Appendix A:
Additions and Amendments to Product-Based Benchmarks in the Cap-and-Trade Regulation

Greenhouse Gas Benchmarks

Greenhouse gas (GHG) benchmarks are metrics that enable the comparison of GHG performance across similar industrial facilities. As described in staff's Initial Statement of Reasons (ISOR) for the Cap-and-Trade Regulation, GHG emissions intensity benchmarks are a key part of the calculation methodology to determine the annual number of free allowances allocated to each eligible industrial facility in the Cap-and-Trade Program.[1] There are two methods of benchmarking: 1) product-based benchmarking (PBB) and 2) energy-based benchmarking (EBB). A product-based benchmark is a function of the quantity of GHGs released per unit of industrial product output. A generic form of a product benchmark is shown in Equation 1.

Equation 1. Example Product Benchmark Formula

$$GHG\ Benchmark = \frac{Emissions\ (tonnes\ CO_2e)}{Output\ (tons)}$$

In the energy-based approach, the benchmark is a function of how many GHGs are emitted to produce the energy that is used at a facility. A generic form of an energy-based benchmark is shown in Equation 2. An energy-based benchmark is based on: 1) boiler efficiency which is set at 85 percent, and 2) fuel choice, set at natural gas.

Equation 2. Example Energy-Use Benchmark Formula

$$GHG\ Benchmark = \frac{Emissions\ (tonnes\ CO_2e)}{Energy\ Used\ (MMBtu)}$$

A distinct difference between PBB and EBB is that PBB is updating while EBB is fixed. That is, the amount of free allocation for PBB is updated annually based on the recent production level, whereas it remains constant for EBB at a historical baseline level. This is the primary reason why PBB is ARB's preferred approach in order to minimize leakage in accordance with AB 32. Resolution 11-32 directs staff to continue working with stakeholders to include more sectors in the PBB methodology. As part of this effort, ARB contracted with Ecofys, the University of California at Berkeley, and Northwestern

[1] See ISOR, Appendix J: http://www.arb.ca.gov/regact/2010/capandtrade10/capv4appj.pdf

University to acquire adequate engineering knowledge to develop benchmarks for the sectors that have complex processes such as refineries and food/beverage processing.

General Benchmarking Process

Staff worked with both the sectors currently subject to the EBB and the sectors identified to be newly entering the program to assess the feasibility of developing PBBs. The assessment included 3 steps: 1) acquire a sound technical understanding of manufacturing process, 2) evaluate the potential number of product units to benchmark, and 3) consult with the covered facilities/stakeholders to determine if sufficient data would be available to construct robust benchmarks.

Throughout the process, staff applied the principles outlined below to ensure that new benchmarks would be developed in a manner consistent with the existing benchmarks. These are:

1. One product, one benchmark
    - Product unit definition is not differentiated by technology, fuel mix, size, age, climatic circumstances, or raw material quality.
    - When a set of products undergoes a similar set of processing steps but may be refined to different levels, use equivalence factors to normalize the target content of the product.[2]
2. Use data years that are representative of normal operation years
    - The benchmark should be set using data years with normal operational conditions so that the value is not affected by factors irrelevant to the operational efficiency. Therefore, years with any abnormal events should be excluded from the calculation. Examples of abnormal events are maintenance, temporary shutdown, or change in the operation due to the external factors uncontrollable by the operator.
    - Unless any abnormal events are identified, data years 2008–2010 should be used because 1) ARB has Mandatory Reporting Regulation (MRR) data to ensure the rigorousness of the data quality (2009 and 10 data are verified), and 2) it levels the playing field with the sectors with existing benchmarks for which 2008–2010 data were used primarily. Since efficiency tends to improve over time, using the same years across the board ensures that the efficiency improvements are taken into account in a fair and equitable manner.

[2] An example of this includes tomato paste: whereas the targeted content is tomato solids, different products can contain different level of moisture.

Modification to the Existing Benchmarks

Staff reviewed the existing benchmarks to ensure that they were developed using the best approach and most appropriate data. Several sectors submitted comments to ARB requesting benchmark review: oil and gas extraction, tissue production, boxboard manufacturing, flat glass, container glass, and cold steel rolling.

As part of the review process, staff worked with stakeholders to 1) recalculate the existing benchmarks to ensure all the supporting data were correct and calculated appropriately, 2) collect more extensive/detailed data to perform further analysis if necessary, and to 3) identify any abnormal events that skewed the benchmark making it non-representative of normal operation years. Below is sector-by-sector description of the issues and proposed changes.

Staff proposes to establish new as well as update existing product-based benchmarks for the sectors outlined below in the “Sector-by-Sector Benchmark Product Proposal” section. In most cases where data from five or more facilities were used to calculate a product-based benchmark, staff included a chart plotting the emissions efficiency per unit product for each facility. Facility names were not included to protect confidential business information. This chart was not produced where data from fewer than five facilities were used to calculate a product-based benchmark, as this could reveal confidential business information.

Sector-by-Sector Benchmark Product Proposal

Crude Petroleum and Natural Gas Extraction (NAICS 211111) and Natural Gas Liquid Extraction (NAICS 211112)

For the upstream oil and gas extraction sector (NAICS codes 211111 and 211112), staff proposed revisions to the existing product-benchmarks for thermal enhanced oil recovery (EOR) crude extraction, non-thermal crude extraction, and natural gas liquid extraction. In addition, staff also proposed a new benchmark for onshore natural gas processing plants that process greater than 25 million standard cubic feet of natural gas per day (MMscf/day). Staff proposes to define the product unit for large gas processing plants as the barrel of gas processed equivalent.

Staff initiated a voluntary data collection survey in order to reassess the benchmarks for the upstream oil and gas extraction sector. This survey was distributed in late 2012 to all covered facilities emitting over 25,000 metric tons CO_2e that extract and process oil and gas, including dry gas and natural gas liquids. All covered facilities in California responded to the survey request; therefore, all covered entities are represented in the proposed benchmarks for this sector.

The existing benchmark for non-thermal crude extraction included production and emissions from both small (<25 MMscf/day) and large (>25 MMscf/day) gas processing plants. Under the proposed benchmarks, the emissions and production for small gas plants are still included in the non-thermal benchmark as they are considered the same facility as the onshore production facility by definition under MRR. The emissions from the large gas plants are now included in the new benchmark for onshore natural gas processing plants, as they are considered separate facilities under MRR. The rationale to keep the large gas plants as separate facilities derives from stakeholders' requests to maintain consistency between MRR and the U.S. Environmental Protection Agency's GHG Mandatory Reporting Program. The total allocation for the sector remains the same whether there is a gas processing benchmark or whether the emissions from the large gas plants are included in the non-thermal benchmark.

Under the proposed benchmarks, small gas processing plants would receive an allocation using the proposed non-thermal production benchmark. Large gas processing plants would receive an allocation for their gas processed using the proposed natural gas processing benchmark; allocation for oil and gas production would be based on the proposed non-thermal production benchmark. As a result of the new data received as part of the voluntary data collection survey, all three existing benchmarks for thermal, non-thermal, and natural gas production went down slightly.

Diatomaceous Earth Mining and Processing (NAICS 212399 All Other Nonmetallic Mineral Mining)

Diatomite is a chalk-like, soft, friable, earthy, very fine-grained, siliceous sedimentary rock comprised of fossilized diatom remains. Diatomite deposits form from an accumulation of amorphous hydrous silica cell walls of dead diatoms in both oceanic and fresh waters. These microscopic single-cell aquatic plants (algae) contain an internal, elaborate siliceous skeleton consisting of two frustules (valves) that vary in size from less than 1 micrometer (μm) to more than 1 millimeter in diameter but are typically 10 to 200 μm in diameter. The frustules have a broad variety of delicate, lacy, perforated shapes, including cylinders, discs, feathers, ladders, needles, and spheres (U.S. Geological Survey 2011). Due to the difference in habitat, freshwater diatoms have different characteristics than marine diatoms. After mining, diatom ore is dried, milled, and then calcined to make different products.

There are two diatomite miner/processors subject to the Cap-and-Trade Program and there is one processor of freshwater diatomaceous earth. Staff collected data for freshwater diatom filter aids and proposes to define the product unit as the short ton of freshwater diatomite filter aids.

Food and Beverage Sector (NAICS 311421, 311615, 311423, 31151, 311911, 31191, 311313, 312120, and 312130)

The Cap-and-Trade Program covers the following food processing sectors: tomato processing, poultry processing, dehydrated flavor processing, dairy processing, pistachio and almond processing, snack food manufacturing, and sugar beet refining. It also covers beer, distilled spirits, juice, and color concentrate and food extracts manufacturing in the beverage sector.

Engagement of External Expertise

Food and beverage processing are complex systems to benchmark because one type of input can go through series of process steps to end up in a variety of products. Facilities commonly produce several different products by utilizing complex processing that incorporates the exchange of mass and heat among processing lines. It requires detailed engineering understanding of the manufacturing process to develop robust benchmarks.

ARB contracted with Ecofys, U.C. Berkeley, and Northwestern University to provide additional expertise. The ongoing work under this contract has involved working with stakeholders and covered facilities to develop technically sound benchmarks for the food and beverage sectors. The process descriptions and resulting product definitions described below rely on work done by the Ecofys, U.C. Berkeley, and Northwestern team.

General Approach

As described earlier, staff followed three main steps to develop product-based benchmarks for all sectors, including the food and beverage sectors. Each step included a substantial amount of work to overcome the challenges associated with the complex manufacturing processes unique to the food and beverage sector, including the following:

- Facilities often manufacture many different food and beverage products using a number of energy-intensive processes,
- Fuel is often combusted in a central boiler and process heat is moved around the facility as steam for use in plant manufacturing processes,
- Many facilities lack the sub-metering necessary to easily quantify how much energy from the central boiler should be assigned to different products, and
- It is common for various final products to have shared upstream thermal processing.

1) Acquire Sound Technical Understanding of Manufacturing Processes

As an initial step, the Ecofys, U.C. Berkeley, and Northwestern team conducted an extensive literature review, including academic research, legislation, and industry publications. The research team also visited eight covered food processing facilities to ensure that the research was based on the actual processing configurations of the plants subject to the Cap-and-Trade Program. On- and off-site interviews were conducted with plant managers and operators to learn about the processes, equipment, and energy involved in making specific food products.

Staff found that PBB development becomes more difficult with increasing process heterogeneity and decreasing process monitoring, especially considering the sub-metering of energy use at each process level. Staff also found that the level of process heterogeneity varied for different food processors, and the quality of process monitoring varied at an individual facility level.

2) Evaluate Potential Number of Product Units to Benchmark

Based on the information collected through step 1, the research team characterized six typical process configuration types commonly used in the food and beverage sector. This characterization became the basis for determining the methodology to allocate facility-wide energy consumption to each product and to determine which products should be given separate benchmarks and which products should be grouped. The description of each process configuration is outlined below.

a) Linear Process Lines

A linear process is a single process line with a single product output. This is the most straightforward processing configuration. Although the inputs to the process may go through multiple process steps, the energy intensity of an output can be derived by dividing total energy input by the amount of output since there is only one product output.

b) Mixing Process Lines

A mixing process line is very similar to a linear process line. However, a mixing process line has multiple raw material inputs which are processed separately before being mixed to produce a single final product. Since only one product is manufactured, the energy intensity can be calculated by dividing total energy by the amount of output. It is critical to include the energy from all the mixing lines as part of the total energy.

c) Parallel Process Lines

Parallel process lines are independent linear processing lines that run parallel. The product output of parallel process lines may be the same or different. Determining the energy intensity for a parallel configuration is straightforward if the thermal use for each line is quantified separately. When no energy sub-metering for each linear process is available, an engineering estimate of the distribution of energy between the lines has to be applied.

d) Branching Process Lines

A branching process line yields several final products from a single raw material stream. Products manufactured in a branching process may undergo thermal processing before and after process stream splits. Common processes may be shared by multiple products at any point in the processing. The difficulty arises when a common process does not have the capability to split the energy consumed by each end product. For example, pasteurization can be used by both cream and butter or evaporation by powdered and condensed milk. It becomes essential to combine energy meter readings available at a plant or unit level with estimated theoretical energy requirements for different products to calculate total energy consumption by each product.

e) Formulated Process Lines

Formulated process lines yield multiple products from multiple processed or raw materials. The key step that distinguishes a formulated process line is the combination of these materials into different products at different ratios, each of which may undergo additional processing. This type of facility is challenging because the different formulations of the product may contain ingredients with very different energy intensities. There can also be hundreds of different products with different percentages of different ingredients. Instead of trying to create individual benchmarks for each formulation, benchmarks can be set for each ingredient. For example, instead of a benchmark for a recipe of 20 percent diced tomatoes and 80 percent tomato paste, benchmarks can be set for diced tomatoes and tomato paste. This allows staff to develop benchmarks for a small number of inputs that can be applied to a wide range of reformulated products.

f) Hybrid Process Lines

Hybrid processing includes a combination of the previously discussed configurations. Product definitions can be developed using the approaches for the individual types of lines.

Additional Considerations

For some products in the food processing sector, the same product may be refined to different concentrations. Other products may undergo a concentration or shearing process that results in the loss of mass. These situations presented complications in determining product definitions because concentration or shearing processes lead to a loss of product mass, and higher levels of thermal concentration require increased thermal input. Staff proposes to apply equivalency factors to normalize the difference in emissions intensity among similar products undergoing concentration or mass loss steps. An example is tomato paste. Instead of differentiating aseptic tomato paste that has different solid content, staff proposes to normalize all tomato paste to 31 percent tomato soluble solids for all aseptic tomato paste. This allows equitable energy efficiency comparison among different paste with different solid content while maintaining one-product, one-benchmark principle. This approach allows for different concentrations of products to be expressed in terms of an equivalent output in one product definition. This is a reasonable approach to avoid the situation where benchmarks need to be developed for each individual concentration of a given product.

3) Consult with the Covered Facilities and Stakeholders for Data Collection to Construct Product-Based Benchmarks

Once products were defined, staff worked with covered facilities and/or trade associations that represent covered sectors to start collecting production and energy consumption data from facilities. The new and modified products and product benchmarks are shown in single and double underline/strikeout in the Cap-and-Trade Regulation 15-day amendments released in March 2014.

Tomato Processing (NAICS 311421)

The largest sector of the food industry by emissions and facilities covered in the Cap-and-Trade Program is the tomato processing sector. In developing benchmarks for this sector, products were separated into two major categories: aseptic and non-aseptic. Aseptic products are sterilized during the process and packaged into pre-sterilized containers. These are bulk products and have a long shelf life. Aseptic products are mostly sold to facilities that reprocess the paste into consumer products. Non-aseptic products, as the name implies, are not packaged aseptically. These products are mostly sold directly to consumers. Thus, these product types were split because of the different process, energy-intensity, and final use of these products.

There are hundreds of different consumer products that include tomatoes from pasta sauce to salsa. These products have a wide range in the percent of tomato product that is used. To be able to compare these formulated products, staff developed three non-aseptic products: tomato paste and puree, whole and diced tomatoes, and tomato juice. No other ingredients, such as other fruits, vegetables, or spices, were included in these products. Thus, the energy to heat and add these other non-tomato ingredients is considered to be embedded into the product categories.

In Figure 1, the facility emissions intensity plot is shown for aseptic tomato paste. In this plot, each facility's aseptic paste emissions intensity is plotted from most efficient on left to most energy intensive on right. The horizontal, dashed line shows the calculated 90 percent of the average emissions intensity of aseptic tomato paste. Because that value is more stringent than the most efficient facility's emissions intensity, the benchmark was set at the best-in-class emissions intensity.

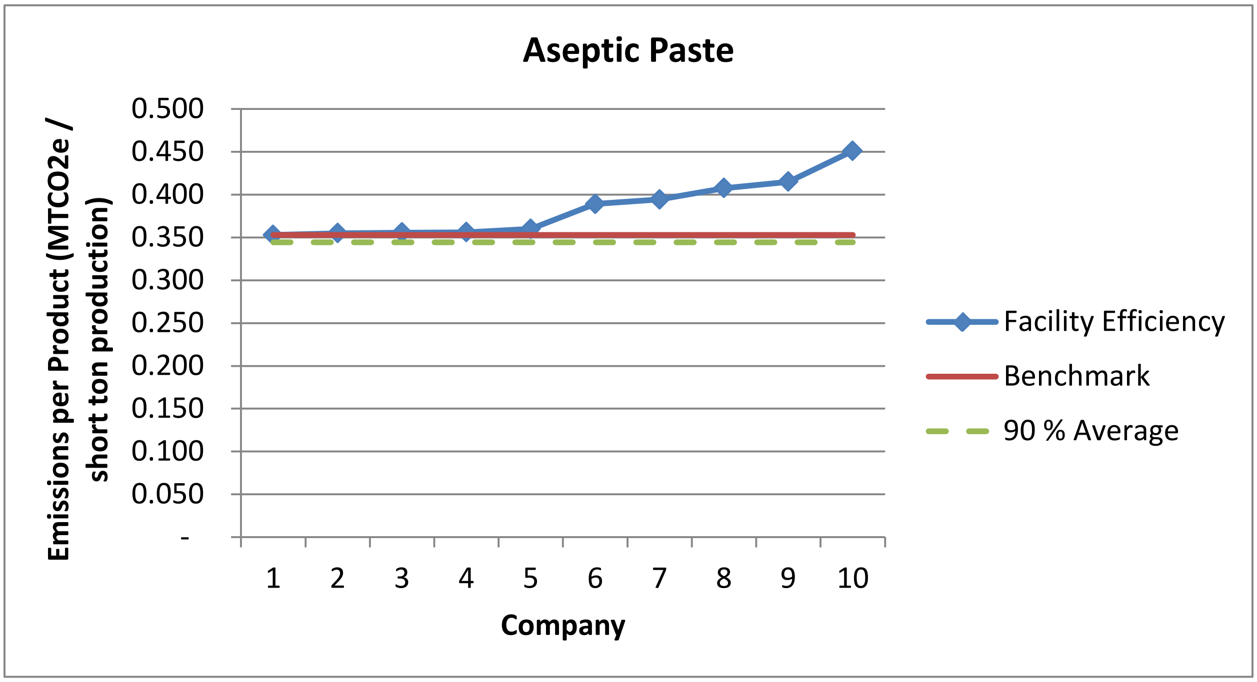

Figure 1: Aseptic Tomato Paste facility emissions intensity and benchmark.

Poultry (NAICS 311615)

The poultry sector includes one facility covered in the Cap-and-Trade Program. Three production activities are performed at this facility: whole chicken and chicken parts, poultry deli product, and protein meal and fat. Whole chicken and chicken parts and poultry deli product production utilize a branching process line with live poultry as the input. Protein meal and fat production use a mixed process line taking the waste products of the other two products.

Dehydrated Flavors (NAICS 311423)

The dehydrated flavors sector has two facilities covered in the Cap-and-Trade Program. The production of dehydrated products uses a linear process line. Thus, there is a benchmark for each product. There are five different dehydrated products in this sector: garlic, onion, chili pepper, spinach, and parsley. The main source of energy to produce these products is the evaporation of water. Since each of these raw products has a different amount of water, the amount of energy varies between the products.

Dairy Manufacturing (NAICS 31151)

Milk processing facilities are engaged in converting whole milk to fluid milk products (milk, buttermilk, skim milk, or ultrafiltered milk), cream, butter, condensed milk, and powdered milk. Whereas fluid milk products require minimum amount of direct energy for processing, powdered milk consumes a significant amount of energy to remove moisture to achieve the required dryness. Powdered milk can be made from different types of milk, most commonly nonfat dry milk and skimmed milk. Nonfat dry milk and skimmed milk powder are processed at different temperatures: low heat, medium heat, and high heat. Low heat powder is processed at temperatures not exceeding 70 °C for 2 minutes. Its undenatured whey protein nitrogen is over 6 mg/g of powdered milk. The intended uses include fluid milk fortification, cottage cheese, cultured skim milk, starter culture, chocolate dairy drinks, and ice cream. Medium heat powder is preheated to 70–78 °C for 20 minutes, and its undenatured whey protein nitrogen is 1.51–5.9 mg/g of powder. Medium heat powder is suitable for prepared mixes, ice cream, confectionery, and meat products. High heat powder is preheated to 88 °C for 30 minutes and its undenatured whey protein nitrogen is under 1.5 mg/g of powder. Its intended uses include bakery, meat products, ice cream, and prepared mixes (American Dairy Products Institute 2002). Most of the powdered milk manufactured by covered facilities is low heat. However, stakeholders believe that there will be increased demand for medium and high heat powder in the future. Powdered milk is also processed from buttermilk, which is derived from the churning of butter and is pasteurized prior to condensing. Buttermilk powder has a protein content of no less than 30 percent. Since buttermilk is not as concentrated as nonfat dry milk or skimmed milk powder prior to drying, buttermilk powder processing requires more energy compared to nonfat dry milk and skimmed milk powder. Staff also identified that some intermediate powder products are brought in from other dairy processors and reconstituted on-site with heat and water to be mixed with in-house powder feedstock to make final products. Finally, staff identified that some milk permeates are concentrated to become animal feed.

Figure **2** to Figure **5** show the emissions intensity of various milk products plotted from most efficient on left to most energy intensive on right. The horizontal line represents the sector benchmark based on 90 percent of the average emissions intensity of the sector.

Figure 2: Condensed milk facility emissions intensity and benchmark.

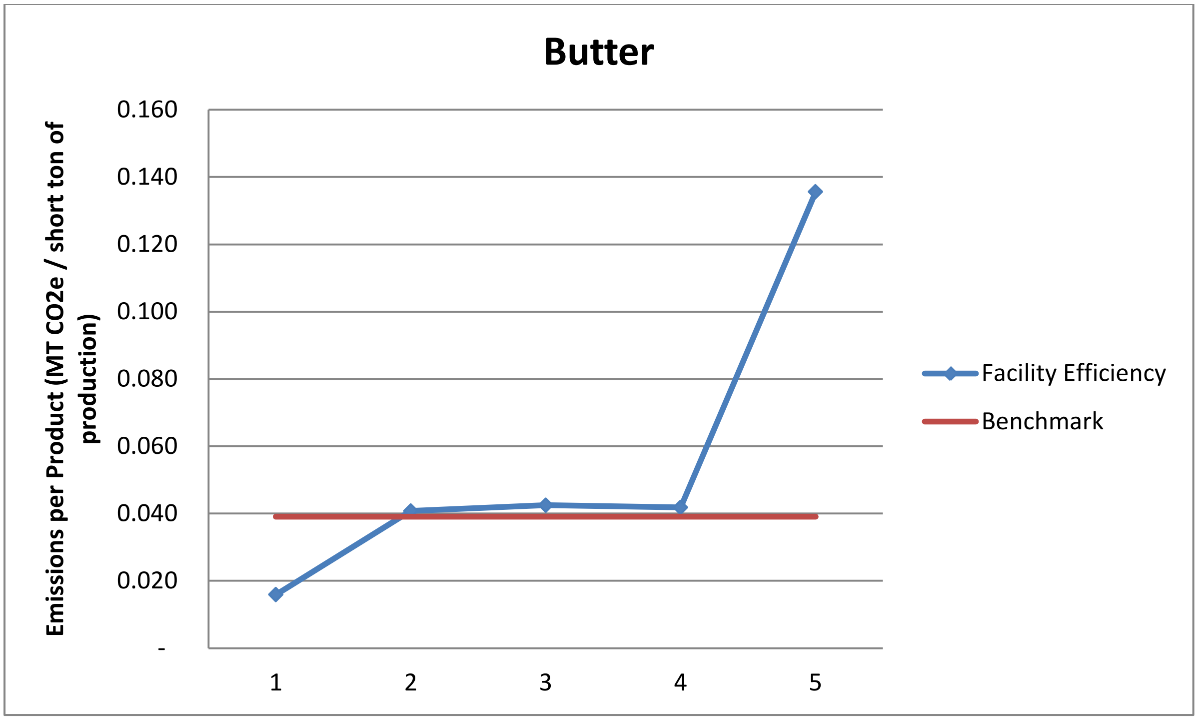

Figure 3: Butter facility emissions intensity and benchmark.

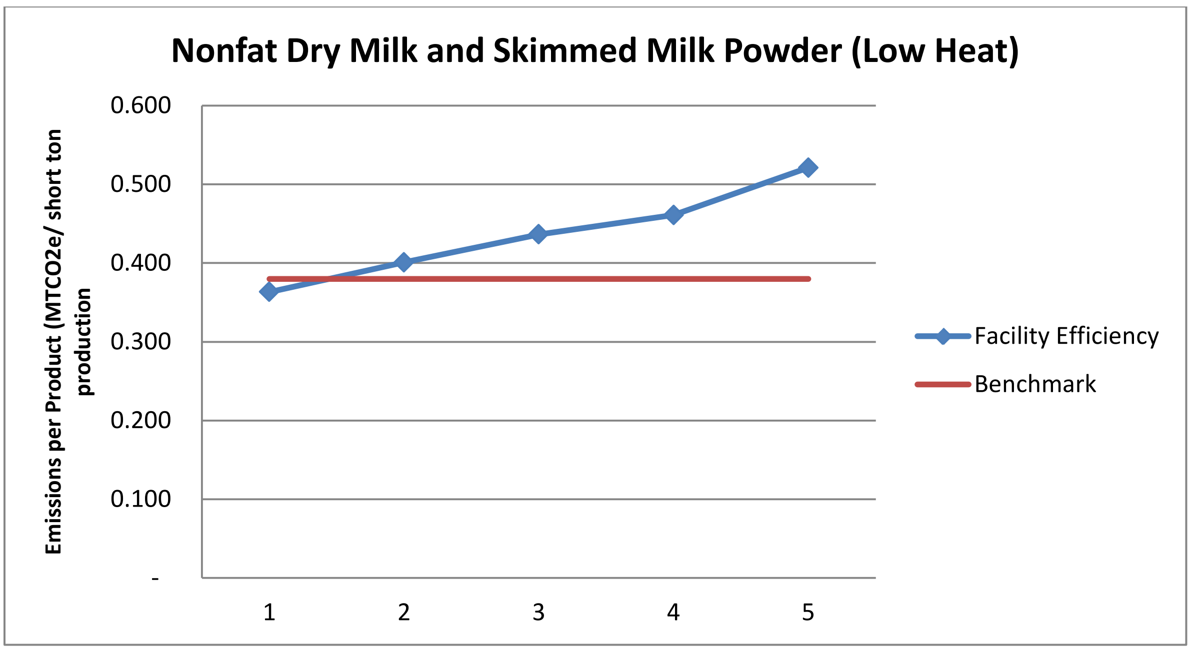

Figure 4: Nonfat Dry Milk and Skimmed Milk Powder (low heat) facility emissions intensity and benchmark.

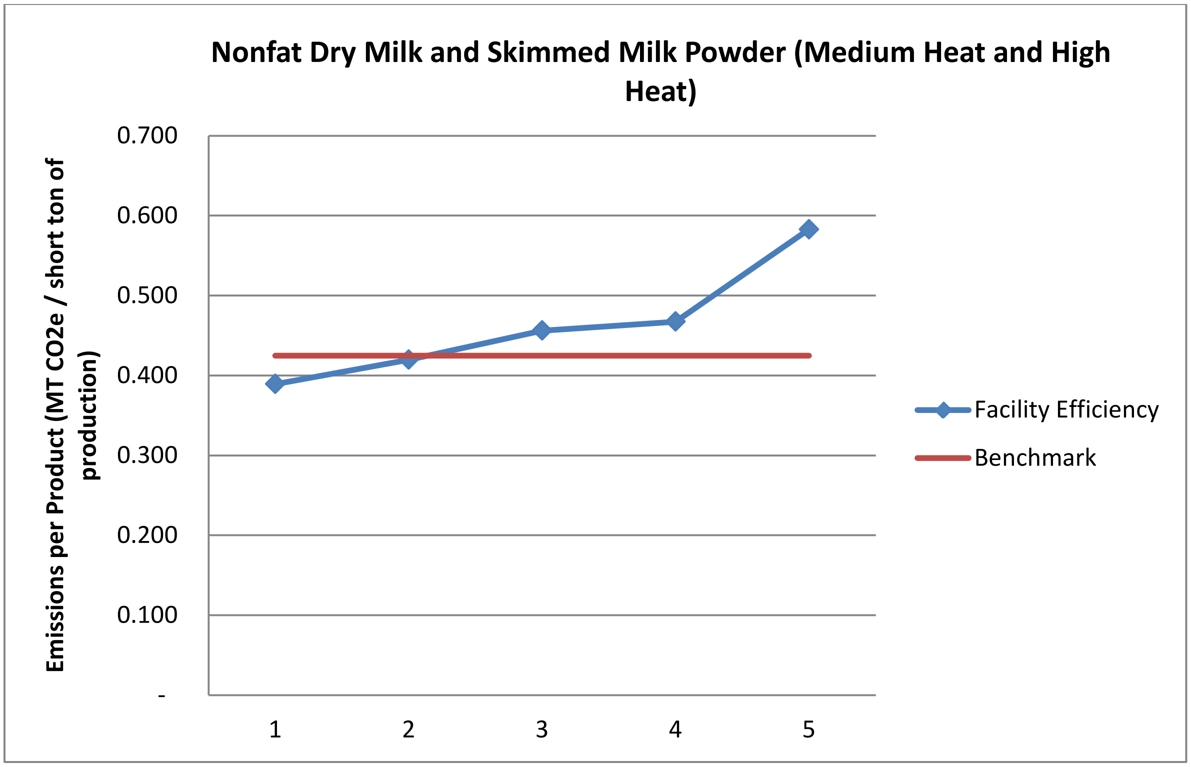

Figure 5: Nonfat Dry Milk and Skimmed Milk Powder (Medium Heat and High Heat) facility emissions intensity and benchmark.

Cheese processing facilities can manufacture cheese and additional products using the whey that remains after cheese production. The whey left over mostly contains water, but also includes small amount of nutrients such as whey protein and lactose. Whey can be filtered to selectively recover ingredients. The protein-rich stream is dried to make whey protein concentrate, and the lactose-rich stream is dried to make lactose or deproteinized whey. Since whey is diluted (contains more than 90% water), it requires a significant amount of energy to process and recover ingredients. As a result, some whey is pre-concentrated and shipped to the facilities that have the capacity to process the whey. Staff identified that the receipt of pre-concentrated whey occurs at some covered dairy-processing facilities. Staff proposes to continue to work with these facilities to determine if the benchmark should take into account the impact of pre-processed whey on emissions intensity.

Five milk-processing facilities and three cheese-processing facilities are covered by the Cap-and-Trade Program.

Roasted Nuts and Peanut Butter (NAICS 311911)

Harvested pistachios are brought to the processing facility, hulled, dried, flavored, and packaged. Pre-processed (hulled and shelled) almonds are also brought to the facility, sorted, and routed either through the pasteurization or to the almond finishing operation where they are blanched, sorted, cut into various sizes, flavored, and packaged. There is one nut-processing facility that is covered in the Cap-and-Trade Program.

Snack Foods (NAICS 31191)

The snacks and chips industry grouping covers the processing of corn-based, potato-based, and baked snack products. Several types of thermal processing are applied in the manufacture of snacks and chips, including frying, cooking, baking and drying. Fried potato chips, baked potato chips, corn chips, corn curls, and pretzels are manufactured at one facility covered by the Cap-and-Trade Program.

Beet Sugar Manufacturing (NAICS 311313)

The beet sugar manufacturing sector includes one facility covered in the Cap-and-Trade Program. The facility produces one major product: granulated-refined sugar. Sugar beet refining makes use of branching and mixing process lines. Other products are produced; however, the energy to produce these products is included in the beet sugar benchmark.

Breweries (NAICS 312120)

The lager beer brewing process begins with malted grain that is delivered to the facilities. The malted grain is milled and transported to a mashing vessel; once heated water is added to the grains, the mixture is considered mash. The mashing process, the temperatures for which are between 45 °C and 70 °C, serves to create a soluble fermentable liquid known as wort. Wort is boiled in a boiling kettle in the most fuel-intensive stage of the brewing process. After wort is boiled for approximately 1.5 hours, hops are added. Once the boil is complete, the hot trub (hop particles) must be removed from the wort through the use of a whirlpool. After fermentation, the beer goes through the finishing process and packaged. There are three breweries covered in the Cap-and-Trade Program.

Wineries (NAICS 312130)

The wineries sector includes one facility covered in the Cap-and-Trade Program. The general manufacturing is a branching process line with fresh grapes as the input. Specific products may utilize a mixing or hybrid approach as different product lines may be blended to obtain the desired output. With many products being manufactured, five benchmarks were developed.

Tissue Manufacturing (NAICS 322121)

There are two tissue manufacturers covered under the Cap-and-Trade Program. During the 45-day comment period for the Cap-and-Trade Regulation in 2010, one company commented that it produced premium quality tissue products that did not compare directly to the products that the other facility produced. To better understand the comment, staff worked with these manufacturers to study tissue products in greater detail. While it is true that the two facilities use different technologies to produce different types of tissue products with different qualities, staff believed that the functionality of the product was still the same: to absorb water. The difference in quality came from the structure of the paper that determines the ratio of the fiber and the void. More water could be absorbed if there were more voids that were structured to better hold water. Staff believed that this difference could be normalized by comparing the mass of tissue product that holds the same amount of water. Therefore, in the proposed 45-day regulatory language made available in 2013, staff proposed to change the product unit from the short ton of tissue to the short ton of tissue that holds the same amount of water by using the following calculation:

> Tissue produced adjusted by water absorption capacity = tissue produced (air dried short tons) x grams of water absorbed by a gram of tissue product

During the 45-day formal comment period in 2013, the second tissue company contended that the water absorbency factor was not an appropriate method to normalize different tissue products since water absorbency is only one of the quality parameters of tissue products. For example, softness is critical for facial tissue to minimize nasal irritation. Paper towel functionality focuses on high water absorbency more than bathroom tissue. The wet strength of paper towels, another quality parameter, makes it unsuitable for use as bathroom paper because it prevents the paper towel from readily breaking down, thereby preventing treatment in a municipal waste water treatment plant. Delicate task wiper functionality concentrates on anti-static dispensing to reduce lint and electrostatic charge in laboratory use. Further review and discussions with the two entities support the idea that different tissue paper products are associated with different quality parameters. Therefore, staff proposes to benchmark bathroom tissue, facial tissue, delicate task wipers, and paper towel manufacturing separately. Staff proposes to use air dried (6 percent of moisture) short ton for facial tissue, delicate task wipers, and paper towels because they are manufactured by one facility.

Recycled Boxboard Manufacturing (NAICS 322130)

Staff reviewed the recycled boxboard benchmark and identified that longer data periods made the benchmark more representative. Staff also identified that an abnormal event in 2010 that did not provide representative data for the facility. Staff proposes to modify the recycled boxboard benchmark using additional data years and excluding 2010.

Petroleum Refineries (NAICS 324110)

The existing benchmark for refineries for the second and third compliance periods is based on the carbon-weighted tonne (CWT) as a proxy for product. The CWT was developed for use in the European Union Emissions Trading System (EU ETS). In response to a request by the refineries, staff is proposing to use complexity-weighted barrels (CWB) instead. Both CWT and CWB were designed by industry expert Solomon Associates under contract with industry organizations. The main differences between the two approaches are that refinery throughputs are reported in barrels (volume) versus tonnes (mass), and that the CWT benchmark is based on European data while the CWB benchmark uses California-specific data and methodologies. Refineries in California argued that they measure throughput in volume rather than mass, and that CWB would therefore be a more appropriate basis for a benchmark.

Total refinery CWB is calculated using throughputs from several dozen types of refinery process units as well as adjustments representing emissions due to off-sites and non-process steam. In mid-2013, all California refineries voluntarily reported detailed 2008 and 2010 refinery data in response to ARB’s refinery survey. Refineries continued to send data updates, and staff reviewed these data with each refinery in early 2014. These data enabled staff to compare CWB, CWT, and actual refinery emissions. The CWB benchmark was calculated using these data, excluding one refinery which had abnormal operations in 2008. Hydrogen production and calcining were excluded from the CWB benchmark so they could be given separate benchmarks.

Staff is proposing a single CWB benchmark for all refineries. Cap-and-Trade Program benchmarks are typically based on industry-wide output and emissions, because this creates a consistent incentive across the industry to produce output while generating as few GHG emissions as possible. The current proposal is consistent with this long-standing ARB practice.

Earlier in this regulatory amendment process, staff considered separate CWB benchmarks for “typical” and “atypical” refineries, where “atypical” refineries were, based on input from stakeholders, defined as smaller and less complex than typical refineries.[3] Stakeholders suggested that staff evaluate the concept of an “atypical” refinery that was developed by EU ETS, but using a definition of “atypical” that was more appropriate for California refineries. Because many smaller and less complex refineries were not involved in Solomon Associates’ creation of the CWB concept, staff considered the possibility that using CWB may lead to overestimating their emissions intensity. However, analysis of the data showed that the CWB-based emissions intensities of relatively small and less complex refineries vary widely; importantly, some smaller and less complex refineries are among the most emissions efficient (in relation to CWB throughput) in the State. Therefore, the results of staff’s analysis indicate that CWB does not systematically favor large and more complex refineries over small and less complex refineries with respect to allocation. This analysis indicates that CWB normalizes for size, complexity, and product mix at refineries. As a result, a single sector-wide CWB benchmark is appropriate.

Some small and less complex refineries have continued to emphasize that they cannot be as efficient as larger facilities. Staff is aware that economies of scale may occur in many industries, and for refineries, these may reflect variations in heat integration. Many other factors may also influence a facility’s emissions intensity, such as the design of its equipment. Benchmarking is not intended to counteract these variations. Instead, CWB correctly satisfies the benchmarking criteria detailed earlier in this document by creating one benchmark for one product (CWB) that recognizes the inherent differences among refinery operations without bias to the refinery configuration.

Figure **6** shows the CWB of each petroleum refinery plotted from most efficient on left to most energy intensive on right. The horizontal line represents the sector benchmark based on 90 percent of the average CWB of the sector.

[3] Air Resources Board (February 2014), Cap-and-Trade Regulation: Proposed Benchmarks for Refineries and Related Industries, http://www.arb.ca.gov/cc/capandtrade/refinery-benchmarking-approach-guidance.pdf.

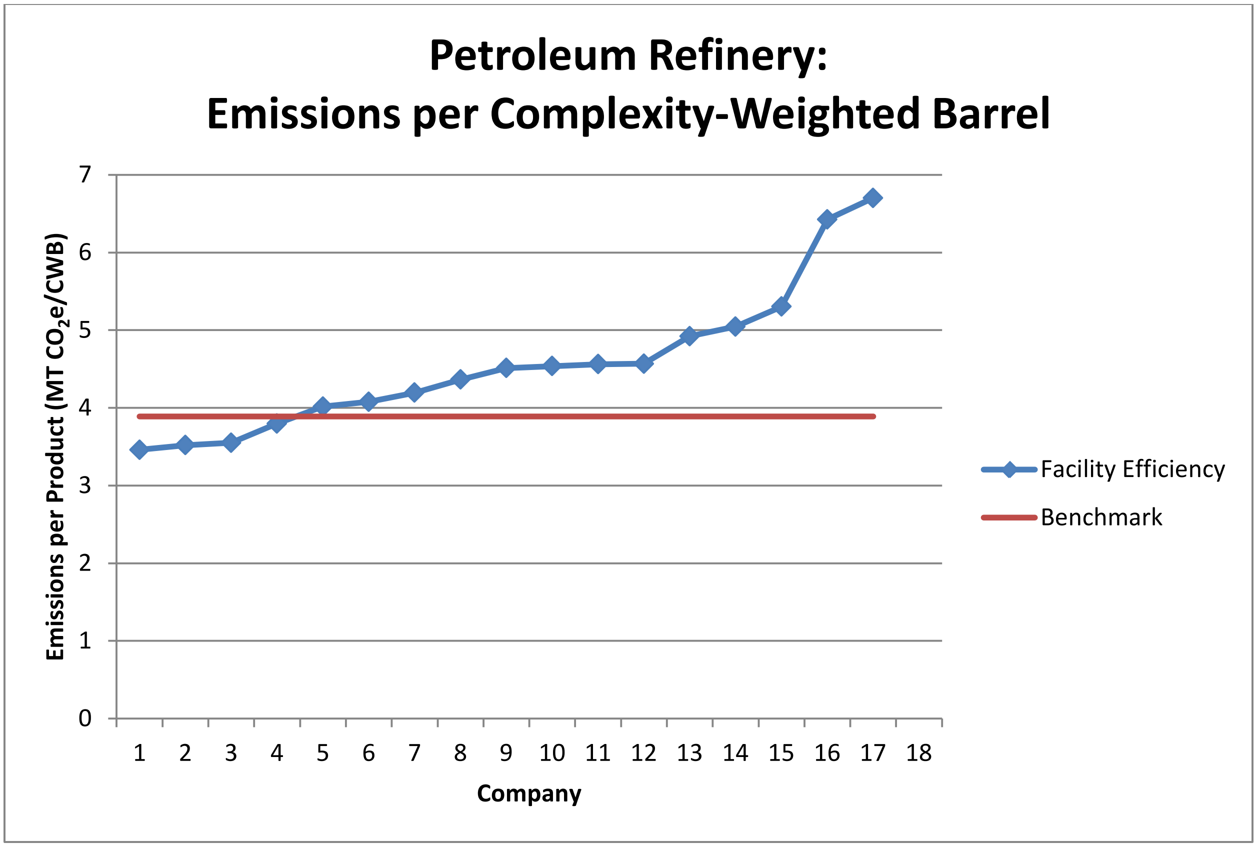

Figure 6: Petroleum refinery emissions per complexity-weighted barrel and benchmark.

Coke Calcining (NAICS 324199 All Other Petroleum Products and Coal Products Manufacturing)

The existing calcining benchmark is based on CWT, while the proposed calcining benchmark was calculated using data voluntarily provided by both calciner facilities covered by the Cap-and-Trade Program.

Industrial Gas Manufacturing (NAICS 325120)

The current benchmark for gaseous hydrogen is based on CWT. Staff is proposing a new gaseous hydrogen benchmark based on actual 2008 and 2010 data from both refinery and merchant hydrogen production in California. Refinery hydrogen data are from the refinery survey, while merchant hydrogen data are from Mandatory Reporting Regulation (MRR) emissions data reports. Consistent with previous proposals, this benchmark will apply to gaseous hydrogen which is produced "on purpose" (i.e., by dedicated hydrogen production equipment).

The current liquid hydrogen benchmark is the same as the current gaseous hydrogen benchmark. A separate benchmark is now proposed for liquid hydrogen. Liquid hydrogen is typically used for different applications than gaseous hydrogen and has different purity requirements, so staff considers it appropriate to define it as a different product. It is currently produced by two facilities in California and represents less than one percent of statewide hydrogen production. Consistent with MRR, the liquid hydrogen benchmark will apply to liquid hydrogen sales.

Figure **7** shows the hydrogen gas production emissions intensity for each facility plotted from most efficient on left to most energy intensive on right. The horizontal line represents the sector benchmark based on 90 percent of the average emissions intensity of the sector.

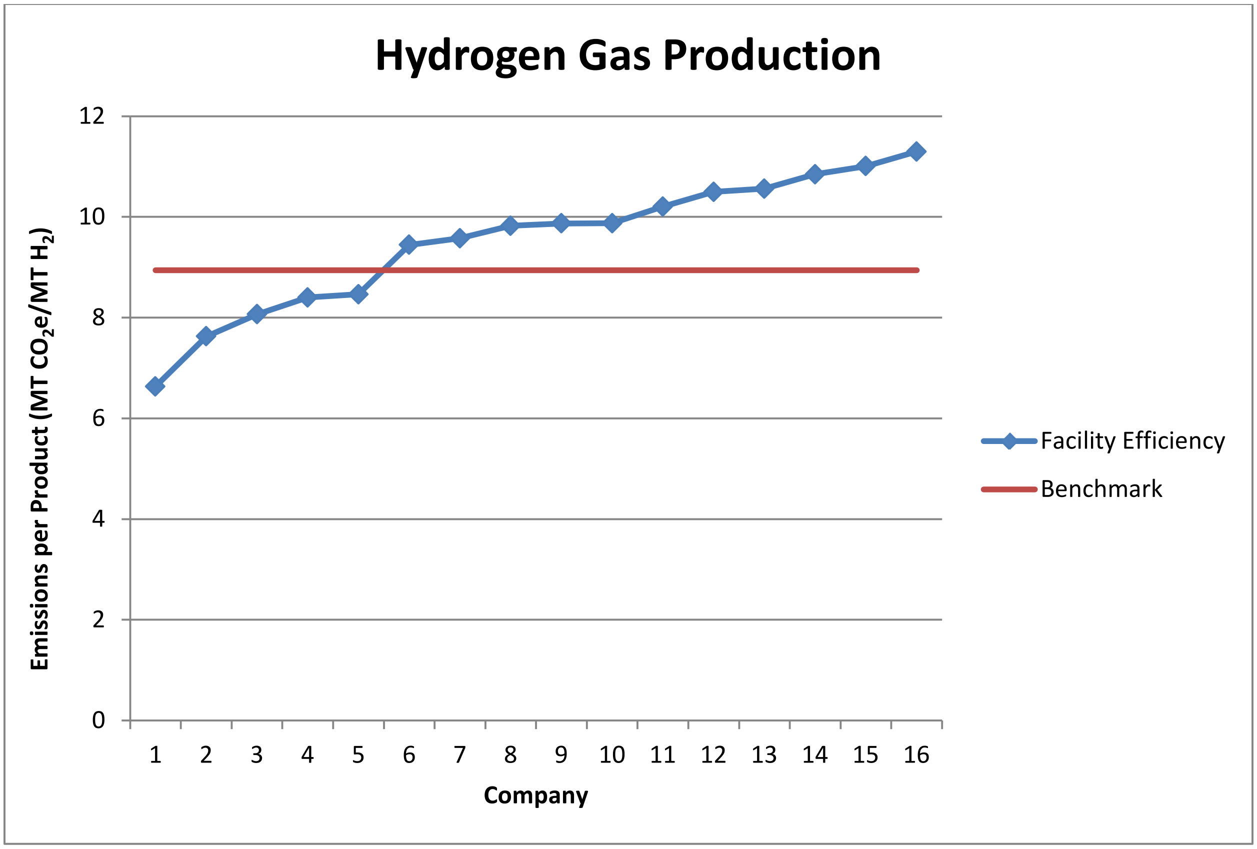

Figure 7: Hydrogen production efficiencies and benchmark.

Flat Glass Manufacturing (NAICS 327211)

The flat glass benchmark was developed using data from an ARB-conducted industry survey in 2009 and maintained extensive data and information for process equipment, production, and emissions.

One company commented that the existing benchmark was not reflective of the actual details of their operation and requested a review. Staff examined all the data that supported the current benchmark and found that there were some assumptions that needed to be validated and also identified some erroneous calculations. In order to set the benchmark values based on the most accurate data available, staff solicited complete data sets from the three flat glass companies. After reviewing the data, staff concluded that two years should be excluded due to abnormal events at some facilities. Staff proposes to revise flat glass benchmark excluding those two years and correcting the calculations.

Glass Container Manufacturing (NAICS 327213)

The container glass sector has commented that the current benchmark that uses the data year 2009 was not appropriate because it did not recognize early actions taken by the facilities. Staff worked with stakeholders to review GHG emissions and glass container production data from the years 2005 through 2010, and were able to incorporate cullet (recycled glass) consumption data that was not available when the existing benchmark was established. Cullet plays a major role in reducing GHG emissions from the glass sector because it can replace virgin feedstock such as soda ash and/or limestone which liberates GHG emissions through the calcining process.

Staff identified that the consumption of cullet at five container glass facilities fluctuated substantially on an individual facility basis, whereas the aggregated trend showed continued increase of cullet used per unit of glass produced. According to CalRecycle's Biannual Report of Beverage Container Sales, Returns, Redemption & Recycling Rates,[4] the amount of glass recycled at a State-wide level continued to increase until 2008 and started declining slowly after 2009. Various factors, such as availability of funding for glass collection facilities and the quality of collected glass, can contribute to variations in cullet supply. Staff agrees that glass container manufacturing facilities cannot control the supply of cullet and believes that using data from additional years to calculate the benchmark would address the temporal fluctuation in cullet use. Staff therefore proposes to use a wider range of data years for container glass to account for this variability.

Figure **8** shows the container glass emissions intensity for each facility plotted from most efficient on left to most energy intensive on right. The horizontal line represents the sector benchmark based on 90 percent of the average emissions intensity of the sector.

[4] This report is available at: http://www.calrecycle.ca.gov/bevcontainer/Rates/BiannualRpt/default.htm.

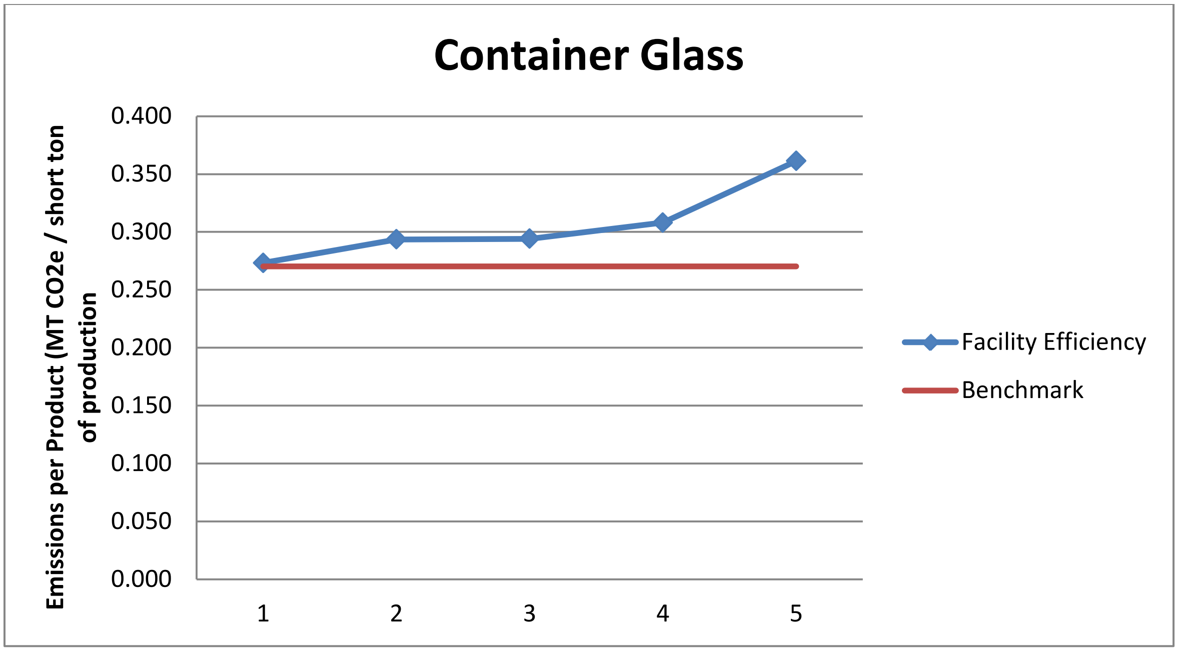

Figure 8: Container glass facility emissions intensity and benchmark.

Cement Manufacturing (NAICS 327310)

Using biomass-derived fuel is a viable option for covered entities to reduce GHG emissions. Staff is proposing to modify the benchmark for the cement sector to take into account eligible biomass-derived fuel consumed on-site. This is consistent with other sectors that combust biogas.

Figure **9** shows the cement emissions intensity for each facility plotted from most efficient on left to most energy intensive on right. The horizontal, dashed line shows the calculated 90 percent of the average emissions intensity of cement production. Because that value is more stringent than the most efficient facility's emissions intensity, the benchmark was set at the best-in-class emissions intensity.

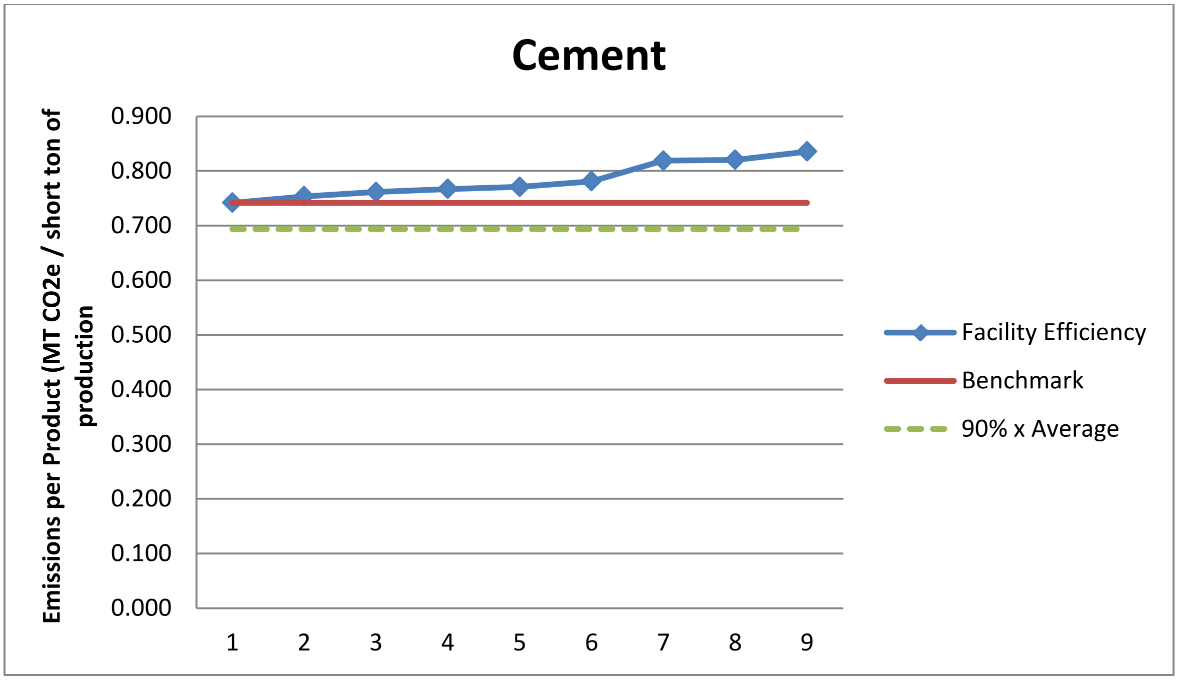

Figure 9: Cement facility emissions intensity and benchmark.

Gypsum Product Manufacturing (NAICS 327420)

Staff proposes to change benchmark unit definitions for gypsum to be consistent with the Mandatory Reporting Requirements. The overall approach and the benchmark values for the gypsum sector are not changed.

Aluminum and Aluminum Alloy Billet Manufacturing (NAICS 331314 Secondary Smelting and Alloying of Aluminum)

A metal billet is a length of metal that has a round or square cross-section that is manufactured via casting. To create aluminum and aluminum alloy billets, scrap aluminum consisting of aluminum, aluminum alloys, and alloying ingredients is melted and cast into billets. Following melting and casting operations, billets may undergo additional processing such as heat treatment.

There is one aluminum and aluminum alloy billet manufacturer subject to the Cap-and-Trade Program. Staff proposes to define the product unit as the short ton of aluminum and aluminum alloy billet.

Lead Acid Battery Recycling (NAICS 331492 Secondary Smelting, Refining, and Alloying of Nonferrous Metal (Except Copper and Aluminum)

Lead is a metal used to produce various products such as batteries, ammunition, construction materials, electrical components and accessories, and vehicle parts. Approximately 89 percent of lead is used to produce batteries.

A secondary lead smelter produces lead and lead alloys from lead-bearing scrap metal. The incoming lead scrap materials are first pre-treated to partially remove metal and nonmetal contaminants. The resulting lead scrap is smelted using either a blast furnace or reverberatory furnace. The molten lead from the smelting furnace is refined in kettle furnaces, and then cast into ingots or used to produce lead alloy products (U.S. EPA 2009).

There are two lead acid battery recyclers that are projected to be newly covered by the Cap-and-Trade Program starting with calendar year 2013. This new coverage occurred because process emissions for lead production became newly covered by MRR in 2013. By closely working with the two facilities, staff learned that the carbon content of lead scrap varied significantly by facility and by year, which affects the emissions per short ton of product. Because these facilities would otherwise be covered by the EBB methodology, which doesn’t take into account process emissions, staff proposes to set a benchmark based on current data while continuing to work with lead acid battery recyclers to understand their emissions profiles in order to refine the benchmarking methodology.

Staff proposes to define the product unit as the short ton of lead and lead alloys.

Iron Foundries (NAICS 331511)

Foundries manufacture castings by pouring metal melted in a furnace into a mold of a desired, and potentially intricate, shape. Achieving the same detail of form as a casting would require extensive tooling and shaping of metal from a mill (U.S. EPA 2002). There is one iron foundry subject to the Cap-and-Trade Program that manufactures ductile iron pipes.

At a pipe manufacturing facility, iron is melted in the cupola furnace at approximately 1,550 °C using scrap steel and recycled materials. In order to obtain ductile cast iron, the iron is injected in the converter with a magnesium alloy. Pipes are then manufactured from the injected iron using a centrifugal casting process. The pipes leave the centrifugal casting shop and are annealed at 960 °C. All pipes are then given a zinc or zinc-aluminum casing (Duktus 2013).

Staff proposes to define the product unit as the short ton of ductile iron pipes.

Nonferrous Forging (NAICS 332112)

Forging is the process of heating metals to a forging temperature well below the melting temperature and then forming the parts through a series of mechanical operations. Different finish product types would require different numbers of processes. There are two forging companies in California that are above or close to 25,000 metric tons CO_2e annual emissions inclusion threshold for the Cap-and-Trade Program. There is also the potential for new entrants at a later time.

In general, forging can be grouped in four categories: impression die, cold die, open die, and seamless rolled ring. Staff obtained data for seamless rolled ring, but not for other types of products due to the fact that the shape, size, and metal properties of the end products heavily depend on the customer specifications.

Based on the product data ARB obtained, staff proposes to define the product unit as the short ton of seamless rolled ring.

Rolled Steel Shape Manufacturing (NAICS 331221)

Steel cold rolling has multiple processes with different energy requirements. One facility provided new and more accurate data to allocate facility-wide emissions to each process and associated output. After reviewing the data, staff made some adjustments to the emissions assigned to each production process based on the newly submitted data. Staff also excluded one year from the new data set since there was equipment maintenance that affected the reading of natural gas metering. Staff proposes to modify the benchmark for pickled steel, cold rolled and annealed steel, galvanized steel, and tin coated product. Since there are two facilities under steel cold rolling, staff applied either the weighted average multiplied by 90 percent or best in class to make sure at least one facility would achieve the benchmark.