## RESIDENTIAL CHARCOAL GRILLING

**a. Source Category Description**

Residential barbecue grilling emissions include emissions from the burning of charcoal, and all types of outdoor meat grilling. Combustion emissions from gas barbecues are not included. Emissions estimates are for charcoal and all types of meat cooked on charcoal, gas, and electric grills.

For this source category, the following SCC was assigned:

**Table 2: Charcoal Grilling SCC**

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| --- | --- |
| **SCC** | **SCC Description** |
| 2810025000 | Miscellaneous Area Sources - Other Combustion - Charcoal Grilling - Residential |

**b. Activity Data**

The activity data needed to estimate emissions from residential charcoal grilling is the number of 2013 households from 1-4 units, the amount of charcoal used in Idaho in 2013, and the amount of meat cooked during outdoor grilling on charcoal, gas, and electric grills. The household data was obtained from the US Census Bureau 2013 5-year estimates.1,2 The fraction of occupied households to total households was used on the total households of 1-4 units to calculate the occupied 1-4 unit households. The amount of charcoal sold in Idaho was calculated (from the Hearth, Patio and Barbeque Association BBQ Statistics total charcoal sold in 2013) 3 using national and Idaho occupied 1-4 unit households. The fraction of Idaho occupied 1-4 unit households compared to the national occupied 1-4 unit households was used on the total charcoal sold in the United States to get the Idaho portion of charcoal sold. Each county was then apportioned tons of charcoal based on their fraction of the total number of 1-4 unit households in Idaho. It was assumed that those in larger apartment units would not have the space to have or use an outdoor grill.

The activity data for the weight of meat cooked was calculated using some generally accepted information about charcoal grilling. It is generally assumed that about 30 charcoal briquettes are needed to cook a pound of meat.4,5 Information from Kingsford on the average weight of their charcoal briquettes indicated that there are about 17.64262 briquettes/lb of charcoal.6 Using this figure, the number of briquettes was calculated for each county and divided by 30 to get the total weight of meat cooked with charcoal per county.

The gas and electric grill meat totals were estimated using some HPBA statistics. Their 2011 State of the Barbecue Industry Report7 estimated that households with charcoal grills cook about 27 times per year. Those with gas grills cook about 45 times per year.7 The later reports don’t have this information, so we are assuming it has remained about the same. The HPBA 5-year average sales figures indicate that about 41% of the grills sold were charcoal grills, and the other 59% are gas/electric grills.8 Since the number of grilling events for charcoal grills is 27 compared to 45 grilling events for gas/electric grills, and only 41% of grilling households have charcoal grills, estimating the amount of meat cooked by the other methods is more complicated.

There were about 2,774 tons of meats cooked in Idaho from charcoal grilling. So we have gas/electric meat cooked (the unknown) / charcoal meat cooked = (gas/electric grilling events \* the percent of gas/electric grills) / (charcoal grilling events \* the percent of charcoal grills) \* (total charcoal meat cooked in Idaho) + total charcoal meat cooked in Idaho = total meat cooked in Idaho from all grilling. The whole formula would be: total meat grilled / 2,775 = (45\*59%) / (27\*41%) \* 2775 + 2775 = 9,431 tons of meat cooked from all barbecue methods in Idaho. Or take the amount of meat from charcoal grilling and multiply by 3.3984, which will give about the same result (total meat estimated / charcoal meat grilled).

Emissions from charcoal lighting fluid can also be estimated for each county. The HPBA estimates that about 37% of those who use charcoal also use lighter fluid to start their grills.9 They also estimate that about 80% of households have a grill of some type.10 The number of charcoal lighter fluid households is estimated by taking 80% of the households and multiplying by the 41% using charcoal grills. Then take 37% of those to estimate the number of households using the lighter fluid. Each of these would then have about 27 barbecue events per year. Lighter fluid is estimated to emit about 0.02 lbs of VOC per barbecue event.11 So the formula is:

1-4 unit occupied households \* 80% with grills \* 41% with charcoal grills \* 37% using lighter fluid \* 0.02 lbs of VOC.

**c. Emission Factors**

EPA developed the criteria emission factors used to estimate charcoal grilling emissions in “Emissions from Street Vendor Cooking Devices.”12 This same report indicates that most of the PM and VOC emissions come from the cooking of meat. The CO and NOx emissions come from the burning of the charcoal. So all VOC and HAPs from VOC, and the PM10/2.5 emissions will use the total tons of meat cooked to estimate emissions. The CO and NOx emissions will be estimated using the total tons of charcoal used for cooking. Idaho used averages from Table E-2 of that report which summarizes the g/kg emissions per weight of both charcoal and meat. The test results from charcoal only and the one test with a cover were not used in the averages. The g/kg emissions factors were converted to lb/ton. The HAP emission factors are based on emission factors from Commercial Cooking Underfired Charbroiling (SCC 2302002200). The resulting emission factors are listed in Table 2.

Lighter fluid VOC emissions are estimated to be 0.02 lbs per barbecue event as noted above. These will be added to the VOC emissions estimated from the grilling of meat since there is no separate SCC to list these emissions..

Emission calculations are based on the activity data of tons of meat or charcoal used per county multiplied by the g/kg of meat or charcoal emissions factors converted to lb/ton.

**d. Control Factors**

No control measures are assumed for this category.

**e. Sample Calculations**

Emissions are calculated for each county using emission factors and activity as:

E*x,p* = A*x* × EF*x,p*

where:

E*x,p* = annual emissions for category x and pollutant p;

A*x* = calculated pounds of meat or charcoal associated with category x;

EF*x,p* = emission factor for category x and pollutant p (pound/ton of meat or charcoal).

**Example:**

The 2013 1-4 unit occupied households for Ada County was 129,646. Using the fraction of the Ada County population compared to Idaho, the total tons of charcoal used in Ada County was 977.2 tons or 1,954,334.3 pounds. Using 30 briquettes needed to cook a pound of meat and figuring that there are 17.64262 charcoal briquettes in a pound of charcoal, the amount of charcoal grilled meat cooked in Ada County was 574.7 tons. (1,954,334.3 pounds charcoal × 17.64262 briquettes/pound of charcoal / 30 briquettes/pound of meat cooked / 2000 to convert to tons). Then using the formula noted above, the total meat cooked from all grilling in Ada County was 1,952.9 tons. The calculation would be: 574.7 \* 3.3984, or 574.7 \* (45\*59%) / (27\*41%) \* 574.7) + 574.7 = 1,952.9.)

The emission factor for PM10-PRI is 18.42 lb/ton of meat grilled

EPM10-PRI = 1,952.9 tons meat grilled × 18.42 pounds PM10-PRI/ton of meat grilled / 2000

= 17.99 tons PM10-PRI

**f. References**

1. U.S. Census Bureau. Community Facts, Housing, [Selected Housing Characteristics, American Community Survey 5-Year Estimates, Idaho](https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml#none), accessed May 2019.
2. U.S. Census Bureau. Guided Search, Selected [Housing Characteristics, American Community Survey 5-Year Estimates (DP04) Idaho Counties](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_DP04&prodType=table).
3. Hearth, Patio and Barbecue Association (HPBA), [Statistics/Barbecue Statistics/Charcoal Shipments for 2013](https://www.hpba.org/), accessed May 2019.
4. [Charcoal Grill Tips from a Real Pro](https://grillingdoctor.com/charcoal-grill-tips-from-a-real-pro/), Accessed May 2019.
5. Hearth, Patio and Barbecue Association (HPBA) 3/23/2015 email from Jessica Boothe on how many briquettes to use to cook a pound of meat or chicken.
6. Kingsford email on the weight of their charcoal briquettes 4/11/2015.
7. Hearth, Patio & Barbecue Association (HPBA), [2011 State of the Barbecue Industry Report](https://www.hpba.org/Resources/PressRoom/barbecue-industry/2011-state-of-the-barbecue-industry-report?searchterm=State%20of%20the%20Barbecue). Internet address. Last Accessed May 2019.
8. Hearth, Patio and Barbecue Association (HPBA), [Statistics, BBQ Grill Shipments](https://www.hpba.org/Resources/Market-Research-Reports/view?barbecue-statistics=CopyofBBQGrillShipments8513.pdf). Accessed May 2019.
9. Hearth, Patio and Barbecue Association (HPBA) 3/23/2015 email from Jessica Boothe on how many people with charcoal grills use lighter fluid.
10. Hearth, Patio & Barbecue Association (HPBA), [2014 State of the Barbecue Industry Report](https://www.hpba.org/Resources/PressRoom/barbecue-industry/2014-state-of-the-barbecue-industry-report?searchterm=2014%20State%20of%20the%20Barbecue%20Industry%20Report). Accessed May 2019.
11. South Coast Air Quality Management District. October 5, 1990. "[Rule 1174. “Control of Volatile Organic Compound Emissions from the Ignition of Barbecue Charcoal](http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1174.pdf)” accessed May 2019.
12. [Emissions from Street Vendor Cooking Devices (Charcoal Grilling), EPA/600/SR-99/048, June 1999](https://www3.epa.gov/ttn/catc/dir1/mexfr.pdf), accessed May 2019.

**Table 2: Charcoal Grilling Emission Factors**

| SCC | Code | Pollutant | lb/ton |
| --- | --- | --- | --- |
| 2810025000 | CO | CO | **3.314E+02** |
| 2810025000 | NOX | NOx | **7.111E+00** |
| 2810025000 | PM25-PRI | PM2.5 Primary | **1.474E+01** |
| 2810025000 | PM10-PRI | PM10 Primary | **1.842E+01** |
| 2810025000 | VOC | VOC | **1.703E+00** |
| 2810025000 | 50000 | Formaldehyde | **0.23419** |
| 2810025000 | 71432 | Benzene | **0.014065** |
| 2810025000 | 75070 | Acetaldehyde | **0.185047** |
| 2810025000 | 85018 | Phenanthrene | **0.000205** |
| 2810025000 | 86737 | Fluorene | **0.001547** |
| 2810025000 | 91203 | Naphthalene | **0.001523** |
| 2810025000 | 91576 | 2-Methylnaphthalene | **0.008112** |
| 2810025000 | 95476 | O-Xylene | **0.001864** |
| 2810025000 | 98862 | Acetophenone | **0.004377** |
| 2810025000 | 100027 | 4-Nitrophenol | **0.016283** |
| 2810025000 | 100414 | Ethyl Benzene | **0.001864** |
| 2810025000 | 100425 | Styrene | **0.323201** |
| 2810025000 | 106423 | P-Xylene | **0.001017** |
| 2810025000 | 106990 | 1,3-Butadiene | **0.017793** |
| 2810025000 | 108383 | M-Xylene | **0.001017** |
| 2810025000 | 108883 | Toluene | **0.006778** |
| 2810025000 | 110543 | Hexane | **0.007456** |
| 2810025000 | 120127 | Anthracene | **1.86E-05** |
| 2810025000 | 123386 | Propionaldehyde | **0.085406** |
| 2810025000 | 108952 | Phenol | **0.050066** |
| 2810025000 | 129000 | Pyrene | **9.66E-05** |
| 2810025000 | 132649 | Dibenzofuran | **0.004159** |
| 2810025000 | 206440 | Fluoranthene | **6.78E-05** |
| 2810025000 | 208968 | Acenaphthylene | **0.002552** |
| 2810025000 | 16672392 | Diethyl Phthalate | **0.014273** |
| 2810025000 | 540841 | 2,2,4-Trimethylpentane | **0.001915** |
| 2810025000 | 50000 | Formaldehyde | **0.23419** |

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| **Averages from "Emissions from Street Vendor Cooking Devices (Charcoal Grilling)" (EPA 1999). PM=PM10. PM2.5= 0.8\*PM10. Meat Cooking = PM, VOC** |
| **Converted from g/kg to lb/ton** |
| **HAP Emission factors are based on emission factors from Commercial Cooking Underfired Charbroiling (SCC 2302002200)** |