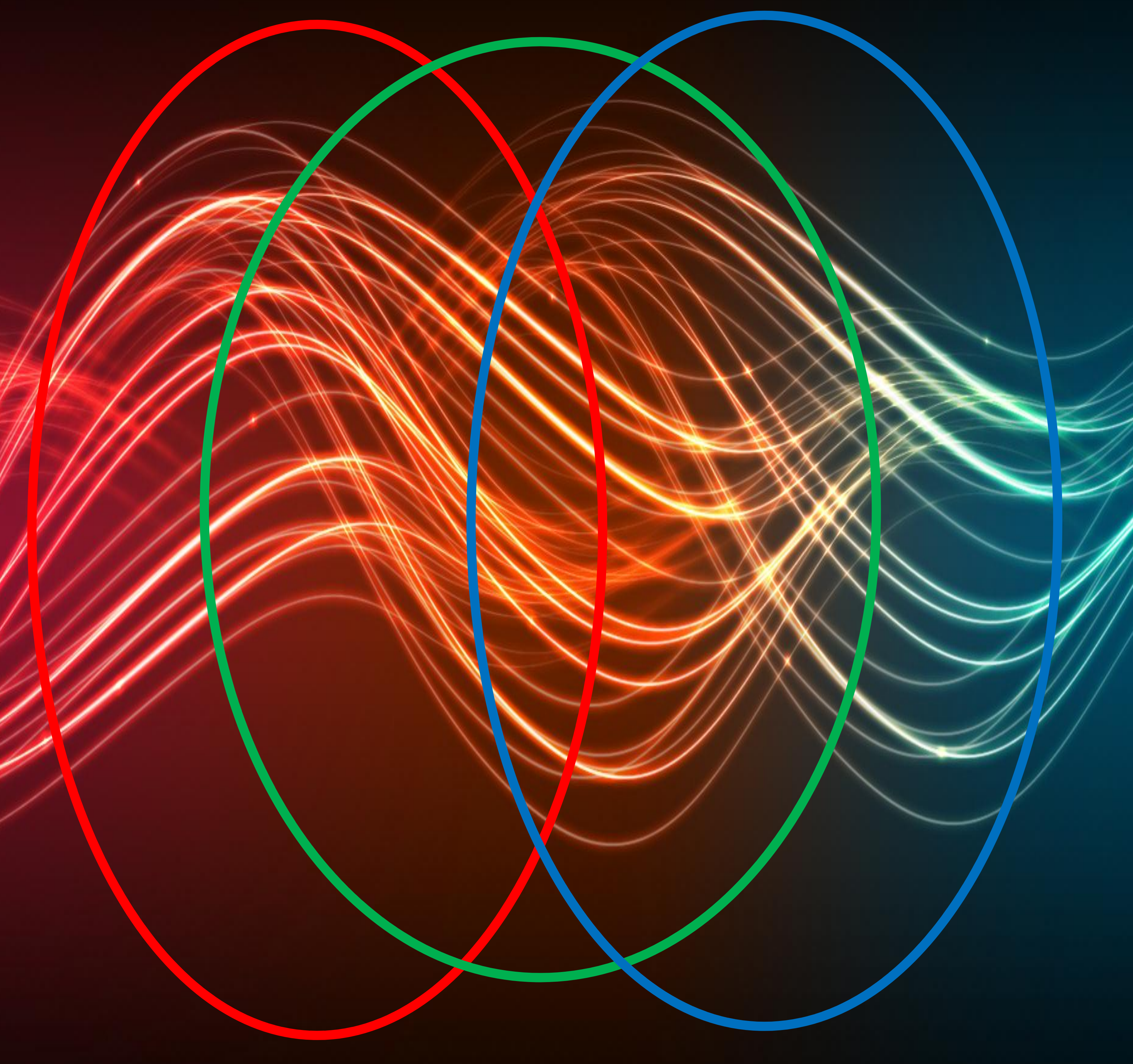
Production, Consumption and Lifecycle Greenhouse Gas Inventories: Implications for CEQA and Climate Action Plans



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Production, Consumption and Lifecycle Greenhouse Gas Inventories: Implications for CEQA and Climate Action Plans

Prepared by members of the AEP Climate Change Committee which consists of leaders of climate action planning practices from consulting firms and agencies that lead many of the local greenhouse gas reduction planning efforts across California. The Committee focuses on advancing the professional practice of local climate action planning through periodic publication of white papers and conference presentations, as well as interaction with state, regional, and local agencies.

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1. Executive Summary

Prepared by Rich Walter, ICF.

What is the proper role of production-based emission inventories, consumption-based emission inventories and lifecycle analysis in CEQA review of greenhouse gas (GHG) emissions and in local Climate Action Plans in California?

In California, local climate action planning by cities and counties and review of greenhouse gas (GHG) emissions of discretionary projects under the California Environmental Quality Act have been conducted in many jurisdictions over the last decade. While some early adopters, such as the City and County of San Francisco, were engaged in climate action planning in the early 2000s, most jurisdictions started to pay attention to climate change issues 1) following the passage of AB 32 in 2006, which established a mandated state target for reduction of GHG emissions, and 2) following the passage of SB 97, which mandated analysis of GHG emissions for new projects under CEQA.

The Intergovernmental Panel on Climate Change (IPCC) developed protocols for national-level GHG accounting that have been in use for the past twenty-five years. These protocols assign responsibility to the producer of GHG emissions and methods consistent with UPCC methods, and were originally used for GHG accounting for local climate action planning and CEQA GHG inventories. Over time, community and CEQA project GHG inventories have gone beyond purely production-based accounting to include activity-based emissions, such as those associated with electricity generation, transportation, waste disposal, and water and wastewater processing outside of a jurisdiction where they are related to activity within a community (or project).

In the last decade, consumption-based emissions accounting methods have been developed which assign responsibilities to the final consumer for all lifecycle GHG emissions associated with consumed goods and services. Lifecycle emissions accounting has also been developed to account for all upstream, use, and downstream GHG emissions associated with a single product or company. Community-scale protocols include production-based, activity-based, and consumption-based methods commonly used as guidance for community GHG inventories.

Some practitioners have advocated that consumption-based emissions accounting approaches, or life-cycle approaches, should be used instead of or in addition to production-based emissions accounting approaches for local climate action planning and CEQA in California. This paper examines these different GHG accounting approaches and provides the Committee's recommendations concerning their use in local climate action planning and CEQA in California. While the focus of this paper is on California, the discussion may be of benefit and interest for climate action planning and environmental review in other parts of the United States.

1.1 DEFINITIONS

The practice of GHG inventorying has developed substantially over the last 25 years. Inventories have been developed for nations, states, cities/counties, corporations, and products. Different methodologies have been developed that assign responsibility for emissions in different ways, as follows:

Production Based Emissions Inventory (PBEI): *A production-based emissions inventory assigns responsibility to the producer of emissions*. PBEIs are developed based on jurisdictional activity data and emission factors, wherever feasible. PBEIs include emissions that occur within the subject jurisdiction.

Consumption-Based Emissions Inventory (CBEI): *A consumption-based emissions inventory assigns responsibility to the final consumer for lifecycle GHG emissions of consumed goods and services.* Upstream embedded emissions within goods and services, use emissions, and downstream disposal emissions are all assigned to the final consumer within the subject jurisdiction. Consumption inventories usually focus on household and government consumption because most business consumption is for the purpose of production of goods and services. Consumption inventories usually do not include production-related emissions within the jurisdiction except to the extent that within-jurisdiction production serves in-jurisdiction consumption. Consumption inventories have been prepared for relatively few municipalities to date, and California does not have a consumption inventory for the state as a whole. Consumption inventories for embedded emissions in goods and services are usually based on regional economic consumption data, combined with national/international state lifecycle emissions factors, for a standard list of products or product bundles. While consumption inventories will sometimes use local or regional data on economic consumption, factors for upstream GHG emissions usually employ state and national average activity and emissions intensity data, compared to the more local data commonly used for production-based and activity-based inventories.

"Activity-Based" Emission Inventory (ABEI): Most recent community inventories in California are actually a hybrid of production and consumption inventory methods, often referred to as "activity-based" emissions inventories. The most widely-followed protocol in the United States is the 2013 U.S. Community Protocol[1,2] which discusses a variety of accounting approaches, but recommends production-based and activity-based approaches to estimating the basic emissions generating activities required for protocol-compliant inventories. Production-based emissions accounting is applied for direct use of energy, and direct emissions of industrial processes and landfill emissions within the jurisdiction. Partial consumption-based accounting is applied to certain sectors because electricity generation, water transportation, wastewater treatment, and waste disposal often occur outside of many jurisdictions. Transportation emissions include emissions from transportation related to land uses within the subject jurisdiction, including portions of trips outside the jurisdiction. Since ABEIs account for emissions consistent with California state methods for the state inventory, they can be used in climate action planning and project-level review utilizing reduction targets related to the state reduction target.

[1] ICLEI. 2013. U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Version 1.1. July.

[2] The Compact of Mayors utilizes the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) and many compact cities are starting to use the GPC instead of the 2013 U.S. Community Protocol. The GPC follows similar production-based and activity-based approaches to GHG inventorying instead of consumption-based approaches.

Lifecycle Emissions Inventory: A lifecycle emission inventory, most commonly used for a single consumer product, includes all the upstream emissions of production including embedded emissions in inputs, manufacturing emissions, transport emissions for moving goods to market, use emissions, and final disposal emissions. Production, consumption, and activity-based inventories include portions of product lifecycles as they relate to the subject jurisdiction. There are no true lifecycle inventories for a community (or state or nation) that include all lifecycle emissions related to both production and consumption in a subject jurisdiction.

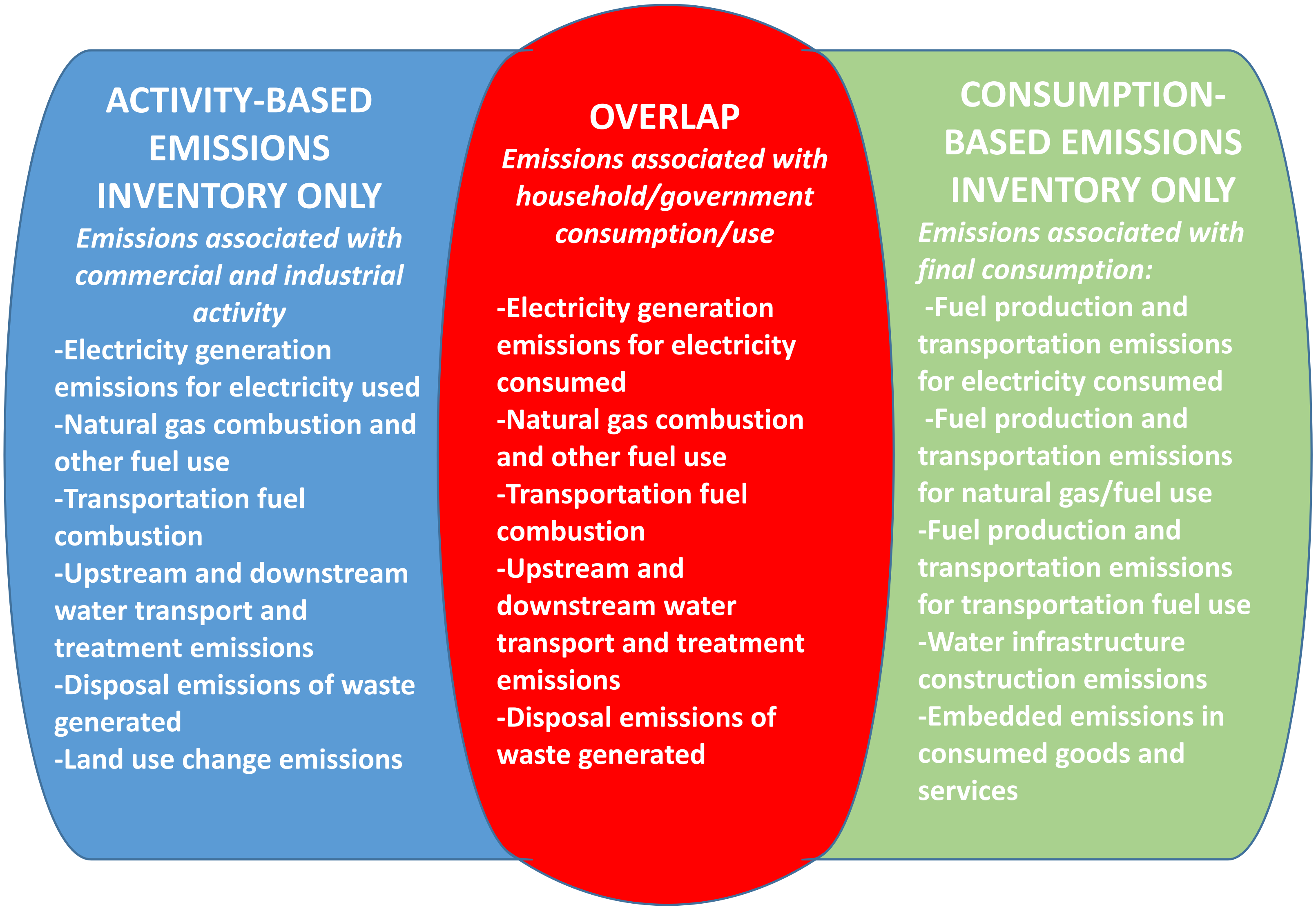
Each of these inventory methods reveals different information about GHG emissions. A production-based emissions inventory will disclose the emissions produced in the subject jurisdiction. A consumption-based emissions inventory will disclose the lifecycle emissions related to consumption within the subject jurisdiction, although the data used is often regional and national in nature. An activity-based emissions inventory will disclose the most immediate emissions related to land use activity within the subject jurisdiction. A lifecycle emissions inventory will identify all upstream, use, and downstream emissions associated with a single product or company.

Table 1.1 shows the general accounting principles by sector for different types of emissions inventories. Figure 1.1 shows the overlap between ABEIs and CBEIs and where emissions are unique to each inventory methodology.

Table 1.1: Comparison of Different GHG Emissions Inventory Approaches

	Production-Based Inventory (Geographic Focus)	Activity-Based Community Inventory	Consumption-Based Inventory	Lifecycle Inventory
Transportation	Transportation fuel combustion within jurisdiction	Transportation emissions due to land uses within jurisdiction	Upstream, use, and downstream emissions due to consumer fuel use	Upstream transportation of inputs, downstream transportation of outputs
Electricity	Generation emissions within jurisdiction	Generation emissions associated with electricity consumption in jurisdiction	Upstream emissions due to consumer electricity consumption	Upstream emissions due to inputs and electricity used in production
Natural Gas	Combustion in jurisdiction	Combustion in jurisdiction	Upstream and use emissions due to consumer natural gas use	Upstream emissions due to inputs, and use emissions due to production
Water	Treatment and transport emissions in jurisdiction	Upstream and downstream emissions due to jurisdictional water use	Upstream and downstream emissions due to consumer water use	Upstream and downstream emissions due to inputs and production
Waste	Landfill emissions in jurisdiction	Downstream emissions associated with disposal of goods consumed in jurisdiction	Downstream emissions associated with disposal of goods consumed within jurisdiction by consumers	Downstream transport and landfill emissions related to waste from production
Industrial and Commercial Fuel Use	Industrial processes and fuel use in jurisdiction	Industrial process, industrial and commercial fuel use in jurisdiction	Not included, except for production for local use	Upstream emissions due to inputs and production fuel use, & production emissions
Land Use Change	Change within the jurisdiction	Change within the jurisdiction	Not included unless direct consumer change	Change in carbon sinks/sequestration due to inputs or production
Embedded Emissions in Goods and Services	Not included	Not included	Included for locally consumed goods and services	Embedded emissions in inputs

Figure 1.1: Comparison of Activity-Based and Consumption-Based GHG Inventories



1.2 COMPARISONS OF DIFFERENT INVENTORY RESULTS

PBEIs are the most common inventory approach for states and nations. CBEIs have been prepared for relatively few municipalities to date in the United States including (but not limited to) San Francisco, Oakland, the greater San Francisco Bay Area, Portland/Multnomah, and Seattle. CBEIs on a national scale have been completed in the United Kingdom, certain other countries in Europe, and Australia, and some lower-level municipalities in those locations have also completed such inventories. ABEIs are most common on a municipal scale, including across California. Lifecycle inventories have been prepared for companies and individual consumer products, but not for municipalities, states, or nations to date.

CBEIs for the jurisdictional areas noted above showed a variety of results compared to production-based emissions inventory estimates. In 2010, the state of Oregon had consumption emissions only 19% higher than its production emissions, whereas Portland and surrounding Multnomah County in 2011 had consumption emissions double their production emissions. Metropolitan cities like San Francisco and Oakland, which have limited production activities, have been shown to have consumption emissions that exceed their production-style inventories by greater amounts (3.7 times and 2.8 times, respectively), whereas the consumption inventory for the entire 2013 San Francisco Bay Area shows consumption emissions only exceeding production emissions by 31%.

Comparison of national production and consumption inventories reveals notable differences between countries. Based on 2004 data, the United Kingdom's consumption emissions exceeded its territorial emissions by 46%, reflecting a high level of imports relative to domestic production. In contrast, China's consumption emissions were 23% less than its territorial emissions, reflecting their heavy reliance on export-oriented industry. Consumption emissions in the U.S. exceed territorial emissions by 12%, reflecting a more balanced level of domestic production and imports than in the U.K.

From these results, some generalities can be derived:

1) The broader the area of the inventory, the more likely that some local consumption is being provided by local production, thus lowering the difference between production and consumption inventories.
2) The less local production within a jurisdiction, such as in the highly urbanized city of San Francisco, the more consumption emissions are likely to exceed production emissions.
3) The comparative amount of production-style emissions (whether mass emissions or per capita emissions) is not a good measure of the likely comparative amount of consumption emissions (whether mass emissions or per capita emissions), since local production is not necessarily directly related to local consumption.

1.3 IMPLICATIONS FOR CEQA

The California state inventory is primarily a production style inventory, with the exception of upstream electricity generation emissions associated with imported electricity. Given the size and geography of the state, nearly all routine daily transportation activity occurs within the state, excluding intrastate and international transportation. At a state level, nearly all of the waste generated is disposed of in-state, and the wastewater generated in the state is also processed in-state. As such, the state inventory is inclusive of nearly all of the emission types commonly included in CEQA project inventories. The state inventory does not include emissions embedded in goods and services from outside the state that are consumed inside California. The state inventory also does not include downstream emissions for transportation of California goods and services outside of the state to interstate and international markets.

There is no fixed standard by which GHG inventories are prepared under CEQA. Instead, a professional practice has been developed by CEQA practitioners and rough norms have become accepted. The principles of GHG accounting used for preparing the California state inventory are generally consistent with those used for preparing CEQA project inventories, although most project-level inventories will include some emissions outside the subject jurisdiction related to activity within the jurisdiction, as describe above for ABEIs. CEQA project inventories usually do not include embedded upstream emissions for consumer goods and services, but do include certain lifecycle emission elements including upstream electricity generation, water-related emissions, and downstream wastewater processing and waste disposal emissions.

In the California Supreme Court ruling in the *Newhall Ranch* case, the court ruled as follows:

> "*Using consistency with A.B. 32's statewide goal for GHG reduction, rather than a numerical threshold, as a significance criterion is also consistent with the broad guidance provided by section 15064.4 of the CEQA Guidelines."*

The court determined that the statewide reduction goals were an appropriate basis for a project-level significance criteria, provided that the lead agency examines the relationship of the project's emissions to the statewide emissions, and adjusts thresholds to take into account regional, local, or project-level considerations. The statewide reduction goals are based on a comparison of current and projected GHG emissions to a statewide 1990 GHG inventory. As such, in order to compare a project-level GHG inventory to a threshold derived from a statewide reduction target based on the statewide inventory, the GHG emissions included in the project inventory must be accounted for in a similar manner to the way the state accounts for GHG emissions.

If a project-level inventory were to include additional upstream embedded emissions associated with consumption of goods and services, or downstream transportation emissions, outside of the state, it would no longer be comparable to the state inventory and a threshold based on state reduction targets could not be used to evaluate the project's GHG emissions. Given the California Supreme Court's determination that it is appropriate under CEQA to compare project GHG emissions to a threshold related to the state reduction goals, there is no logical rationale to include GHG emissions in a CEQA project inventory if they are not included in the state's GHG inventory, nor to use methodologies to account for emissions different from those employed in the state's GHG inventory.

It's conceivable that consumption-based GHG inventories could become a requirement for CEQA project analysis (or jurisdictional CAPs intending to provide CEQA tiering) in the future, if—and only if—the following five criteria have been met: 1) the state completes a consumption inventory and forecasts for California with transparent methods and data (such that they can be applied by others); 2) the California legislature adopts a GHG reduction target based on a statewide consumption inventory; 3) the state adopts a plan (like the AB 32 Scoping Plan or the 2030 Scoping Plan) for the reduction of consumption-based GHG emissions; 4) there is a legally-defensible consensus on methods and sufficient reasonably-available public data to support the development of project CBEIs and data; and 5) a methodology is developed that can identify suitable thresholds related to statewide consumption emissions targets that are appropriate for a diversity of cities and counties across the state. This framework exists today for activity-based CEQA project GHG accounting. It is neither reasonable nor feasible for an individual CEQA lead agency to complete such a framework for CBEIs, and thus there is insufficient reasonably-available information to mandate CBEIs for CEQA evaluations today.

While it is recommended that CEQA practice continue the current ABEI GHG accounting described above, developing estimates of consumption-based emissions or certain aspects of consumption-based accounting could be a useful informational tool for CEQA lead agencies and public education.

While there have been several lower-court cases concerning the limits of upstream and downstream emissions in CEQA, there are no CEQA appellate rulings to date concerning which GHG emissions should or should not be included in a CEQA GHG inventory. There are no CEQA appellate rulings concerning consumption-based inventories or lifecycle accounting to date. As such, there are no legally binding precedents concerning these issues. Thus, CEQA lead agencies are advised to seek advice from legal counsel should they be faced with legal challenges on related matters.

1.4 IMPLICATIONS FOR CLIMATE ACTION PLANS

CBEIs are emerging as an additional tool in our climate action planning and sustainability toolboxes. However, CBEIs should not serve as a replacement for production-based or activity-based inventories in California. We recommend use of CBEIs as a supplemental and complementary resource to ABEI community GHG inventories, primarily as information and education resources for local elected officials, climate action planners, and consumers. In addition, we recommend that CBEIs are separated from ABEI community GHG inventories in order to maintain the affective use of both inventory types within a climate action plan and that the intended use of the CBEI and ABEI are clearly explained. An effective way of maintaining this separation is to show the CBEI and ABEI inventories within separate tables preceded or followed by text explaining the purpose of each inventory and why both are shown within a climate action plan. We make these recommendations based on the following considerations.

Local governments rely on community GHG inventories to identify sources and estimates of GHGs, primarily to inform policy development and target setting. Upstream emissions or embodied emissions of materials are interesting and informative at the individual, household, or corporate level, but less likely to be useful in setting local policy to reduce community GHG emissions. State and federal governments have traditionally regulated product and material standards. Corporations and public agencies have direct control over purchasing of goods and services and can implement sustainability or environmentally preferable purchasing practices and other measures to reduce consumption-based emissions in their supply chain of products and services. Local governments have generally not been inclined to adopt local regulations that restrict private purchasing related to the carbon footprint or embodied emissions of product supply chains (product materials and content). There are examples of local government sustainability policies that can have the co-benefit of reducing upstream or downstream emissions, such as prohibitions on the use of single-use plastic bags and Styrofoam. However, these are often motivated by or connected to other environmental impacts, such as water pollution and harm to wildlife. CBEIs and lifecycle analysis are useful as an educational tool and can inform business, household, or individual purchasing and consumption decisions without the need for local government regulatory intervention.

Emissions from the supply chain upstream and downstream are accounted for in other project and jurisdictional production-side accounting, which can create a risk for double-counting. Methods and measurement tools for consumption-based emissions are still under development, as are methods for analyzing changes in local consumption patterns. Due to the early and evolving use of CBEI and the limited role of local governments to directly control consumption-based emissions, strategies to reduce consumption-based emissions could be more aspirational than actionable and measurable.

Use of CBEI is emerging in many cities, however there is no established best practice for how to address consumption-based emissions in local climate action plans. Tracking consumption-based strategies can be difficult and time consuming for local government staff. More case studies and research are needed to confirm the most effective local actions to reduce consumption. In the meantime, consumption-based inventories can provide helpful information for consumers and an expanded lens with which to assess GHG emissions.

2. Defining Different Inventory Methodologies

Prepared by Rich Walter, ICF.

The practice of greenhouse gas (GHG) inventorying has developed substantially over the last 25 years. Inventories have been developed for nations, states, cities/counties, corporations, and products. Different methodologies have been developed that assign responsibility for emissions in different ways, as follows:

Production Based Emissions Inventory (PBEI): *A production-based emissions inventory assigns responsibility to the producer of emissions*. Two variants of PBEIs exist:

- PBEI with a Geographic Focus: With this approach, an inventory would include only emissions that are produced within the subject jurisdiction. Most national and state inventories, including the state of California, follow this approach, which has been codified in the inventory guidance of the Intergovernmental Panel on Climate Change (IPCC).[3] Early community inventories also followed this approach using early guidance developed by ICLEI but, as explained below, community inventories today commonly include some emissions outside the subject jurisdiction related to electricity, water, waste, and often to transportation related to activities within the jurisdiction.
- PBEI with a Lifecycle Focus: Another conceptual inventory approach would be to include all lifecycle emissions associated with production within the subject jurisdiction. This would differ from a geographic focus inventory that only includes emissions within the subject jurisdiction by also including upstream and downstream emissions outside the subject jurisdiction that are related to production inside the jurisdiction. The authors are unaware of this approach being implemented by any jurisdictions to date.

PBEIs are usually developed based on locally-derived activity data and emission factors (such as electricity generation emissions, natural gas consumption, vehicle miles traveled/fleet efficiency, industrial/landfill emissions, etc.).

Consumption-Based Emissions Inventory (CBEI): *A consumption-based emissions inventory assigns responsibility to the final consumer for lifecycle GHG emissions of consumed goods and services.* Upstream embedded emissions within goods and services, use emissions, and downstream disposal emissions are all assigned to the consumers within the subject jurisdiction. Consumption inventories are usually focused on household and government consumption, because inclusion of commercial consumption would result in double-counting, since commercial consumption is for the purpose of production of goods and services for the final consumer. Consumption inventories usually do not include production-related emissions within the jurisdiction except to the extent that within-jurisdiction

[3] The current IPCC protocols can be found here: http://www.ipcc-nggip.iges.or.jp/

production serves in-jurisdiction consumption.[4] At a national level, a consumption inventory would not include export production emissions, since such emissions would not be related to domestic consumption. Consumption inventories have been prepared for relatively few municipalities to date (see further discussion in Chapter 4). California does not have a consumption inventory for the state as a whole.

Because all types of consumption cannot be directly measured, all consumption inventories to date are based on consumer economic consumption survey data for the subject area (as available), and on emissions factors for different goods and services, often derived from national lifecycle databases. While most consumption inventories make efforts to use locally-derived data where feasible, due to the complexity of all goods and services involved in consumption, these inventories must use much broader life-cycle data sets in order to derive emissions factors compared to more specific emission factors used in other inventory approaches.

The 2013 U.S. Community Protocol included an appendix that presented various methods for conducting consumption-based inventories, but does not require the inclusion of lifecycle emissions associated with consumption in a jurisdictional inventory to be considered consistent with the Community Protocol. Instead, the Community Protocol requires certain basic emissions-generating activities defined in the protocol using production-based and activity-based accounting approaches.

The Community Protocol (2013) summarizes the current state of practice for CBEIs as follows:

> *At the time this Protocol is being written, consumption-based accounting of greenhouse gas emissions at the community scale is a relatively young field. Methods are still being tested, evaluated and compared, and "best practices" have not yet been identified. Additional new methods and variations on those methods may still be developed. As such, this Protocol does not recommend one method over another, but rather describes the existing approaches in their current state of development, and leaves it fully to Protocol users to determine which (if any) approaches to use.*

"Activity-Based" Emission Inventories (ABEI): Most recent community inventories are actually a hybrid of production and consumption inventory methods, often referred to as "activity-based" inventories. The most widely followed protocol in the United States is the 2013 U.S. Community Protocol, which includes a combination of methodological recommendations. Production-based emissions accounting is applied for direct use of energy, direct emissions of industrial processes, and landfill emissions within the jurisdiction. Partial consumption-based accounting is applied for electricity, water, and waste disposal because electricity generation, water transportation, wastewater treatment, and waste disposal often occur outside many jurisdictions. The focus of these ABEIs is on the more immediate emissions associated with activity in the subject jurisdiction, with some extensions to the next upstream

[4] It is possible to include consumption for the commercial sector in addition to household and government consumption in a CBEI. However, this is not the common approach in most CBEIs to date due to the concern about double-counting. Most commercial GHG emissions are associated with production of goods and services for local, state, national and international markets. As a result, the local production emissions are included in the state and national averages used to derive average embedded emissions used in CBEIs. As a result, local production emissions for goods and services that are consumed locally would be double-counted if the commercial sector is included in a CBEI, unless an adjustment is made.

element of the supply chain for electricity (to the power plant) and water (to the water source), and the next downstream element of disposal of jurisdictional waste or wastewater outside the jurisdiction. While these ABEIs include some consumption approaches, they do not include the embedded emissions of goods and services consumed in the jurisdiction. Because ABEIs account for emissions consistent with the California methods for the state inventory, they can be used in climate action planning and project-level review, utilizing reduction targets related to the state reduction target.

Lifecycle Inventory: A lifecycle inventory, most commonly done for a consumer product, includes all of the upstream emissions of production including embedded emissions in inputs, manufacturing emissions, transport emissions for moving goods to market, use emissions, and final disposal emissions. Production and consumption inventories include portions of product lifecycles as they relate to production or consumption in the subject jurisdiction. There are no true lifecycle inventories for any community (or state or nation) that include all lifecycle emissions related to both production and consumption in a subject jurisdiction.

Each of these inventory methods reveals different information about GHG emissions. A production inventory will disclose the emissions produced in the subject jurisdiction. A consumption inventory will disclose the emissions related to consumption in the subject jurisdiction, although the data used is often regional and national in nature. An activity-based inventory will disclose the most immediate emissions related to land-use activity within the subject jurisdiction. A lifecycle inventory will identify all upstream, use, and downstream emissions associated with a single product.

Table 2.1 presents a summary of key differences between PBEIs, CBEIs, and ABEIs. Table 2.2 presents a summary of how emissions are accounted for with the four different inventory approaches.

Table 2.1: Key Differences between Emissions Inventory Approaches for Community Inventories

Subject	Production-Based Emissions Inventory (PBEI)	Activity-Based Emissions Inventory (ABEI)	Consumption-Based Emissions Inventory (CBEI)
Emissions Covered	Emissions produced in the jurisdiction	Emissions produced in jurisdiction and next upstream or downstream emissions for certain sectors	Life-cycle emissions associated with consumption
Allocation	Producer	Producer and Consumer	Consumer
Mitigation focus	Jurisdictional production	Jurisdictional activities	Jurisdictional consumption
Comparability	Consistent with state inventory approach	Consistent with state inventory approach	Not consistent with state inventory approach
Complexity	Low	Low - Moderate	High
Transparency	High	High	Low
Uncertainty	Low	Low	High
Current Coverage	Most early inventories; strict PBEI approach not widely used anymore for community inventories	Most current community and CEQA project inventories follow this approach	Not in common use and in few U.S. cities to date

Table 2.2: Comparison of Different GHG Emissions Inventory Approaches

	Production-Based Community Emissions Inventory (Geographic Focus)	**Activity-Based Community Emissions Inventory**	**Consumption-Based Community Emissions Inventory**	**Lifecycle Emissions Inventory (for a Product)**
Key Principle	*Emissions produced within jurisdiction*	*Emissions related to residential, commercial, industrial, government activity within the jurisdiction*	*Emissions related to final consumption of goods and services within a jurisdiction*	*All upstream and downstream emissions connected to production*
Responsible party	*Producers within Jurisdiction*	*Producers and consumers within jurisdiction*	*Consumers*	*Producers*
Transportation	Transportation fuel combustion within jurisdiction.	Emissions related to travel due to land uses in jurisdiction (often split 50/50 between origin and destination for community inventories)	Upstream production, transportation to market, fuel combustion related to consumer fuel use	Upstream transportation of inputs, downstream transportation of outputs
Electricity	Electricity generation emissions within jurisdiction	Electricity generation emissions associated with electricity consumption in jurisdiction	Upstream fuel exploration, production, transportation, and power plant generation related to consumer electricity use in jurisdiction	Upstream fuel production and transport, electricity generation emissions of electricity used in production
Natural Gas	Natural gas combustion within jurisdiction	Natural gas combustion emissions in jurisdiction	Upstream production and transport (including leakage) emissions and combustion associated with natural gas use for consumer end use	Upstream production and transport, natural gas used in production
Water	Water transportation emissions, treatment and wastewater emission within jurisdiction	Upstream transportation, treatment, and downstream wastewater treatment related to water consumption in jurisdiction	Upstream transportation, treatment, and downstream wastewater treatment related to consumer water consumption in jurisdiction	Upstream water production, transport, and treatment emissions, downstream wastewater treatment and transport associated with production.

Table 2.2: Comparison of Different GHG Emissions Inventory Approaches

	Production-Based Community Emissions Inventory (Geographic Focus)	Activity-Based Community Emissions Inventory	Consumption-Based Community Emissions Inventory	Lifecycle Emissions Inventory (for a Product)
Waste	Landfill emissions within jurisdiction	Downstream emissions associated with disposal of goods consumed in jurisdiction	Downstream emissions associated with disposal of goods consumed.	Downstream transport and landfill emissions related to waste from production.
Industrial and Commercial Fuel Use	Industrial processes, industrial and commercial fuel use within jurisdiction	Industrial process, industrial and commercial fuel use in jurisdiction	For CBEIs focused on household/government consumption only, local production fuel use not included (except as included in embedded emissions)	Upstream fuel production and transport and fuel use in production
Land Use Change	Change in carbon sinks/sequestration within the jurisdiction	Change in carbon sinks/sequestration within the jurisdiction	Not included except to the extent that direct consumer land use change	Change in carbon sinks/sequestration within the jurisdiction related to production
Embedded Emissions in Goods and Services	Not included	Not included	Upstream production and transportation and use emissions for goods and services consumed by consumers in jurisdiction.	Embedded emissions in inputs

Table 2.2: Comparison of Different GHG Emissions Inventory Approaches

	Production-Based Community Emissions Inventory (Geographic Focus)	Activity-Based Community Emissions Inventory	Consumption-Based Community Emissions Inventory	Lifecycle Emissions Inventory (for a Product)
Notes	This approach is most commonly used for national inventories. Previously used for community-scale inventories, but found to lack critical information especially in transportation (due to link of travel to other jurisdiction), electricity (uneven distribution of power plants), and water (in some areas, long-distance transport and wastewater treatment outside jurisdiction).	Most common approach to community inventories today. Inventories per 2013 U.S. Community protocol usually include emissions both within and without jurisdiction for transportation, electricity, waste, and water based on connection to activity in the jurisdiction (such as electricity use), but do not extend inventory to embedded emissions in goods and services from outside the jurisdiction or downstream transport of products.	"Consumers" usually defined as households, government, and business Investment only (but not in all cases). In CBEI's focused on household consumption, vast majority of industrial and commercial emissions are considered intermediary inputs to goods and service provision and thus are not included as they are not related to final consumption.	Most commonly used in corporate lifecycle inventories for consumer products. Not currently used for city/county/national inventories because lifecycle inventories are not bound by jurisdiction.

3. Differences in Sectoral GHG Emissions Accounting

This section discusses the differences between production-based, activity-based, consumption-based and lifecycle inventory approaches for completing sectoral GHG inventories.

3.1 ELECTRICITY AND NATURAL GAS

Prepared by Hilary Haskell, SDG&E

3.1.1 ELECTRICITY

Estimates of GHG emissions related to electricity must take into account the variety of choices available to customers, including shifting statewide renewable portfolio requirements for electricity providers, options to choose between "standard" portfolios or up to 100% renewable energy from investor-owned utilities (IOUs), options to purchase from new community choice aggregator (CCA) entities, and expansion of rooftop solar. The existing renewable portfolio standard (RPS) target of 50% renewable energy sources by 2030 set forth by Senate Bill (SB) 350 (2015, De León) is continuing on an upward trend, with SB 100 (2017, De León) proposing a loftier goal of 60% renewables by 2030, and a completely renewables-based electric power source by 2045.

3.1.1.1 ELECTRICITY PROVIDED BY NONRENEWABLE ENERGY

In 2015 approximately 45% of California's electric power was generated from natural gas sources, while only about 6% came from coal and oil combined.[5] Therefore, natural gas is the focus of this analysis. As shown in Figure 3.1, the lifecycle of electric power production from nonrenewable fuels includes research/development, extraction/production, gathering/processing, transport/storage, power generation, and electricity transmission/distribution to end users, all of which are accounted for in a CBEI. A PBEI would only include electricity generation within a given jurisdiction, whereas an ABEI would include emissions associated with power generation and transmission/distribution to end users.

The National Energy Technology Laboratory found that for the 2010 Natural Gas Domestic Fuel Mix, based on the average GHG emissions across the various types of natural gas power plants, approximately 64% of GHG emissions are attributable to power plant emissions, approximately 25% are related to fuel acquisition, and the remaining 10% of GHG emissions come from fuel transport.[6]

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[5] California Energy Commission. Total System Electric Generation. Website: http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html, accessed June 30, 2017.

[6] U.S. Department of Energy National Energy Technology Laboratory. *Power Generation Technology Comparison from a Life Cycle Perspective* (2013). Website: https://www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Life%20Cycle%20Analysis/Technology-Assessment-Compilation-Report.pdf, accessed June 30, 2017.

Power plant combustion of natural gas (or other nonrenewable fuel sources) accounts for most GHG emissions related to electric power production. Because California imports approximately 90% of its natural gas supply, most of the upstream emissions of natural gas production are outside of the state.[7] An additional consideration is that, with an increasingly renewable energy portfolio in California, natural gas is used to balance the grid's renewable power sources in conjunction with the recent increase in energy storage technology.

Figure 3.1: Non-Renewable Energy Lifecycle

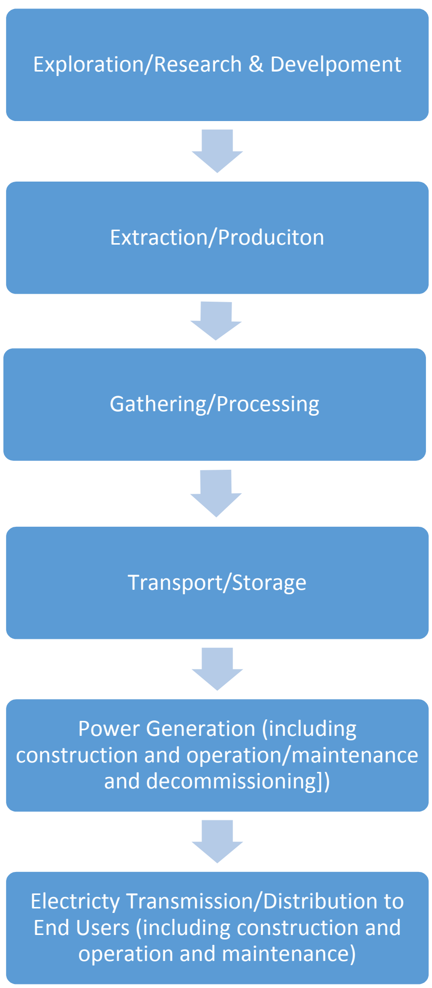
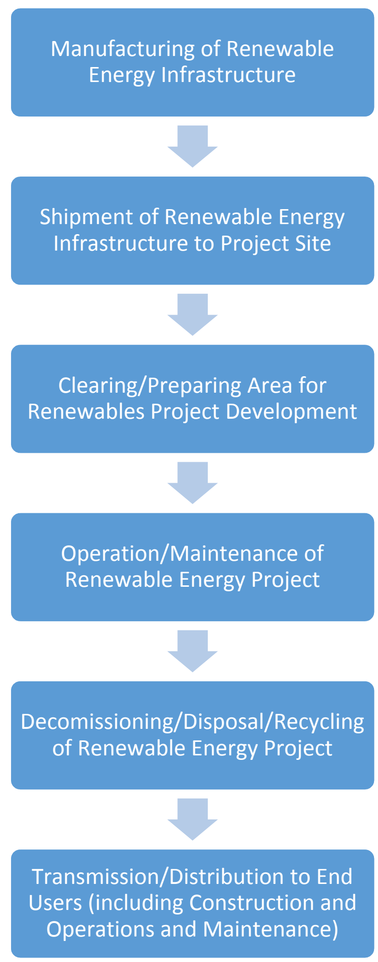


Figure 3.2: Renewable Energy Lifecycle



3.1.1.2 ELECTRICITY PROVIDED BY RENEWABLE ENERGY

For electricity produced from renewable energy, production- and consumption-based inventories should not differ in their outcomes, as much as they do for non-renewable energy. The main driver of the high lifecycle GHG emissions associated with non-renewable energy—power plant fuel combustion—does

[7] California Energy Commission. Supply and Demand of Natural Gas in California. Website: http://www.energy.ca.gov/almanac/naturalgas_data/overview.html, accessed June 30, 2017.

not occur with renewable energy. Figure 3.2 above shows the components of the renewable energy lifecycle. The main contributor to the lifecycle GHG emissions for renewable energy sources occur upstream, in contrast to non-renewable energy sources. The GHG emissions associated with manufacturing infrastructure, and with construction of renewable energy projects, are much higher in contrast to their almost non-existent operational GHG emissions. The construction of renewable energy projects (including hydro, wind, solar and geothermal, which were used for 85% of California's renewable electricity power source in 2016[8]) accounts for approximately 68% of the GHG emissions associated with renewable energy, based on the construction of the facility, maintenance, and any methane leakage.[9] If geothermal renewable energy is not included as part of this analysis, the construction share is even higher (79%), since geothermal has much higher operational GHG emissions than other renewable energy technologies.

3.1.2 NATURAL GAS

Natural gas consumed within a jurisdiction results in combustion emissions at the point of use. There are upstream emission associated with the exploration, production, and transportation (including leakage) of natural gas to the end user, as described above, concerning natural gas used for electricity generation. PBEIs and ABEIs would include only the combustion emissions at the end use. A CBEI would include both the combustion emissions and the upstream lifecycle emissions for gas utilized for final use within a jurisdiction. Note that commercial and industrial natural gas for production within a jurisdiction would not be included in a CBEI focused on final consumption of households and government, since commercial and industrial use of natural gas is only an intermediary use and not a final consumptive use.

3.1.3 COMPARISON OF APPROACHES

Inventories of GHG emissions for electricity and natural gas for different inventory methods differ depending on where the majority of the GHG emissions occur, and on the relative differences between commercial and industrial vs. residential use of electricity and natural gas.

Currently, California imports about 26% of its electricity,[10] thereby indicating that a purely production-based inventory does not include all GHG emissions related to electricity, and especially for electricity produced from natural gas. For this reason, the California state inventory by the ARB includes the electricity generation emissions for electricity imported into California. While early PBEIs included only electricity generation within a subject jurisdiction, current ABEI practice for individual local jurisdictional CAP inventories or CEQA project inventories is to include electricity generation emissions related to jurisdictional electricity consumption regardless of location. Thus the primary differences between ABEIs and CBEIs are due to 1) the additional inclusion of upstream fuel lifecycle (exploration, production, and transport to the power plant) in CBEIs for final consumption of electricity, and 2) the exclusion of

[8] California Energy Commission. Tracking Progress: Renewable Energy. Website: http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf, accessed June 30, 2017.

[9] Uchiyama, Yohji. Life Cycle Assessment of Renewable Energy Generation Technologies. IEEJ Transactions on Electrical and Electronic Engineering: Volume 2, Issue 1. Website: http://onlinelibrary.wiley.com/doi/10.1002/tee.20107/pdf, accessed June 30, 2017.

[10] U.S. Energy Information Administration. *California Imports about a Quarter of its Electricity on Average.* Website: https://www.eia.gov/todayinenergy/detail.php?id=30192#tab2, accessed: June 30, 2017.

emissions associated with commercial and industrial gas consumption from CBEIs (while these are included in ABEIs).

PBEIs, ABEIs, and CBEIs all include natural gas combustion within the jurisdiction, while CBEIs include upstream lifecycle emissions associated with the fuel cycle.

3.2 TRANSPORTATION

Prepared by Chris Gray, WRCOG.

A PBEI approach to transportation would only include transportation emissions that occur within the subject jurisdiction. PBEI approaches for transportation were used in early community inventories, but in California are no longer widely-used.

An ABEI approach to transportation would include transportation emissions related to land-use activity in the subject jurisdiction that occur both within and outside of the jurisdiction, which is the standard currently used for CEQA and CAP analysis in California.

A CBEI would include the lifecycle emissions associated with fuel used for final consumption in the subject jurisdiction. Most commonly, CBEIs limit their inventory to lifecycle emissions associated with household and government fuel use.

There is currently no practice of including all lifecycle emissions (both upstream and downstream) associated with all activity within a jurisdiction.

3.2.1 PRODUCTION-BASED APPROACH

GHG emissions associated with transportation are primarily related to the use of various types of energy to power cars, trucks, buses, ships, trains, and other vehicles. On-road vehicle emissions are usually the largest source transportation emissions for most jurisdictions, regions, and states. In many instances, transportation emissions are the single largest category for communities of all sizes. ARB's recent GHG inventory identifies that transportation-related emissions account for nearly 40 percent of all emissions statewide.

In a production-based GHG inventory, transportation-related emissions are reflected based on fuel consumption, measured either directly or indirectly. The most common means of estimating on-road emissions is to first estimate vehicle miles traveled (VMT), then use vehicle fleet fuel efficiency to determine first fuel consumption and then GHG emissions. VMT estimates can account for travel both within and outside of a community. Production-based and activity-based GHG inventories estimate on-road GHG emissions from transportation based on the following factors:

- Number of trips produced
- Length of each trip
- Any discounts applied to trips which travel to other jurisdictions
- Breakdown of the fleet by vehicle type (car, bus, truck, etc.)
- Anticipated fuel consumption by each vehicle type
- Emissions factors for each type of fuel

Historically, the vast majority of vehicles have been powered by either gasoline or diesel fuel, though other fuel types are becoming increasing prominent. Electric cars or other zero tailpipe emission automobiles can be addressed through adjustments to the fleet mix, the fuel type, emission factors, or other factors in the calculation. While zero-emissions vehicles have no use emissions, they produce upstream emissions, such as electricity generation emissions for vehicles, or hydrogen fuel production and transport emissions for hydrogen-powered vehicles. These upstream emissions would not be included in a PBEI.

3.2.2 ACTIVITY-BASED APPROACH

An ABEI includes transportation emissions related to the land-use activity within a jurisdiction, even if some the transportation emissions occur outside the jurisdiction. The intent of an ABEI is to include the direct vehicle, vessel, train, and transit emissions that occur due to the land-use activity. The limit of an ABEI is commonly the limit of a regional travel demand model. A common practice for community inventories for on-road vehicle emissions is to apportion 50% of the emissions to the trip origin, and 50% of the emissions to the trip destination. The underlying implication of this 50/50 approach is that the origin jurisdiction and the destination jurisdiction share responsibility for the emissions of a trip between the two jurisdictions. An ABEI should include the electricity generation emissions for electrical vehicles, similar to how an ABEI addresses electricity use, but will not include the upstream fuel cycle for transportation related to the subject jurisdiction.

An ABEI approach uses methodology, data, and reduction measures that readily align with other transportation planning efforts, and data exists to support specific transportation inventories on the local scale. For example, regional transportation planning agencies like Metropolitan Planning Organizations (MPOs) use exactly the same process above to identify regional VMT and GHG emissions as part of their Regional Transportation Plan (RTP) efforts, which are updated every four years. Air quality planning efforts for criteria pollutants often use similar methodologies and tools for documents they are required to prepare and regularly update.

The ABEI approach is the most common approach for transportation emissions inventories for community inventories in California at present.

3.2.3 LIFECYCLE EMISSIONS OF TRANSPORTATION FUELS

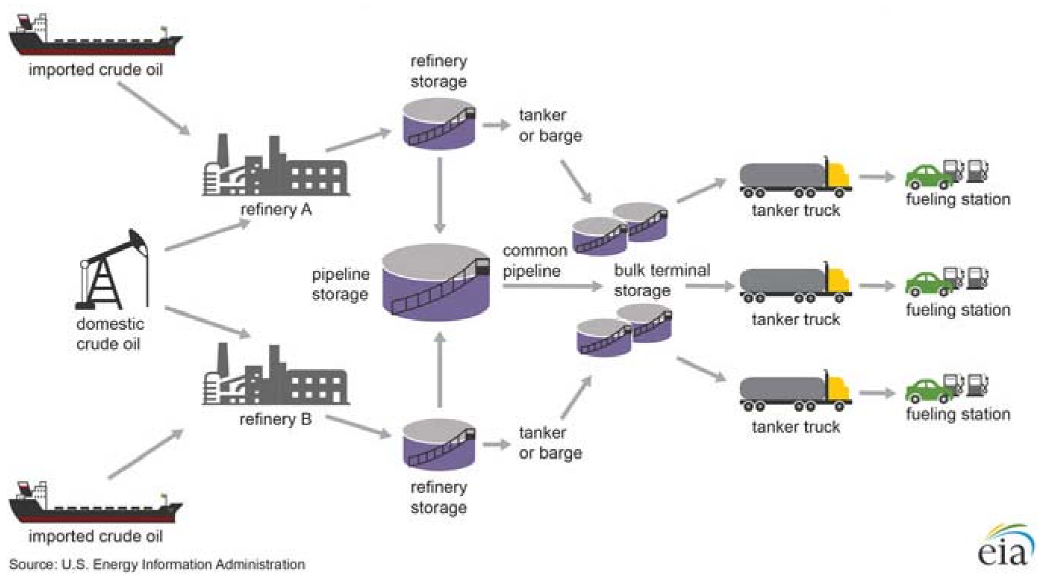
Lifecycle emissions of petroleum, which is widely used for fuel, include emissions related to the following, for gasoline and diesel:

- Energy and emissions associated with fuel exploration for petroleum
- Energy and emissions required to extract petroleum
- Energy and emissions associated with the transportation of petroleum to a refinery
- Energy and emissions required to process petroleum into gasoline and diesel fuel
- Energy and emissions required to transport gasoline to a local market
- Emissions associated with the combustion of gasoline and diesel fuel

For a widely-used fuel like gasoline, estimating consumption-based emissions for a local jurisdiction would incur complexity regarding how gasoline is processed and sold at the retail level. According to the United States Energy Information Agency (US EIA), a component of the United States Department of

Energy, it is not possible to determine the origin of gasoline sold by any retail establishment, for a variety of reasons. First, oil refineries that produce gasoline often comingle petroleum from several sources, depending on oil supply, prices at a given time, and other factors. Emissions associated with domestic oil could be significantly different from oil derived from foreign sources. Second, oil refineries often distribute gasoline, resulting in further mixing of fuels from different sources. The US EIA developed the graphic below (Figure 3.3) to illustrate the flow of petroleum throughout the refining process.

Figure 3.3: Flow of Crude Oil, Gasoline, and Diesel Fuel to Fueling Stations



Lifecycle emissions of different transportation fuels (gasoline, diesel, biodiesel, ethanol derived from different sources, hydrogen, electricity, natural gas, etc.) have been estimated by CARB in the implementation of the low-carbon fuel standards (LCFS) through the use of the California-modified Greenhouse gases, Regulated Emissions, and Energy Use in Transportation (GREET) tool. While GREET analyses have been done on the most common transportation fuels on an average state basis, no prior analyses breaks down the different fuel supply for different parts of California or on a local city or county level. State-level or national-level averages are suitable for use in state and national climate action planning, but combining data based on economy-wide averages with locally specific data would obscure differences between jurisdictions on the upstream emissions side. Furthermore, the GREET analysis uses national or foreign regional (e.g., Middle East, not Saudi Arabia or Kuwait) averages for fuel source emissions. This means that the estimate of the upstream emissions beyond combustion is not actually indicating emissions associated with fuel consumed in California, but rather those emissions associated with more general consumption of a given amount of a particular type of fuel. While GREET analysis is invaluable in identifying the upstream and downstream components of fuel lifecycle emission on a comparative basis, without adjustment to the specific fuels consumed within a jurisdiction, its use in local consumption-based inventories would be much less precise than the production-based accounting approaches.

3.2.4 CONSUMPTION-BASED APPROACH

A CBEI approach for transportation emissions would employ many of the same analytical tools and approaches as an ABEI inventory, but would include significant complications and uncertainty in trying to estimate the upstream emissions associated with fuel consumption within a single local jurisdiction. A methodology to identify lifecycle emissions associated with just gasoline consumption within a specific jurisdiction would require a significant amount of data, which would be difficult and costly to obtain for a local jurisdiction. For example, an analyst would need to estimate how much of the oil refined to produce gasoline consumed locally would be produced domestically, and how much would be imported. For each of the upstream cycle categories, additional analysis would be required to estimate the emissions associated with each method of petroleum extraction, perhaps even broken down by region or sub-region. For example, the emissions associated with fracking in Texas, a deep sea oil well in the Gulf of Mexico, or a large facility in Saudi Arabia could be significantly different, and the discrepancies would need to be addressed. Production and extraction methods are dynamic over time. Thus it is highly challenging to make accurate assumptions for locally-consumed fuel for the entire lifecycle and furthermore to project such use and emissions into the future.

Any GHG analysis is further complicated by the need to identify not only an existing baseline, but also a future condition. A defensible methodology would need to consider how the distribution of domestic and foreign oil would change over time. The analysis would also need to evaluate how the petroleum would be brought to the local market, whether by pipelines, trains, or tanker trucks.

While state and national averages are available and commonly used for CBEIs, much of the data to customize lifecycle fuel emissions based on local fuel consumption is not readily available. In contrast, data on fleet mix, fuel emission factors, and other data currently used in production-based inventories can be obtained from a variety of sources. State and regional transportation agencies, air districts, the Air Resources Board, and other agencies readily provide the information needed in a traditional transportation inventory because they develop this information for their own use. Therefore, a consumption-based inventory for transportation emissions would be a significant burden on a local agency because of the need for additional data and analysis, without the precision provided by current production-based accounting approaches.

For CBEIs focused only on household and government consumption, emissions associated with fuel use by businesses and services would not be included, because business and services produce goods and services for public and private consumption, rather than for final consumption. The final consumer of locally-manufactured goods and services would be responsible for the GHG emissions whether located in the local municipality, in another California city, or elsewhere in the world.

3.2.5 COMPARISON OF APPROACHES

PBEI or ABEI approaches include local fuel-use emissions related to combustion. In contrast, only household and government fuel-use are included in a consumption-based inventory. A CBEI approach to transportation focused on household and government consumption (the most common approach to date) would include household and government fuel use emissions on a life cycle basis, using more specific data on the combustion use emissions and more general/national-level data on the upstream emissions. Both PBEI and ABEI approaches to transportation would include all residential, commercial, industrial, and government fuel-use combustion emissions, but would exclude the upstream emissions; A PBEI would only include emissions in the jurisdiction while an ABEI would include transportation emissions related to land use activities within the jurisdiction whether in the jurisdiction or not.

3.3 WATER AND WASTEWATER

Prepared by Eli Krispi and Tammy Seale, Placeworks.

GHG emissions occurring from water use are the result of electricity used to treat and transport water between its source and its ultimate delivery to the end user. GHG emissions from wastewater generation are caused by the electricity needed to transport wastewater between where it originated and the treatment plant, for treatment (both treatment electricity and any methane released during treatment), and for transport to the discharge point. The upstream emissions associated with water and the downstream emissions from wastewater are best analyzed separately, although they can be aggregated for reporting purposes.

In many communities, most or all of the electricity and treatment of wastewater often takes place outside of the subject jurisdiction, so would not be captured in a strict PBEI that reflects only activities within the jurisdictional boundaries. However, guidance documents for community inventories, such as the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, include methods for calculating these emissions, and it is recommended that these indirect emissions be calculated.

Some community inventories do not include GHG emissions outside of their jurisdiction because of concerns over jurisdictional control, but many ABEIs in California include both upstream water electricity emissions and downstream wastewater emissions. The methods used to calculate the immediate indirect water and wastewater-related energy emissions are the same for CBEIs as for PBEIs and ABEIs, but the methods differ on which emissions to include, as discussed below.

3.3.1 UPSTREAM TRANSPORTATION ENERGY

California has an extensive statewide network to transport water between its source and its ultimate end users. The state-owned State Water Project (SWP) and federal Central Valley Project (CVP) consist of massive dams, aqueducts, and pumping stations that transport water from the Sierra Nevada to areas across California. Local governments in the San Francisco Bay Area and Southern California have constructed large-scale aqueducts of their own that tap into distant water sources, such as the Colorado, Owens, Tuolumne, and Mokelumne rivers. On a smaller scale, communities and water districts throughout the state obtain water from nearby lakes, rivers, and groundwater basins. All of this activity to transport water, even in jurisdictions that obtain water from water bodies and groundwater basins entirely within their boundaries, requires a substantial amount of electricity. Electricity use for water-related activities occurs in four categories:

- **Supply**: The process of initially obtaining the water from its source, either through pumping or gravity. For desalinated water, the desalination process itself is included.
- **Conveyance**: Transporting the water from its source to the treatment location, via pumping or gravity.

- **Treatment**: Treating the water to the required standard.
- **Distribution**: Pumping the water from the treatment facility to homes, businesses, and other end-users.

To address concerns that water-related electricity use may be double-counted in electricity use from buildings and facilities, communities have the option to exclude electricity use from these sources, or to report them as informational items not included in the total. Activities with the potential for double-counting include distribution, treatment, and supply and conveyance within the jurisdiction.

A PBEI would only include water transportation and treatment electricity emissions if they occurred within the subject jurisdiction. An ABEI would include the electricity emissions related to jurisdictional water use whether they occurred within the jurisdiction or not. A CBEI would include all the emissions included in an ABEI, but would also include lifecycle emissions of consumed inputs for water treatment, such as treatment chemicals, as well as the construction of the plant and delivery pipelines. Because treatment plants and pipelines are built for long capital lifetimes, it would be challenging to assign an appropriate emissions factor to current water delivery for prior plant and pipeline construction.

3.3.2 DOWNSTREAM WASTEWATER PROCESSING

A typical GHG emission inventory estimates the methane emissions resulting from the decomposition of organic material as part of wastewater processing activities. Downstream wastewater processing also requires electricity to collect and process the wastewater at a treatment facility, and then to discharge it in an environmentally-responsible manner. There are two categories of wastewater-related emission activities, as follows:

- **Treatment**: Processing the wastewater at a treatment facility. These facilities can be large- or small-scale, including “package systems” intended to treat a single neighborhood, but does not include individual septic systems.
- **Disposal**: Discharging the wastewater into the environment.

Wastewater processing activities may occur within or outside of the jurisdiction where the wastewater is generated. If the treatment and/or disposal occurs within the jurisdictional boundaries of the community, then a strict PBEI would exclude the wastewater-related energy use and methane emissions, while ABEIs and CBEIs would include wastewater-related emissions whether or not they occurred in the subject inventory. A comprehensive CBEI would also include any consumable inputs at the wastewater treatment plant, such as treatment chemicals, as well as the construction of the plant itself. Because treatment plants are infrastructure built for long lifetimes, it would be challenging to assign an appropriate emissions factor to current wastewater treatment for prior plant and pipeline construction.

3.4 EMBEDDED EMISSIONS FROM GOODS AND SERVICES

Prepared by Dave Mitchell, Mitchell Air Quality Consulting.

CBEIs account for the emissions embedded in the products people consume. The emissions generated in each step of the production and transport of materials to the consumer are referred to as upstream emissions. For example, a paper coffee cup includes embedded emissions from harvesting wood, refining wood into paper at a mill, shipping to a warehouse and then to the corner coffee shop where it is sold to a consumer filled with coffee. Materials purchased by consumers also result in waste that must be disposed of, which in turn results in GHG emissions referred to as downstream emissions. This includes disposal of packaging waste, food waste, and for durable goods, disposal at the end of their useful life. For example, the paper cup could be transported to a landfill or recycling facility, or to an incinerator, or to a composting facility for disposal. The GHG emissions will depend on the disposal method used by the waste hauler and the landfill serving the community.

When assessing lifecycle emissions related to products, emissions during the entire product lifecycle should be addressed. The full lifecycle emissions of individual products are known as “cradle to grave” emission accounting because they include each step of the product lifecycle including upstream emissions, product use, and downstream emissions when the item reaches the end of its useful life.

The State of Oregon CBEI[11] includes lifecycle emissions for a variety of consumer products. The inventory includes pre-purchase upstream emissions, use emissions, and post-consumer disposal for various product categories. Some products and services such as food and beverages, healthcare, and retailers have limited-use emissions and small post-consumer disposal emissions. Other products that consume energy after purchase such as vehicles, appliances, and lighting produce most of their lifecycle emissions during use and lesser amounts during production. The state of Oregon CBEI estimates for each of these example categories, and the percentage of each part of their lifecycle, are presented in Table 3.1 below.

Table 3.1: State of Oregon Select Emission Categories and Life Cycle Percentages

	Total Emissions MMTCO2e	**Pre-Purchase (% of Category)**	**Use (% of Category)**	**Post-Consumer Disposal% (% of Category)**
Vehicles	18.9	13.8	86.2	0.5
Appliances	11.7	2.6	97.4	0.9
Food and Beverages	9.1	97.8	0.0	3.3
Healthcare	4.0	100.0	0.0	2.5
Lighting	2.9	0.0	100.0	3.5
Retailers	2.1	13.8	86.2	0.5
Source: Consumption Based GHG Inventory for Oregon -2005				

Most products consumed in an individual community are produced elsewhere. CBEIs include emissions from products consumed within the community, but not the emissions from producing the products in that community that are consumed in other communities. For example, if a community has a car factory, no emissions from production of the cars are included in the inventory. The embedded emissions from production of all vehicles are only accounted for at the consumer level in the inventory.

CBEIs are based on economic data on the dollar value of goods and services, and not on individual emission calculations for each product. Sufficient data is rarely available to calculate community-specific emissions due to the large number of products and services, and the complexity of the supply chain.

[11] Oregon Department of Environmental Quality, Department of Energy, and Department of Transportation, 2013. Oregon's Greenhouse Gas Emissions through 2010: In-Boundary, Consumption-Based, and Expanded Transportation Section Inventories. July 18. Available: http://www.oregon.gov/deq/FilterDocs/OregonGHGinventory2010.pdf

Instead, regional, state, and global economic data and emissions factors are based on commodity sector averages due to the complexity of supply chains. Using such data does not allow the inventory to account for differences in emissions at production facilities, which may have higher or lower carbon intensities than the average, or to differentiate between individual products.

Attributing upstream emissions to materials consumed can be accomplished using broad industry-wide averages, but not for the purpose of attributing responsibility. For example, we know broadly that the steel used in cars is processed by using raw materials, including virgin iron ore and recycled steel; and we know the locations of mines and the extent of recycled metal use in each country. This information is used to generate an average energy use calculation for the mining, transportation, smelting, etc., required to produce a given amount of steel. This would not account for individual variation for steel produced with renewable energy instead of coal, or for whether the recycled material is local or transported by ship to another country for processing. The manufacturers make the steel parts that are then assembled at an assembly plant. The energy used at the assembly plant will vary depending on the source of electricity and heat used at the plant. In the future, it may be possible for car manufacturers to purchase "green" steel and other environmentally "friendlier" commodities for their vehicles, and to report those mitigations as part of the window sticker along with miles per gallon of fuel. Until there is a robust GHG accounting system throughout the supply chain this will not be possible.

3.4.1 IMPLICATIONS FOR CEQA

This discussion refers to products purchased for the construction and operation of a development project subject to CEQA.

3.4.1.1 PRODUCTION EMISSIONS OF GOODS AND SERVICES

The current most common CEQA approach to addressing emissions associated with goods and services is to include the production emissions associated with production of goods and services by commercial/industrial projects, and the disposal emissions of waste generated by the project. Embedded emissions in goods and services consumed by the project occupants are not included in CEQA inventories to date. Some strict PBEIs will not include waste disposal in other jurisdictions, but most recent ABEIs do.

3.4.1.2 CONSUMPTION EMISSIONS OF GOODS AND SERVICES

Materials consumed by projects include products needed for building construction, and products used by occupants of completed projects. Examples include building materials such as wood products, cement, roofing materials, etc. used in construction and consumer products such as cars, appliances, furniture clothing, food, cleaning supplies etc. used by people living or working in a project. Everything we purchase has embedded GHG emissions from each step of the production and distribution process. Raw materials are mined and refined and transported to the next point in the production process. Each step requires energy to be expended and causes GHGs to be emitted.

The short answer as to whether embedded product emissions should be included in CEQA analysis is "No." The CEQA accounting system for GHG emissions follows the principal that, in order to meet nexus requirements, impacts addressed must have a reasonable relationship to the project. Production of goods is usually too far removed from use to attribute responsibility for upstream emissions to an individual project. The supply chain for each of the thousands of products consumed is often very complex and can vary with time. Vendors change, plants open and close, mines play out, resources are substituted, manufacturing techniques change, new products are introduced, and technologies advance. The production facilities are often not new impacts but part of the existing conditions. As described earlier, the data used in consumptive inventories, while good for general use, does not accurately reflect local conditions and may be considered speculative to apply to a project analysis.

3.4.1.3 LIFECYCLE EMISSIONS OF GOODS AND SERVICES

Example: XYZ Brewery proposes a new facility that will produce beer for its three local beer pubs and also for sale in local markets and for wider distribution regionally and nationally.

The typical CEQA analysis assesses the direct emissions from natural gas used to heat the building and for the production process, electricity consumed by the building, electricity used for water and water treatment and transport, employee transportation and trucking emissions, and waste-related emissions. These sources of emissions can be controlled or influenced by the brewery and by the approving land-use authority during the permit and environmental process. Further, these sources of emissions relate to the emission sources in the ARB Scoping Plan (and updates) and in most CAPs. Such accounting provides some elements of a life cycle emissions but not all upstream emissions.

CEQA analyses do not normally include upstream impacts of production from activities that occur outside the geographic area of the analysis. The production of beer requires grains, glass bottles, fermentation tanks, etc., which are likely produced outside the community. For example, the impacts of glass bottle manufacturing are addressed by the community where the glass facility is located. Emissions from transporting the bottles to the brewery are partially included in the project’s motor vehicle emissions as part of the project’s VMT, and partially included in the bottle factory’s jurisdiction. Impacts of growing and storing the grain used to make beer are not included in normal CEQA analyses. The precise sources of these upstream activities are seldom known at the time a project is going through the CEQA process, and could change at any time during project operations. CEQA requires projects to be assessed for their direct and indirect impacts to the environment. Generally, upstream emissions for a project are considered part of the existing environment. For example, glass manufacturers can accommodate new customers with their existing production capacities. New more productive plants replace old plants over time, and customers come and go. Overall grain production is not likely to increase to satisfy the demand of the new brewery, but rather is part of the global food economy. Therefore, CEQA practice has been to limit the scope of the analysis to those impacts most directly attributable to the project.

CEQA analyses do not normally include downstream emissions that occur after production is complete, except for the portion of the transportation emissions from trucking the finished product to a local distribution point based on average trip lengths in the emission model and waste-related emissions. The downstream transportation emissions beyond the model boundaries are instead presumed to be related to non-project distribution facilities within California, the U.S., or abroad. For example, BevMo! facilities receiving beer from the subject brewery would be responsible for the VMT-related emissions up to the transportation model limit for the jurisdiction where the BevMo! is located. Waste impacts from disposal of the empty bottles is attributed to the home or business where the product is used, and not to the business that produced the product.

3.4.2 IMPLICATIONS FOR CLIMATE ACTION PLANS

3.4.2.1 PRODUCTION EMISSIONS OF GOODS AND SERVICES

Current community climate action plans (CAPs) usually include direct and indirect emissions of production using the ABEI methods, but not the upstream emissions from the facilities supply chain, or downstream post-sale emissions. CBEIs that focus on household and government consumption do not include any production-related emissions from facilities, only the embedded emissions in products consumed within the geographic boundaries. However, where production in a jurisdiction serves local consumption, local production emissions will be included in the embedded emissions for products consumed locally, although the estimation may be based on regional or national patterns emissions intensities, depending on data availability.

Counties with large agricultural sectors usually include emissions related to food production in their inventories and CAPs. Emission-generating activities from the agriculture sector include, but are not limited to, fertilizer application, farming equipment operation, agricultural burning, livestock grazing, and confined animal facility manure decomposition emissions. The inventories for the agriculture sector in CAPs commonly do not include upstream emissions from pesticide and fertilizer production, and feed imports from outside the jurisdictional boundary. Direct and indirect emissions of local farming and food processing are usually included, as well as transportation emissions from shipping raw materials and finished products, to the extent of the transportation model used. A PBEI for a CAP would only include emissions related to farming and food processing, and related transportation in the jurisdiction; while an ABEI for a CAP would also include transportation splits with destinations in the model domain, as well as upstream electricity and water-related emissions, and downstream wastewater and waste emission related to agricultural waste. Downstream emissions related to long-distance transportation outside the model domain, and disposal of food waste after consumption (and sometimes raw waste without consumption), is not usually included in the community ABEI and instead is accounted to the consumer. A CBEI for a CAP would not include any emissions related to farming or food processing, since these emissions would be accounted only to the consumer (in whatever jurisdiction they reside).

3.4.2.2 CONSUMPTION EMISSIONS OF GOODS AND SERVICES

When developing a community inventory for a CAP, addressing materials consumed can provide additional information about the lifecycle emissions of consumed goods. However, if a jurisdiction decides to complete a consumption inventory, we recommend including emissions from material consumed in a separate consumptive inventory, for information purposes only, and using a geographic production-based inventory to set community targets and for CEQA streamlining.

Communities may prepare consumptive-based emission inventories for several reasons. Communities and individuals may be interested considering the carbon content of items they consume. Policy makers can use the inventory to consider the lifecycle emissions implications of implementing new government vehicle fleet technologies and energy production facilities. For example, fleet purchasers can consider the embedded emissions in purchasing EVs from battery production and disposal compared to purchasing gasoline vehicles. One finding of recent consumptive-based inventories is that emissions from the production of food is substantial, and the types of food we choose can make a significant difference in emissions. For example, meat and dairy products have high embedded emissions, while those from vegetables are relatively low. In another example, the transportation distance savings from buying locally-produced food may be offset by less efficient production and distribution than what's achieved in the global market. Buying locally may be a community economic or health goal, but GHG reductions may not be a reason to promote it if the production emissions on balance outweigh the transportation emissions.

It seems logical that some but not all consumers would buy products with lower embedded supply chain emissions, even if they're costlier than a product with a high emission supply chain, if that information was disclosed. However, most consumers will base their purchase on price.

3.4.2.3 LIFECYCLE EMISSIONS OF GOODS AND SERVICES

There is no current practice of including all lifecycle emissions of all goods and services consumed or produced within a jurisdiction in a climate action plan, and the authors are not aware of any completed such analyses. Such an approach would result in double-counting between jurisdictions, since it would require assigning equal full responsibility for the entire lifecycle to both the producer and consumer. Due to the double-counting issue, such an approach is not recommended.

A lifecycle inventory may help influence individual manufacturing companies in a community to consider upstream emissions in their supply chain, and downstream emissions of their products, to reduce their carbon footprint. Many companies are examining their carbon footprint through programs like the Carbon Disclosure Project (CDP), which provides a means of comparison at the corporate level. CDP's Supply Chain Initiative members engage with suppliers to reduce carbon emissions from purchasing decisions. Showing businesses and the public the emissions embedded in their purchases can help increase participation in these types of initiatives. The CDP Supply Chain Initiative is a start in this direction, but is nowhere near complete enough to use as the basis for a community or an individual to compare purchasing options among similar products based on GHG emissions.

4. Comparison of Different Jurisdictional Inventories

Prepared by Rich Walter, ICF.

CBEIs have been completed at the national, state, and municipal level. This section discusses a number of the CBEIs prepared to date and compares their results to PBEIs and ABEIs. This review is by no means a comprehensive review of CBEIs. The reader is directed to the references cited below for links to all the CBEIs discussed herein. The inventory reports provide a wealth of data about their data sources, emissions included and excluded, methods used to quantify consumption, and the implications for local climate action planning as identified by the individual entities.

4.1 THE INTERNATIONAL PERSPECTIVE

Much of the interest in CBEIs originally developed in the international discussions about responsibility for GHGs. The original and still dominant paradigm is that nations are responsible for the emissions produced within their own jurisdictions. However, there has been considerable concern about the movement of GHG-intensive industries from developed countries in North America, Europe, and Japan to China, India, and other developing countries and the embedded emissions in imports to developed countries.

Recent studies, including notably the work of Davis & Caldeira (2010),[12] have identified that 20 to 25 percent of global $C0_2$ emissions are generated from the production of internationally-traded products, and these emissions are growing. Between 1990 and 2008, emissions from export industries from developing and developed countries increased CO_2 by 1.6 GT, while domestic emission within the Kyoto Protocol Annex B countries (countries with reduction obligations) reduced by 0.5 GT (Peters et al. 2011)[13]. An illustration of the flow of emissions associated with international trade is shown in Figure 4.1.

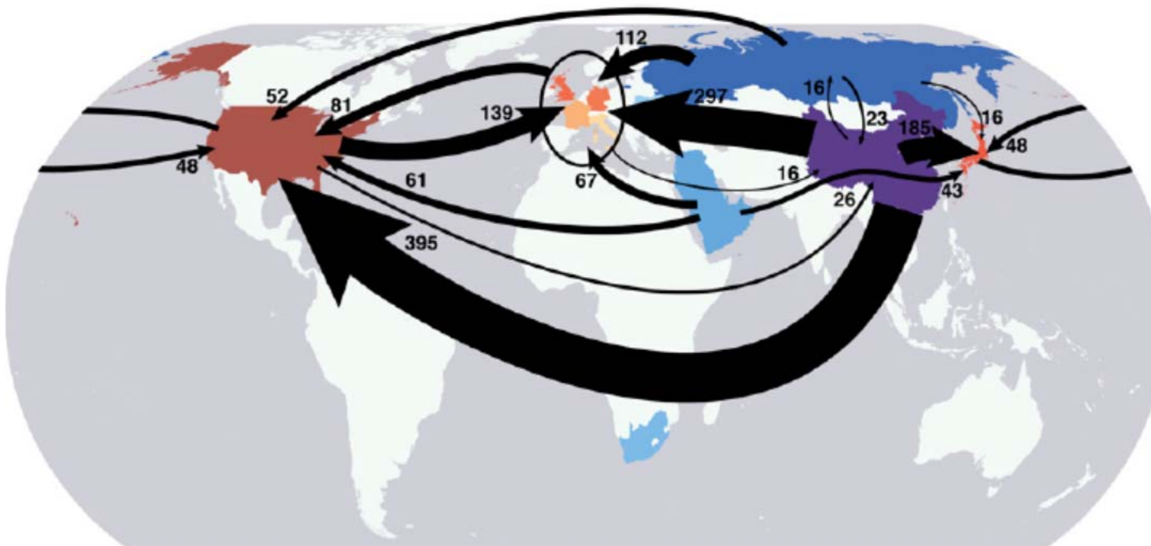
CBEIs at the national level are not used to identify responsibilities in formal international climate conventions, but a number of countries have developed them including Australia, Europe, and Canada (but not the U.S.). Australia and the United Kingdom have committed to updating consumption inventories periodically. One study of emissions in the U.K. identified that territorial-based inventories showed a reduction in GHG emissions of 27% between 1990 and 2009, while consumption-based emissions grew by 20% from 1990 to 2008, with a temporary drop of 9% in

[12] Davis, S., and Caldeira, K. 2010. Consumption-based accounting of C02 Emissions. Proceedings National Academy of Sciences Vo. 107, No. 12, p. 5687-5692. Available: http://www.pnas.org/content/107/12/5687.full

[13] Peters, G, Minx, J., Weber, C., Edenhofer, O. 2011. Growth in Emissions Transfers via International Trade from 1990 to 2008. Proceedings National Academy of Sciences Vo. 108, No. 21, p. 8903-8908. Available: http://www.pnas.org/content/108/21/8903.full.pdf

2008-2009 due to the global financial crisis (Barrett et al. 2013).[14] Domestic emission for UK consumption over this period showed substantial reduction, direct emissions were more or less flat, while emissions associated with imports dramatically increased (Barrett et al. 2013).

Figure 4.1: Largest interregional fluxes of emissions embodied in trade (Mt CO2/year) from dominant net exporting countries (blue) to the dominant net importing countries (red) (Peters et al. 2011).



Comparison of national territorial inventories and national consumption inventories reveals notable differences between countries. Based on 2004 data, the United Kingdom's consumption emissions exceeded its territorial emissions by 46%, reflecting a high level of imports relative to domestic production. In contrast, China's consumption emissions were 23% less than its territorial emissions, reflecting that country's heavy reliance on export-oriented industry. Consumption emissions in the U.S. exceed territorial emissions by 12%, reflecting a more balanced level of domestic production and imports than in the U.K. Further data comparing PBEI to CBEI results are shown in Table 4.1 below.

4.2 STATE AND COMMUNITY-SCALE CONSUMPTION INVENTORIES

CBEIs have been prepared for relatively few municipalities to date in the United States including (but not limited to) San Francisco, Oakland, the San Francisco Bay Area, Portland/Multnomah County (Oregon), Seattle (Washington), and the state of Oregon. These jurisdictions have employed a variety of approaches to completing consumption inventories. Many have used economic input-

[14] Barrett J., Peters G., Wiedmann T., Scott, K., Lenzen M., Roelich, K., and Le Quéré C. 2013. Consumption-based GHG emission accounting: a UK case study, Climate Policy, 13:4, 451-470. Available: http://www.tandfonline.com/doi/abs/10.1080/14693062.2013.788858

output models (such as IMPLAN) to derive consumption patterns, and then applied lifecycle databases to derive emission factors for different goods and services. Inventories prepared for the City/County of San Francisco, King County (Washington), Portland/Multnomah County (Oregon), and the state of Oregon all used IMPLAN. The San Francisco Bay Area Consumption Inventory prepared by BAAQMD and UC Berkeley employed custom econometric models for household consumption using a variety of available household expenditure data. The CBEI for Oakland used the UC Berkeley Cool Climate Calculator (which is a household-based tool) and the USEPA's WARM model, among other tools. However, the Oakland CBEI is unique among examples reviewed because it included consumption emissions associated with residential, commercial, and transportation consumption, whereas all the other examples noted above focused on final household and government consumption. The consumption inventory for Denver used custom estimates of air travel, fuel production, cement use, and home good purchases to supplement a more production-style inventory. Due to the variety of methods used, one cannot strictly compare the results of the different inventories unless the exact same methods are used.

As shown in Table 4.1 below, CBEIs for these jurisdictional areas show a variety of results compared to production-style inventory estimates. Based on these studies, in 2010 the state of Oregon had consumption emissions only 19% higher than its production emissions, whereas Portland and surrounding Multnomah County in 2011 had consumption emissions double their production emissions. Metropolitan cities like San Francisco and Oakland, which have limited production activities, have been shown to have consumption emissions that exceed their production-style inventories by even higher amounts (3.7 times and 2.8 times, respectively); whereas the consumption inventory for the entire San Francisco Bay Area for 2013 shows consumption emissions exceeding production-style emissions by only 31%. From these results, some generalities can be derived:

- The broader the area of the inventory, the more likely that some local consumption is being provided by local production, thus lowering the difference between production and consumption inventories.
- The less local production within a jurisdiction, such as in the highly urbanized city of San Francisco, the more consumption emissions are likely to exceed production emissions.
- The comparative amount of production-style emissions (whether mass emissions or per capita emissions) is not a good measure of the likely comparative amount of consumption emissions (whether mass emissions or per capita emissions), since local production is not necessarily directly related to local consumption.

One finding of note in CBEIs to date concerns the relation between wealth and GHG emissions. There are many drivers of consumption emissions including residential electricity sources, weather, proximity to services and work, food choices, etc., and household income level is also a factor. Since CBEIs use household consumption as a primary diver of emissions (other sources are business investment and government consumption), it stands to reason that different household consumption patterns and levels show up as differences in consumption emissions. The city-level CBEIs noted above may be too limited a data set to make a connection between household income levels and consumption emissions, but the San Francisco Bay Area CBEI provided an estimate of consumption emissions for every jurisdiction in the BAAQMD District. As shown in Figures 4.2 and

4.3, in the BAAQMD study a notable difference in household consumption GHG footprints was identified between more wealthy and less wealthy jurisdictions. In Alameda County, the city of Piedmont, which is a centrally-located relatively wealthy enclave surrounded by Oakland, has the highest estimated household consumption emissions, far exceeding neighboring Oakland which is more economically diverse, and which exceeds even the most outlying suburban communities of Pleasanton, Dublin, and Livermore. In Contra Costa County, a similar pattern applies, as the highest household consumption emissions were in the affluent cities of Alamo, Orinda, Danville Lafayette, Moraga, San Ramon and Clayton; notably exceeding lower-income locations that are relatively farther away from employment centers, such as Pittsburg and Antioch. Wealth effects on consumption will also influence differences in consumption emissions between states and countries.

The methodology used for the BAAQMD study utilizes the same methodology used by the UC Berkeley Cool Climate Network tool for estimating household consumption emissions.[15] The Cool Climate Network tool can be used for any location in the United States to estimate individual household consumption emissions. One could also use the tool to derive a community-scale consumption emissions inventory provided sufficient information is available concerning community households and patterns of consumption.

The consumption-based inventories have been used by some jurisdictions to support policies that address consumption-based emissions. The City of Emeryville in Alameda County used the CBEI in their CAP to support policies to reduce food scraps sent to landfills, achieve zero waste to landfills and to reduce consumption-related emissions by encouraging sustainable consumption and minimization of the carbon intensity of business supply chains.[16] Portland and Multnomah County in Oregon used the CBEI in their CAP to support policies including reducing consumption-related emissions by encouraging sustainable consumption and supporting Portland businesses in minimizing the carbon intensity of their supply chains; reducing food scraps sent to landfills by 90 percent, reducing per capita solid waste by 33 percent and recovering 90 percent of all waste generated.[17]

[15] Tools can be found here: http://coolclimate.berkeley.edu/

[16] City of Emeryville. 2016. Climate Action Plan 2.0. Available: http://www.ci.emeryville.ca.us/338/Climate-Action-Plan

[17] Portland and Multnomah County. 2015. Climate Action Plan 2015: Local Strategies to Address Climate Change. Available: https://www.portlandoregon.gov/bps/article/531984

Table 4.1: Comparison of Production-Based Inventories and Consumption Inventories for Select Entities

Jurisdiction	Year	Community Inventory MMT C02e	Consumption Inventory MMT C02e	Consumption/ Community %	Community Inventory/Capita MTCO2e/person	Consumption Inventory/Per Capita MTCO2e/person	Notes	Source
United States	2004	5,800	6,500	112%	19.7	22.0	Multiregional input-output model from 2004 global economic data.	Davis & Caldeira, 2010
China	2004	5,100	3,950	77%	3.9	3.0		
India	2004	1,360	1,260	93%	1.3	1.2		
United Kingdom	2004	555	808	146%	9.3	13.6		
Denver, CO	2005	11.1	14.6	132%	19.2	25.2	Added air travel, fuel production, cement use, and home food purchases.	Ramaswami et al., 2008[18]
San Francisco, CA	2008	5.9	21.7	370%	7.3	26.9	Used IMPLAN model to identify consumption included household, government and business investment consumption	SEI 2011[19]
King County, WA	2008	23.4	55.0	235%	12.4	29.3		SEI 2012[20]
State of Oregon	2010	62.8	74.7	119%	16.4	19.5		Oregon DEQ, DOE, and DOT 2013
Portland/Multnomah County, OR	2011	7.9	15.8	200%	10.6	21.2		Portland/Multnomah County 2015[21]
Oakland, CA	2013	2.7	7.6	278%	6.7	18.6	Consumption emissions associated with household, commercial, and transportation consumption.	Oakland, 2014
San Francisco Bay Area (BAAQMD), CA	2013	88.2	115.2	131%	12.4	16.2	Household consumption only.	Jones and Kammen, 2015[22]

[18] Ramaswami, A., Hillman, T., Janson. B, Reiner, M, and Thomas, G., 2008. A Demand-Centered Hybrid Life-cycle Methodology for City-Scale, Greenhouse Gas Inventories. Environmental Science and Technology 2008 42 (17), pp. 6455-6461. Available: http://pubs.acs.org/doi/abs/10.1021/es702992q

[19] Stockholm Environmental Institute, 2011. Consumption-Based Emissions Inventory for San Francisco. May. Available: https://sfenvironment.org/download/sf-consumption-based-emissions-inventory

[20] Stockholm Environmental Institute, 2012. Greenhouse Gas Emissions in King County. February. Available: http://www.kingcounty.gov/~/media/services/environment/climate/documents/2008/ghg-inventory-full.ashx?la=en

[21] Portland and Multnomah County. 2015. Climate Action Plan 2015: Local Strategies to Address Climate Change. Available: https://www.portlandoregon.gov/bps/article/531984

[22] Jones, C., and Kammen, D., 2015. A Consumption-Based Greenhouse Gas Inventory of San Francisco Bay Area Neighborhood, Cities and Counties: Prioritizing Climate Action for Different Locations. December 15. Prepared for BAAQMD. Available: http://www.baaqmd.gov/research-and-data/emission-inventory/consumption-based-ghg-emissions-inventory

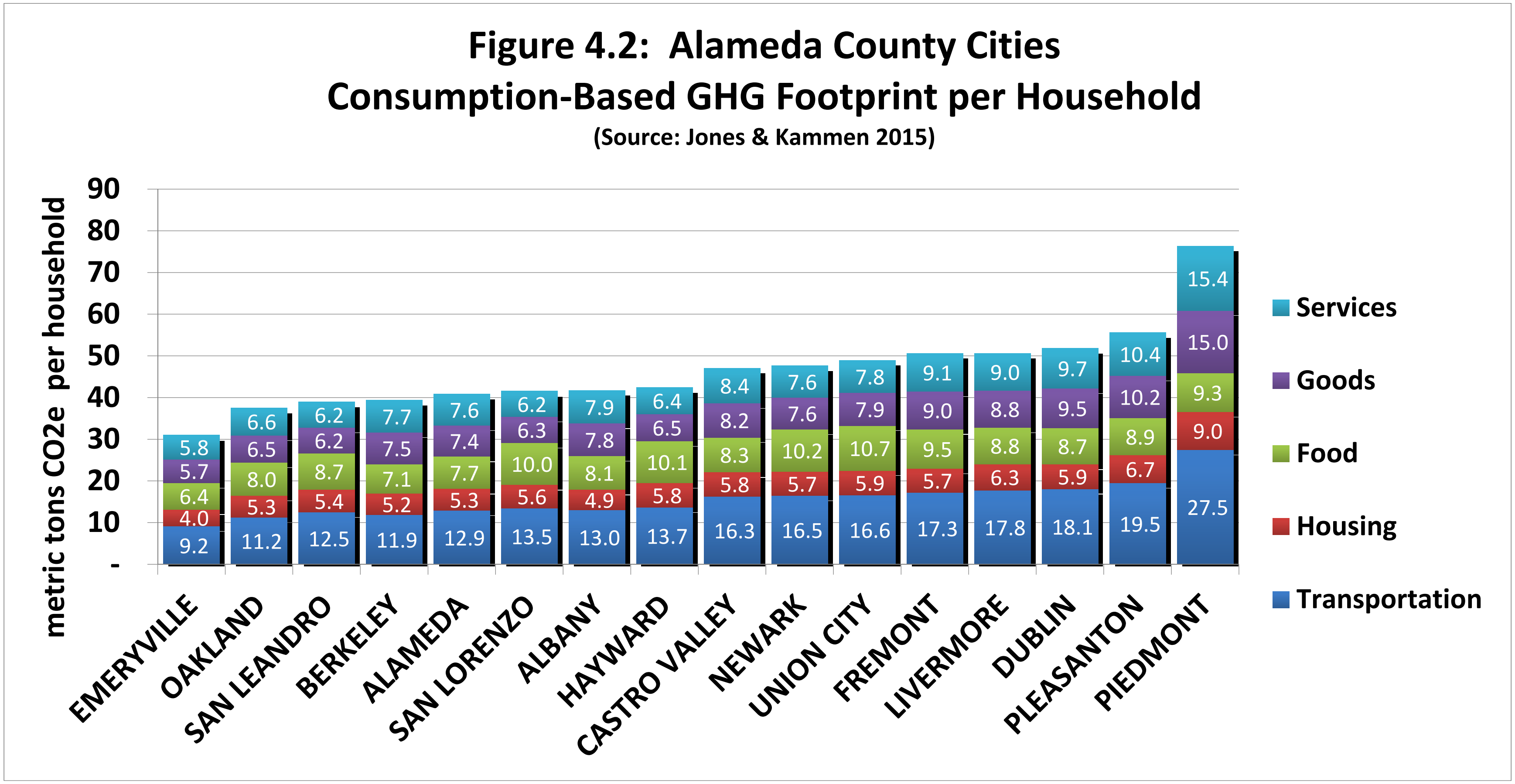
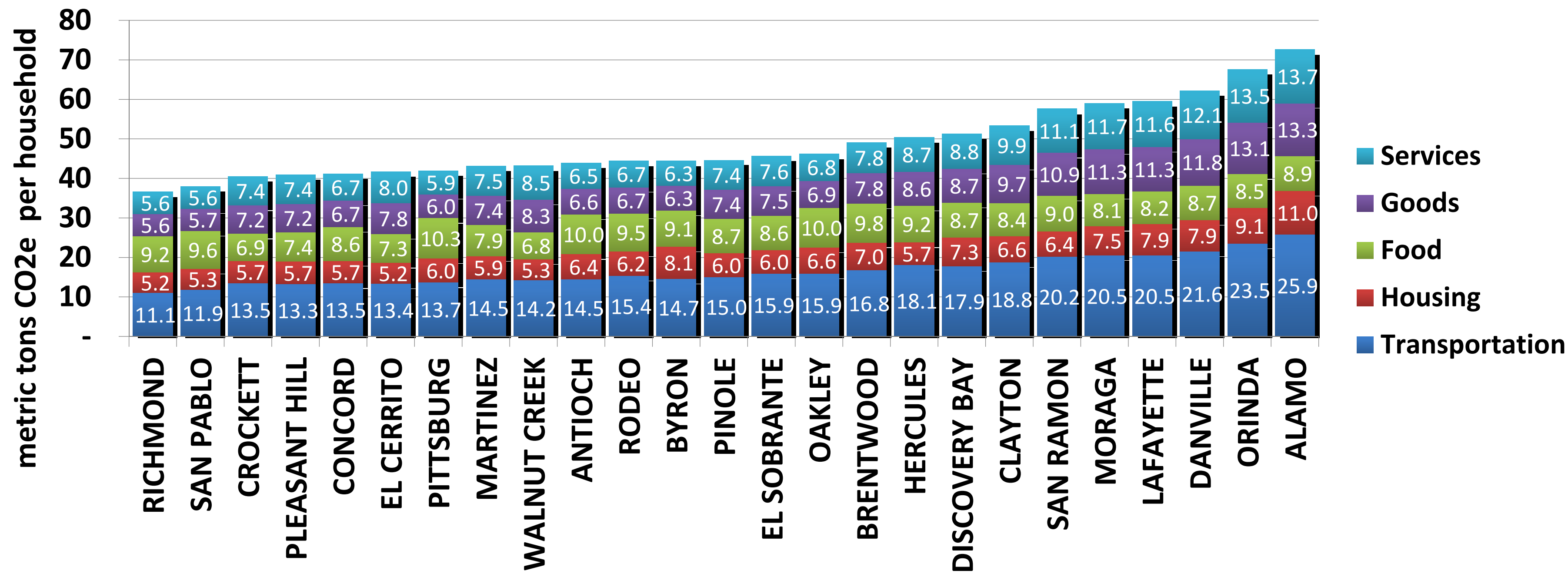


Figure 4.2: Alameda County Cities
Consumption-Based GHG Footprint per Household
(Source: Jones & Kammen 2015)
metric tons CO2e per household
90
80
70
60
50
40
30
20
10
-
EMERYVILLE: 9.2, 4.0, 6.4, 5.7, 5.8
OAKLAND: 11.2, 5.3, 8.0, 6.5, 6.6
SAN LEANDRO: 12.5, 5.4, 8.7, 6.2, 6.2
BERKELEY: 11.9, 5.2, 7.1, 7.5, 7.7
ALAMEDA: 12.9, 5.3, 7.7, 7.4, 7.6
SAN LORENZO: 13.5, 5.6, 10.0, 6.3, 6.2
ALBANY: 13.0, 4.9, 8.1, 7.8, 7.9
HAYWARD: 13.7, 5.8, 10.1, 6.5, 6.4
CASTRO VALLEY: 16.3, 5.8, 8.3, 8.2, 8.4
NEWARK: 16.5, 5.7, 10.2, 7.6, 7.6
UNION CITY: 16.6, 5.9, 10.7, 7.9, 7.8
FREMONT: 17.3, 5.7, 9.5, 9.0, 9.1
LIVERMORE: 17.8, 6.3, 8.8, 8.8, 9.0
DUBLIN: 18.1, 5.9, 8.7, 9.5, 9.7
PLEASANTON: 19.5, 6.7, 8.9, 10.2, 10.4
PIEDMONT: 27.5, 9.0, 9.3, 15.0, 15.4
Services
Goods
Food
Housing
Transportation

Figure 4.3: Contra Costa County Cities Consumption-Based GHG Footprint per Household

(Source: Jones & Kammen 2015)



5. Implications for CEQA

Prepared by Rich Walter, ICF.

There is no fixed standard by which GHG inventories are prepared under CEQA. Instead, a professional practice has been developed by CEQA practitioners and rough norms have become accepted. The principles of GHG accounting used for preparing the California state inventory are also used for preparing CEQA project inventories. Most project-level inventories use the methods describe above for ABEIs. Similar to considerations of inventories for jurisdictions, CEQA project inventories usually do not include embedded upstream emissions for consumer goods and services, but do include certain lifecycle emission elements, including upstream electricity generation and water-related emissions, and downstream wastewater processing and waste disposal emissions. Table 5.1 summarizes the standard approaches used for CEQA GHG inventories.

Table 5.1: Standard Approaches to CEQA GHG Baseline Inventories and Forecasts

Key Principle	*Emissions directly and indirectly related to project activities, but readily estimable and accountable to the project without speculation and under control or influence of CEQA lead agency*
Responsible party	*Project*
Transportation	Emissions related to travel due to project within the boundary of the travel demand model used
Electricity	Electricity generation emissions associated with electricity consumption by the project
Natural Gas	Natural gas combustion emissions associated with direct use by project
Water	Upstream transportation, treatment, and downstream wastewater treatment related to project water consumption
Waste	Downstream emissions associated with project waste generation
Industrial and Commercial Fuel Use	Project industrial processes and industrial and commercial fuel use
Land Use Change	Project decrease in carbon stock/sequestration due to vegetation/soil removal or disturbance and/or project increase in carbon stock/sequestration due to planting or habitat creation/restoration
Construction Emissions	Project construction equipment and transportation emissions. Does not usually include embedded emissions in construction materials (concrete, steel, etc.)
Embedded Emissions in Goods and Services	Not included

The California state inventory is primarily production-style, with the exception of electricity, for which upstream electricity generation emissions associated with imported electricity are included. Given the size and geographic setting of the state, nearly all routine daily transportation activity occurs within the state, excluding intrastate and international transportation. In California, nearly all the waste generated within the state is disposed of in-state, and the wastewater generated in the state is also processed in-state. As such, the state inventory is inclusive of nearly all of the types of emissions commonly included in CEQA project inventories. The state inventory does not include emissions embedded in goods and services that come from outside the state but which are consumed inside California. The state inventory does not include downstream emissions for transportation of California goods and services outside of California to interstate and international markets.

In the California Supreme Court ruling in the *Newhall Ranch* case, the court ruled as follows:

> "*Using consistency with A.B. 32's statewide goal for GHG reduction, rather than a numerical threshold, as a significance criterion is also consistent with the broad guidance provided by section 15064.4 of the CEQA Guidelines."*

The court determined that the statewide reduction goals were an appropriate basis for a project-level significance criteria, provided that the lead agency examines the relationship of the project's emissions to the statewide emissions and appropriately adjusts thresholds to take into account regional, local, or project-level considerations. Thus, CEQA thresholds used to evaluate GHG emissions on a project-level are related to the statewide reduction goals. The statewide reduction goals are based on a comparison of current and projected GHG emissions to a statewide 1990 GHG inventory. That 1990 GHG inventory is mostly a production-style inventory (with the caveat about electricity emissions noted above). As such, in order to compare a project-level GHG inventory to a threshold derived from a statewide reduction target based on the statewide inventory, the GHG emissions included in the project inventory must be accounted for in a similar manner to how the state accounts for GHG emissions.

If a project-level inventory were to include additional upstream embedded emissions associated with consumption of goods and services, or downstream transportation emissions, outside of the state, it would no longer be comparable to the state inventory and a threshold based on state reduction targets could not be used to evaluate the project's GHG emissions. Given the California Supreme Court's determination that it is appropriate under CEQA to compare project GHG emissions to a threshold related to the state reduction goals, there is no current requirement in CEQA to include GHG emissions that are not included in the state's GHG inventory, nor to use methodologies to account for emissions different from those employed in the state's GHG inventory.

Based on professional practice to date, California air districts have collaborated in the development of quantification tools for estimating project GHG emissions. The most commonly-used quantification tool, CalEEMOD, uses the ABEI accounting methods described in this paper. CalEEMOD does not include any methods for estimating embedded emissions in goods and services, or downstream transportation emissions, for interstate or international transport of goods to market. CalEEMOD is universally recommended by California regional air districts and by CAPCOA, the professional organization of California Air Pollution Control Officers, for use in CEQA evaluations. The regional air districts and CAPCOA are recognized experts in air quality and GHG emissions, and thus their recommendations constitute substantial evidence under CEQA that lead agencies are allowed to rely on.

There have been a few CEQA analyses for projects that have included estimates of emissions associated with certain construction materials, such as concrete. While it is feasible to estimate upstream emissions associated with cement manufacturing (provided reasonable and non-speculative assumptions can be made about cement source, and production emissions data is available), the emissions associated with cement manufacturing by non-project entities are accounted for in project inventories for the cement plant, and by the jurisdiction containing the cement plant. Thus, inclusion of such emissions would result in double-counting of emissions. Furthermore, in the case of cement, manufacturing is directly regulated by the state, both as a point source and under the California cap and trade regulation, and thus such emissions can be presumed to be controlled sufficiently through state regulation to meet the state's legislated GHG reduction goals. While one could include cement manufacturing emissions associated with project concrete use, the addition of such emissions would not add any information necessary to make conclusions about the significance of project emissions compared to statewide reduction goals. Similar conclusions could be made about steel and other materials from other jurisdictions–they are either accounted for in other project or jurisdictional inventories, or are outside the state (or country) and thus beyond the purview of state inventory practice.

A further challenge to including consumption-based emissions for construction materials and consumer goods and services is that they may have elongated supply chains, and the data necessary to accurately quantify embedded emissions may not be readily available, due to business practices concerning proprietary data, or due to the fact that other jurisdictions (particularly outside California or outside the United States and Europe) may not track GHG emissions in sufficient detail. CEQA admonishes lead agencies to avoid speculation in completing their analyses and making conclusions. Furthermore, CEQA does not require a lead agency to complete every study possible, but rather to fully disclose impacts based on reasonably available data. Developing project-specific estimates of embedded GHG emissions for all construction materials, or future consumed goods and services that are related to complex supply chains, would require extensive research and may not be able to accurately identify GHG emissions for many consumed items without substantial uncertainty.

The state has addressed lifecycle emissions in the Final Statement of Reasons (FSR) prepared for the amendment to Appendix F of the CEQA Guidelines pursuant to SB 97, which is the state law that established the requirement that GHG emissions must be assessed under CEQA:

> *The amendments to Appendix F remove the term —lifecycle. No existing regulatory definition of —lifecycle exists. In fact, comments received during OPR's public workshop process indicate a wide variety of interpretations of that term. (Letter from Terry Rivasplata et al. to OPR, February 2, 2009, at pp. 5, 12 and Attachment; Letter from Center for Biological Diversity et al. to OPR, February 2, 2009, at pp. 17.) Thus, retention of the term —lifecycle in Appendix F could create confusion among lead agencies regarding what Appendix F requires. Moreover, even if a standard definition of the term —lifecycle existed, requiring such an analysis may not be consistent with CEQA. As a general matter, the term could refer to emissions beyond those that could be considered —indirect effects of a project as that term is defined in section 15358 of the State CEQA Guidelines. Depending on the circumstances of a particular project, an example of such emissions could be those resulting from the manufacture of building materials. (CAPCOA White Paper, pp. 50-51.) CEQA only requires analysis of impacts that are directly or indirectly attributable to the project under consideration. (State CEQA Guidelines, § 15064(d).) In some instances, materials may be manufactured for many different projects as a result of general market demand, regardless of whether one particular project proceeds. Thus, such emissions*

> *may not be caused by the project under consideration. Similarly, in this scenario, a lead agency may not be able to require mitigation for emissions that result from the manufacturing process. Mitigation can only be required for emissions that are actually caused by the project. (State CEQA Guidelines, § 15126.4(a)(4).)*

While the FSR does not preclude the possibility of including some lifecycle emissions in CEQA analyses, it highlights the problematic nature of such emissions in terms of attributing them directly to a project. The Natural Resources Agency also explicitly chose to exclude the term "lifecycle" from its requirements, indicating that it did not think such emissions are necessarily mandatory for project-level assessment.

In California, CEQA is sometimes used by advocates to exert legal pressure to obtain policy outcomes which the advocates have been unsuccessful to achieve by other means. As such, one can expect that disputes over GHG inventory methods may become another in a long line of potential legal challenge arguments used in CEQA appeals. In fact, there have already been two lower court cases[23] in California addressing certain GHG inventory methodological questions:

- *TRANSDEF vs. California ARB (Sacramento County Superior Court).* This challenge concerned the ARB 2014 Scoping Plan Update and the inclusion of the California High-Speed Rail project as a GHG reduction measure. The petitioner argued that the CEQA document for the 2014 Scoping Plan Update was inadequate because the ARB had not considered the lifecycle emissions associated with construction materials (in particular, cement), and did not properly consider that the high-speed rail project would offset only its construction GHG emissions at some point in the future after 2020. Among other findings, the court ruled that the petitioner did not demonstrate how the issues it raised would result in a significant impact under CEQA, and thus the ARB's CEQA documentation was adequate. As this is a lower court ruling, it has no bearing on CEQA case law.
- *California Riverwatch vs. County of Sonoma, et. al. (Sonoma County Superior Court).* This case concerned an EIR for a Climate Action Plan which was challenged in part because the petitioner believed that the GHG inventory should have included all upstream emissions for tourists visiting the jurisdiction, including airplane emissions, and all downstream emissions for transportation of products produced in the jurisdiction (particularly wine) to other places in the world. The Petitioner did not cite any evidence or examples to support that these remote emissions could be reasonably estimated by the County; they merely asserted that they should be included. The lead agency objected to the petitioner's argument for many of the reasons discussed in this white paper. It argued that to include such lifecycle emissions would depart from the professional practice used by all other jurisdictions in the state and the state itself; would result in an inventory that cannot be compared to other inventories; would require the estimation of distant and remote emissions for which sufficient data may not be available; and would include remote upstream and downstream emissions that are not under the County's control. The Petitioner's requests for upstream tourist air travel would require acquisition of currently non-existent data on the travel methods and destinations of all Sonoma tourists throughout their entire trip, in order to accurately apportion airplane emissions for trips that

[23] Superior Court rulings are not considered legal precedent in California jurisprudence. Only higher court rulings (Appellate Court and Supreme Court) can be cited as legal precedent. Superior court rulings only apply to the individual case in question.

> included Sonoma County as only one part of a broader itinerary (which is normal); not to mention the complexity that would be involved in assigning emissions to different jurisdictions within Sonoma County. The Petitioner's request to account for the entire downstream transportation lifecycle emissions of wine or other products produced in Sonoma would also require currently non-existent data on the exact worldwide final destination of every bottle of wine, and the precise transportation emissions to the final consumer, including for foreign locations such as China. Furthermore, the County does not (and cannot) control interstate and international travel and transportation, which are matters of interstate commerce under federal jurisdiction and international commerce under the shared jurisdiction of the U.S. and foreign countries. Despite these objections, the court asserted that it was feasible to estimate the emissions, and that the lead agency should have done so. It is the opinion of the lead author of this white paper that the court's ruling is highly flawed, in that the court is asking the lead agency to engage in speculation, to account for emissions over which the lead agency has no control, and to create an inventory that cannot be compared to other inventories or to a threshold related to the state's inventory. The lead agency is presently considering whether or not it will appeal the decision. This second lower court ruling is also not legal precedent and thus does not bear on governing case law under CEQA.

It is important to continue the practice of CEQA GHG accounting focused on the emissions that are most readily estimated (without speculation), that are under the influence or control of the lead agency, and that are consistent with statewide methods of GHG accounting. CEQA is intended to disclose the GHG emissions associated with a project and, if significant, to require feasible mitigation to reduce those emissions. CEQA lead agencies can only legally mitigate emissions over which they have influence or control. That influence or control does not extend to the upstream embedded emissions for consumer goods, such as exploration and mining of raw resources, manufacturing of goods, and transportation of them to market, in particular when such materials are produced outside of the jurisdiction, California, or the U.S. Cities and counties do not control the downstream transportation of good produced within their jurisdictions to other locations in California, other states, or other countries. They cannot specify the transportation method or transportation vehicles or markets served outside California or the U.S., because to do so would be regulating interstate or international commerce, which is the sole purview of the federal government (and foreign countries).

It is conceivable that consumption-based GHG inventories could become a requirement for CEQA project analysis (or jurisdictional CAPs intending to provide CEQA tiering) in the future, if—and only if—the following five conditions have been satisfied: 1) the state completes a consumption inventory and forecasts for California with transparent methods and data (such that they can be applied by others); 2) the California legislature adopts a GHG reduction target based on a statewide consumption inventory; 3) the state adopts a plan (like the AB 32 Scoping Plan, or the 2030 Scoping Plan) for the reduction of consumption-based GHG emissions; 4) there is a legally-defendable consensus on methods and sufficient reasonably available public data to support the development of project CBEIs and data; and 5) a methodology is developed that can identify suitable thresholds related to statewide consumption emissions targets that are appropriate for a diversity of cities and counties across the state.[24] This

[24] Given that there is limited local control of embedded emissions in locally consumed goods unless they are produced locally, it will be challenging to define local consumption-based emissions targets. This will be complicated by the diversity of production activities in different cities and counties across the state.

framework exists today for PBEIs and CBEIs. It is not reasonable nor feasible for an individual CEQA lead agency to complete such a framework and thus is not reasonably available information for CEQA evaluations today.

While it is recommended that CEQA practice continue the current ABEI GHG accounting described above, developing estimates of consumption-based emissions or certain aspects of consumption-based accounting could be a useful informational tool for CEQA lead agencies and for public education. A CEQA lead agency may want to estimate certain embedded GHG emissions, such as concrete; and while there is nothing to prevent such an analysis and disclosure at the lead agencies discretion, it is the position of this paper that such an analysis should be optional rather than mandatory. If embedded emissions are estimated, it is recommended that the analysis fully disclose all assumptions and uncertainty associated with the estimates. This is particularly important if a CEQA lead agency chooses to analyze consumption emissions of consumer goods and services that may include long supply chains, for which data may be incomplete or unavailable. The use of national or international averages for goods and services from lifecycle research should be disclosed, as they may (or may not) reflect emissions for specific local project consumption emissions. If upstream or downstream lifecycle emissions outside of the routine ABEI are estimated, it is recommended that they not be combined with the standard inventory emissions, and be disclosed separately.

There are no CEQA appellate rulings to date concerning which GHG emissions should or should not be included in a CEQA GHG inventory. There are no CEQA appellate rulings concerning consumption-based inventories or lifecycle accounting to date. As such, there are no legally binding precedents concerning these issues. Hence, CEQA lead agencies are advised to seek advice from their legal counsel should they be faced with legal challenges on related matters.

6. Implications for Climate Action Plans

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Climate action plans are designed to serve several purposes. First and foremost, they are intended to identify community emissions and the means to reduce GHG emissions that are the most appropriate, effective, and feasible for an individual community. Additionally, they provide a basis for CEQA streamlining for new development planned for the community. This is accomplished by developing a qualified GHG reduction strategy or CAP with an emission inventory of both existing sources and new development projects planned and by implementing strategies applicable to existing and new development to reduce emissions to a target level by a future year or years. Projects consistent with the CAP can then qualify for CEQA streamlining provisions. Another purpose is to increase community awareness of climate change and to promote individual actions to reduce their greenhouse gas footprints. The potential use of CBEIs for CAPs is evaluated in light of these purposes.

CBEIs are emerging as an additional tool in our climate action planning and sustainability toolboxes. However, CBEIs should not serve as a replacement for production-based or activity-based inventories in California. We recommend use of CBEIs as a supplemental and complementary resource to ABEI community GHG inventories, primarily to serve as informational and educational resources for local elected officials, climate action planners, and consumers.

We recommend that CBEIs are separated from ABEI community GHG inventories in order to maintain the affective use of both inventory types within a CAP and that the intended use of the CBEI and ABEI are clearly explained. An effective way of maintaining this separation is to show the CBEI and ABEI inventories within separate tables preceded or followed by text explaining the purpose of each inventory and why both are shown within a climate action plan. This approach does not diminish the information provided by a CBEI. One example is how the City of Santa Monica used a focused life cycle analysis of plastic grocery bags as evidence supporting the City's Single Use Bag Ordinance.[25] This use of a CBEI was effective because of the focused approach and was kept separate from the City's ABEI based CAP emissions inventories.

In California, local climate action plans must demonstrate consistency with the state's 2020 and 2030 GHG reduction targets, established in AB 32 (2006) and SB 32 (2016), both of which are tied to production-based state GHG emissions inventories for 1990, 2020, and 2030. Local CAPs should continue to include GHG reduction targets related to state goals and targets. Keeping the CBEI within a CAP separate from the ABEI is particularly important to maintain the ability of the jurisdiction to be able to track progress toward an AB32 and SB 32 compliant reduction target and meet the qualifications found in CEQA Guidelines §15183.5.

Local governments rely on community GHG inventories to identify sources and estimates of GHGs, primarily to inform policy development and target setting. Upstream emissions or embodied emissions

[25] City of Santa Monica, Office of Sustainability and Environment (January 2011). Single-Use Carryout Bag Ordinance.

of materials are interesting and informative at the individual, household, or corporate level, but less likely to be useful in setting local policy to reduce community GHG emissions. State and federal governments have traditionally regulated product and material standards. Corporations and public agencies have direct control over purchasing of goods and services, and can implement sustainably- or environmentally-preferable purchasing practices and other measures to reduce consumption-based emissions in the supply chain of their products and services. Local government have generally not been inclined to adopt local regulations that restrict private purchasing related to their carbon footprint or embodied emissions of product supply chains (product materials and content). There are examples of local government sustainability policies that can have the co-benefit of reducing upstream or downstream emissions, such as prohibitions on the use of single-use plastic bags and Styrofoam. However, these are often motivated by or connected to other environmental impacts, such as water pollution and harm to wildlife. CBEIs and lifecycle analysis are very useful as an educational tool and inform business, household, or individual purchasing and consumption decisions without the need for local government regulatory intervention.

Community climate action plans that aim to be “Qualified GHG Reduction Strategies” consistent with CEQA Guidelines must include a set of quantified reduction measures that achieve local reduction targets consistent with state reduction targets. CAPs can include secondary goals and accounting for consumption or lifecycle emissions, but they are not mandatory to achieve qualified status, and they should not be substitutes for primary reduction goals tied to state targets. Community climate action plans must be transparent in providing a measurable path toward reduction of GHGs from all sectors and sources in their direct control. Local GHG reduction strategies that are not in direct control of a local agency, or are not measurable, can be included as informational or supportive items but should not serve as a replacement for quantified measures that provide a clear path to a reduction target tied to a production-based or activity-based inventory.

Emissions from the supply chain upstream and downstream are accounted for in other project and jurisdictional production-side accounting, which can create a risk of double-counting. The current protocol for accounting and reporting of community GHG emissions is derived from protocols for national and global accounting of all production-based emissions. Methods and measurement tools for consumption-based emissions are still under development, as are methods for analyzing changes in local consumption patterns. Due to the early and evolving use of CBEI, and the limited role of local governments to directly control consumption-based emissions, strategies to reduce consumption-based emissions are currently more aspirational than actionable and measurable.

The Urban Sustainability Directors Network (USDN) prepared a Sustainable Consumption Toolkit (http://sustainableconsumption.usdn.org) based on its findings that consumption is a key driver of climate change, pollution, and resource depletion. The toolkit supports an advancement of sustainable consumption, providing information and resources. The USDN Sustainable Consumption Toolkit identifies the following potential roles of local governments in addressing CBEIs in climate action plans:

- **Promote.** Make the connection in the relationship between sustainable consumption and climate change.
- **Fund.** Provide grants and other financial support.
- **Educate and reach out.** Provide resources and information that helps the public mitigate carbon emissions based on materials and activities that have the highest impacts.

- **Develop programs and services.** Incubate climate action programs in partnership with other organizations based on sustainable consumption assessments.
- **Demonstrate or lead by example.** Municipal agencies can implement internal climate action strategies, such as institutional purchasing policies, that reflect the consumption-based carbon emissions analysis.

Use of CBEI is emerging in many cities, however there are currently no established best practices for how to address consumption-based emissions in local climate action plans. Tracking consumption-based strategies can be difficult and time consuming for local government staff. More case studies and research are needed to confirm the most effective local actions to reduce consumption. In the meantime, consumption-based inventories can provide helpful information for consumers and provide an expanded lens to assess GHG emissions.