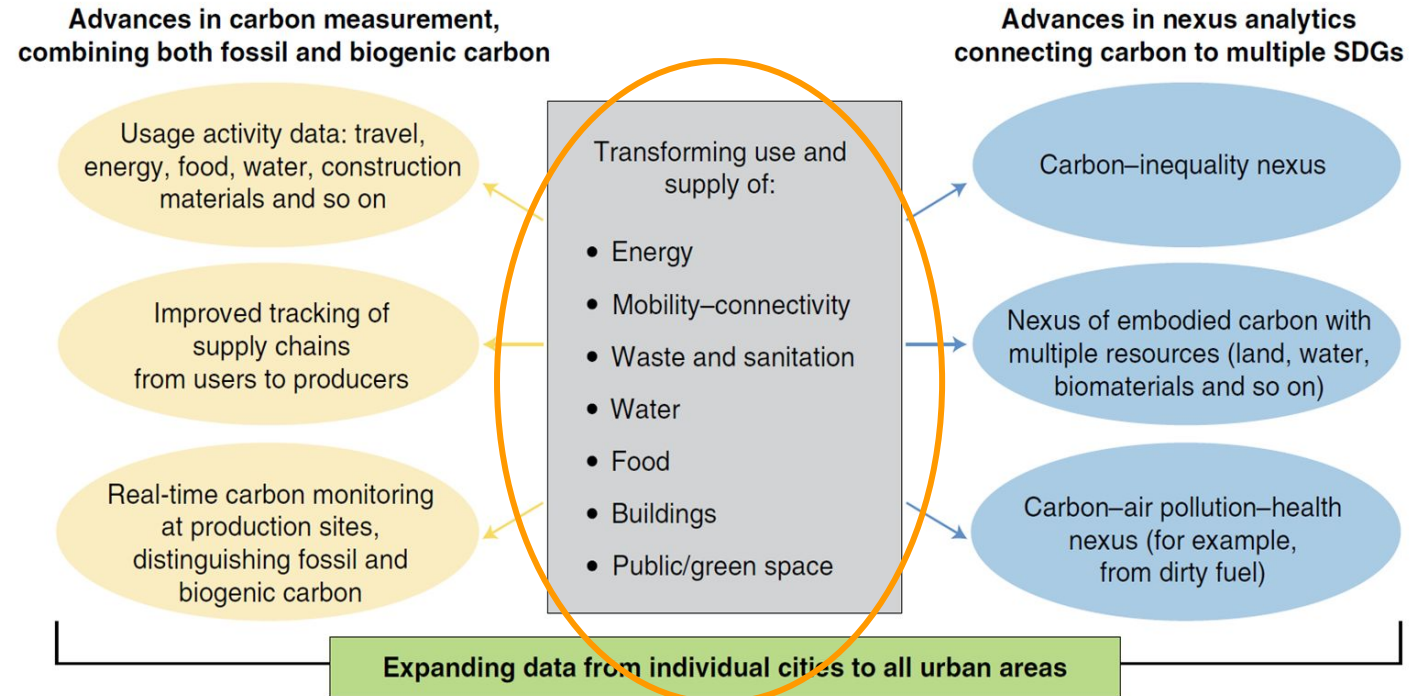
- ICLEI US Community Protocol
  - Household Consumption
  - Economic Data Approach
  - Currently undergoing an update
  - Concluded: *...consumption-based accounting of greenhouse gas emissions is a relatively young field. No real standards exist, and “best practices” have not yet been identified.*





# Protocols & Guidance

- Net Zero Sustainable Cities
  - Combines traditional community-wide emissions – Scopes 1,2,3 & includes key provisioning systems of a community
  - Represents >90% of Global Emissions
  - Linked to SDGs, health, and transitional approaches e.g. nature based solutions, food-action, adaptation.
  - Concluded: ... *cities urgently need better usage-activity data*



**Fig. 1 | Key advances required in urban carbon analysis.** Carbon measurements (left) and carbon-SDG nexus analytics (right).



# Scope of Larimer County CBEI

- Energy
  - Direct
  - Indirect – Upstream & Downstream
- Mobility-Connectivity
  - Fuel – Direct and Upstream
  - Missing Cement Data for Infrastructure
- Waste & Sanitation
  - Solid Waste
  - Wastewater
- Buildings
  - Embodied Carbon
  - Residential & Commercial
- Water
- Food
  - Purchases
  - High level emissions/\$ for major categories
- Public Green Space
  - Forests & Trees
  - Agriculture



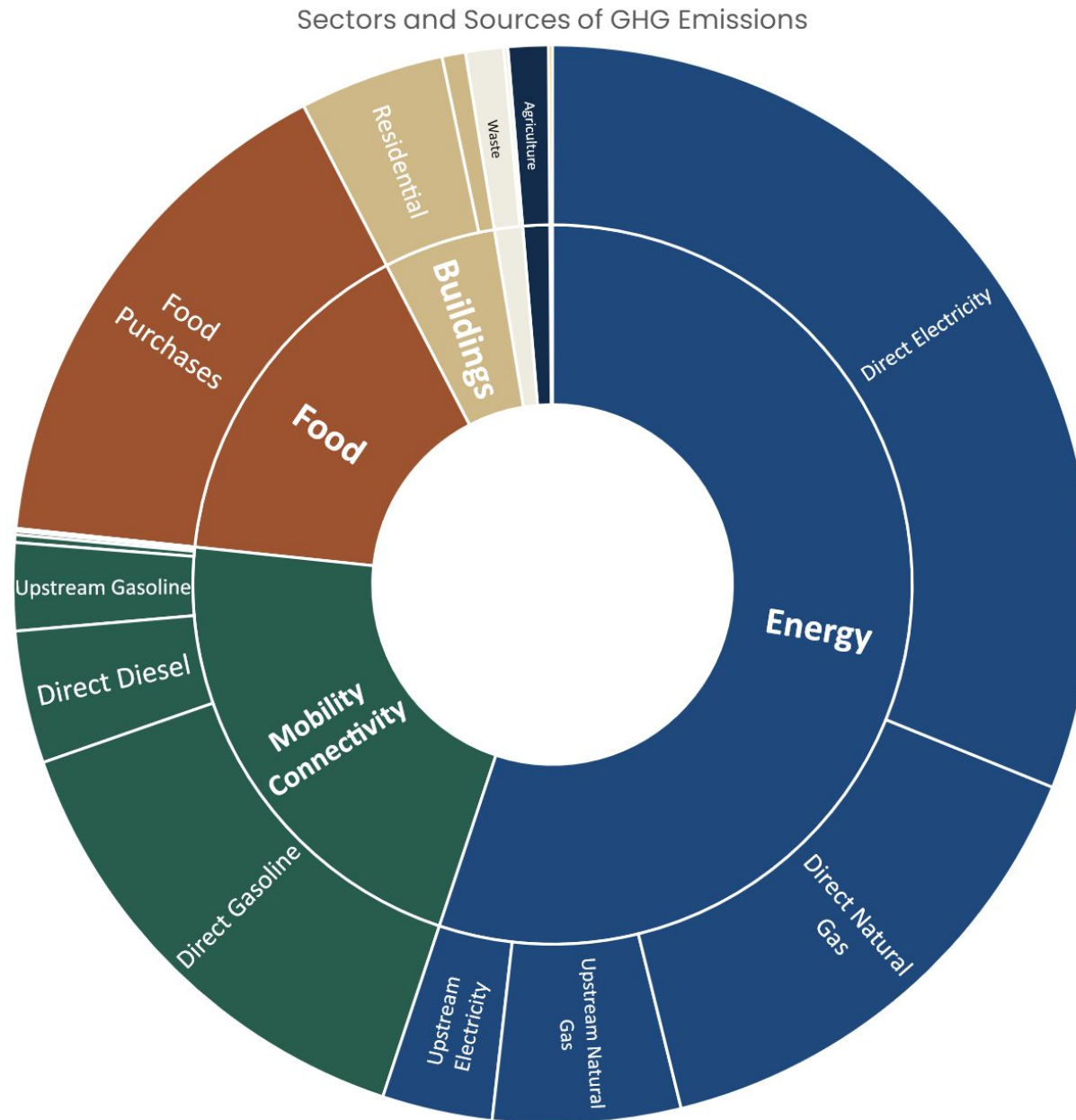


# Results – 7 Provisioning Systems

Consumption Based Emissions by Sector		
Emission Sector	Emissions (mtCO <sub>2</sub> e)	Percentage of Total
Energy	3,258,175	58.3%
Mobility- Connectivity	1,268,307	22.7%
Waste- Sanitation	74,666	1.3%
Buildings	298,494	5.3%
Water	7,130	0.1%
Food	928,678	16.6%
Public Green Space	(247,497)	- 4.4%
<b>Total</b>	<b>5,587,952</b>	<b>100%</b>



# 7 Provisioning Sectors and Sources





# Energy Deep Dive

Emission Sector	Emission Source	Emissions (mt CO2e)	Percentage of Total
Energy	Direct Electricity	1,840,982	33%
	Upstream Electricity	195,469	3%
	Direct Natural Gas	889,259	15.91%
	Upstream Natural Gas	332,465	5.9%

- Direct Sources align with traditional inventory
- Upstream are additional emissions
  - Full Life Cycle of generating source
  - Fugitive Emissions from fuels
  - Upstream methane leakage largest contributor

- 1) Studies conducted as part of NREL's Life Cycle Assessment Harmonization Project ("Life Cycle Assessment Harmonization," NREL, <https://www.nrel.gov/analysis/lifecycle-assessment.html>)
- 2) U.S. Department of Energy "vision" studies, including Hydropower Vision (DOE 2016), Wind Vision (DOE 2015), Geothermal Vision (Millstein et al. 2019) and On the Path to SunShot (Wiser et al. 2016)
- 3) Grid-scale lithium-ion battery and hydrogen fuel cell stationary storage literature compiled under the Los Angeles 100% Renewable Energy Study (Nicholson et al. 2021)



# Mobility Deep Dive

Emission Sector	Emission Source	Emissions (mt CO <sub>2</sub> e)	Percentage of Total
Mobility Connectivity	Upstream Gasoline	155,060	3%
	Upstream Ethanol	(7,276)	- 0.1%
	Upstream Diesel	13,475	0%
	Upstream Electricity	442	0%
	Direct Gasoline	860,930	15.407%
	Direct Ethanol	4,462	0.1%
	Direct Diesel	234,821	4%
	Direct Electricity	6,393	0.11%

- Direct Sources align with traditional inventory
- Upstream are additional emissions
  - Wells to Pump for fuels – fugitive emissions
  - Ethanol

Dept of Energy, Argonne National Laboratory GREET well to wheel calculator:  
<https://www.anl.gov/topic/greet>





# Food Deep Dive

Emission Sector	Emission Source	Emissions (mt CO2e)	Percentage of Total
Food	Food Purchases	928,678	16.6 %

- Consumer Expenditure Surveys used for \$ on Food items (7 Categories)
- Emission factors for food production combined with emissions from transportation, wholesale and retail trade to create an emission factor at point-of-sale.

Jones, C. M, Kammen, D. M, & McGrath, D. T. (2008). Consumer-oriented Life Cycle Assessment of Food, Goods and Services. *UC Berkeley: Berkeley Energy and Climate Institute*. Retrieved from <https://escholarship.org/uc/item/55b3r1qj>



# Buildings Deep Dive

Emission Sector	Emission Source	Emissions (mt CO2e)	Percentage of Total
Buildings	Residential	257,040	5%
	Commercial	41,454	1%

- Embodied carbon of materials
- Completed projects in 2022
- Assessors Data
- Pitkin County analysis of materials/sqft

*Embodied Carbon in Construction Calculator (EC3) to estimate embodied carbon. Utilized average environmental product declarations (EPDs) and applied them to building materials. Average assume 50% of building products have a lower embodied carbon value.*





# Public & Green Space Deep Dive

Emission Sector	Emission Source	Emissions (mt CO2e)	Percentage of Total
Public Green Space	Agriculture	71,244	1%
	Forestry/Trees	(318,741)	- 5.7%

- Fertilizer inputs (2017)
- Uncertainty around livestock and crops
- Forestry & Trees = net of emissions and removals (2016–2019)

US Community Protocol and Global Protocol for Emissions and Removals from Forests and Trees outside of Forest  
USDA Ag Census



# Waste, Wastewater, & Water Deep Dive

Emission Sector	Emission Source	Emissions (mt CO <sub>2</sub> e)	Percentage of Total
Waste & Sanitation	Waste	67,189	12%
	Wastewater	7,478	0.1%
Water	Water Delivery	7,130	0.1%

- Waste and Sanitation align with traditional inventory
- Water
  - Extraction
  - Conveyance
  - Treatment
  - Distribution

*US Community Protocol Appendix E & F, 2013*





# Applications – Transportation

- Regional approaches to align efforts
  - Stay Engaged in regional transportation conversations
- Integrate transportation into development
  - Transit Oriented Development
  - Development with EV Charging considerations
  - Reduce reliance on vehicles



# Applications – Energy

- Continue push for low/no carbon energy
- Continue push for energy efficiency
- Push for local renewable energy held by local suppliers for economic effects.





# Applications – Housing / Building Materials

- Electrification
- Carbon reduced building materials
  - Especially concrete and steel
- Transit Oriented Development
- Move towards more closed loop building materials
- Densification along major transportation corridors



# Applications – Food

- Stop Food Waste Programs
  - Engage Restaurants and Grocery Chains
  - Cooperation with food banks, charitable organizations
  - Increased Compost
- What other solutions might be here? As we electrify and decarbonize the grid, food will become a very large piece of the puzzle...
- Focus on local regenerative Ag





# Applications – Green Space

- Maintain and enhance existing Forest and Tree space
- Link to compost program
- Reduce Synthetic fertilizer

## New Notes

- Consider if/how COMAT-Farm, might be relevant
- Colorado STAR Program
- Soil Carbon Solutions Center



# Future Opportunities

- CBEI workbook is the foundation
- Other data sets for future iterations
  - Cement
  - Localized food surveys
  - Localized building materials





# Questions?



# Discussion

- After reviewing this, are there additional tactics that you think could be added to our existing list of actions to address consumption related emissions?
- How does this affect the way that you are thinking about the work to come? What else do you need to know?





# Questions and Answers

- Under the impression that you can't count tree/forested area unless you actively manage that; is that correct?
  - Similar to other GHG inventories, when you look at the boundary of the county you are including the emissions and removal of all activities, including forests and trees, regardless of who manages those lands. Can do additional analysis to better understand the level of control and influence based on those land owners.
- CSU is looking at including upstream emissions in their inventory for the first time. Using FERA—fuel energy related activities—for referencing these emissions sources. Is this the same thing or similar to what was captured in the CBEI?
  - Yes, sounds the same. Like the FERA acronym—it's much more specific and explanatory!



# Questions and Answers

- Under the buildings deep dive, when looking at the embodied carbon of materials. Were you able to include basement square footage in that. Usually total SF doesn't include basements, could throw off analysis.
  - Will double check this, relatively certain we pulled from total square footage that looks at finished basement area as well.
- Where does prairie land factor in to conversations around soil health?
  - Huge carbon opportunity in grasslands, and important ways to understand soil health, but unfortunately something that isn't quite there from a data perspective yet. There are a couple groups that can look at remote sensing for soil carbon analyses, but there aren't data set readily available.
  - Is there a way to have more understanding around the acreage of this land in general?





# Questions and Answers

- Does the food analysis look more at overall consumption of food or the types of food and the emissions levels from them?
  - There are a couple of different options for looking at emissions factors from food. Unfortunately the more detailed data set looks at emissions per calories consumed rather than dollar spent, and we didn't have the specific data on calories consumed—it is difficult to get that from dollars spent.
  - Curious about what is newer in that space from trying to find opportunities and impacts.
  - Carbon impact of food is less per dollars spent in the restaurant space—this relates to often less food waste in the restaurant space.
  - What about looking at the totality of impact? E.g., there is the impact of food waste from restaurants, plus the building impacts from embodied carbon, transportation to get there, etc.



# Questions and Answers

- Does the analysis include the full embodied life cycle emissions from all emissions sources, including renewable energy?
  - Yes, we looked at all of the sources of energy production and the lifecycle emissions from those production facilities and activities. This data comes from NREL's embodied carbon analysis.
- Is there a way for a CBEI in the future to track the impact of technology transfer and exportation. E.g., if a facility were to be built that manufactured a specific type of equipment for carbon capture, but the technology was actually installed elsewhere outside the county, is there any 'taking credit' for the fact that tech manufactured locally is having a positive climate impact globally/nationally?
  - From an accounting perspective, no, but the narrative opportunity is there. Vestas Wind Turbines exist all over the world, but many people associate it with Windsor and Brighton - where the factories are.





# Discussion Points

- How does this inventory allow us to incorporate current or near future policy level decisions (e.g., building codes, etc.)
  - Provides new data to an existing set of data. E.g., we've known the emissions per kWh of electricity for a while, but this allows us to understand the upstream emissions related to this activity. So it provides some new data that can be contemplated on specific actions. Gives a perspective that can allow things to rise to the top (e.g., food consumption) that is often low on the list based on a traditional inventory.
- Where do local governments come into play? How is this work funded?



# Discussion Points

- Currently no direct mention of embodied carbon in building materials within the CSFR plan—is this a gap that needs to be addressed?
  - General consensus among the industry nationally is that there is no standard regarding an understanding of embodied carbon in building materials. Fort Collins may move towards starting to look at the big two (concrete and steel) to get a start on reducing emissions in this space.
    - Is this something that Larimer County would consider looking at within the code adoption process, in collab with Fort Collins?





# Discussion

- Are there cautions about how a group could potentially misuse this info, or how to ensure that it isn't used to take things in a direction that is opposite where CSFR is trying to go?
  - We know based on the data where there is opportunity to reduce carbon in these sectors. We can use this to take the best first step, but wouldn't plan a long term strategy around this data.
  - We have to ensure that disproportionately impacted populations are not bearing the brunt of this work.
  - Does our grid have the capacity for EVs right now? Even at a high adoption rate, this won't happen for many years and the grid will continue to evolve. Education is key to the adoption of these technologies, and regulation is essential to making change happen quickly. E.g., existing buildings can be addressed in code through the change out of mechanical systems, etc.



# Discussion

- We haven't included anything in the CSFR so far around shifting diets to be more plant based.
  - Boulder County's Household CBEI recommendations included a red meat ban. Other County's across the state are working to bring ag/livestock into the solution through practices.
  - Could look at adding support for plant-based producers within the local food action, and support more for regenerative ranching





# Discussion

- Does food include food delivery?
  - Yes, “Other food at home” includes this.
- Why are goods and services not included?
  - County has limited control over the emissions associated with these.
- Does the buy clean colorado act impact Larimer County?
  - Highlights importance of including cement and asphalt in future inventories.
- Food portion will get bigger as electrification and renewable energy increases. Does this shift our emphasis and where the opportunities are?
  - Opportunities to shift ag practices and think about local food.



# Discussion

- Can we get to net-positive?
  - Regenerative farming practices and healthy ag practices.
  - There is an opportunity to focus on carbon-soil solutions.
- What are the food system solutions beyond composting and reducing waste?
- Can we map out the roles and responsibilities of all stakeholders involved? What specifically should we target. Who has the most to gain from reductions and who has the biggest opportunity for reductions?





# Discussion

- Leverage IRA and Larimer County programs to reduce energy portion of the pie.
- Think about the economic impacts and the circular economy of local energy production. Positive economic benefit of a local energy provider.

