



## 2015 Area Source Emissions Inventory Methodology 610 – RESIDENTIAL WOOD COMBUSTION

### I. Purpose

This document describes the Area Source Methodology used to estimate emissions of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), fine particulate matter less than 2.5 microns (PM<sub>2.5</sub>), fine particulate matter less than 10 microns (PM<sub>10</sub>), volatile organic compounds (VOC), sulfur oxides (SO<sub>x</sub>), and ammonia (NH<sub>3</sub>) from the combustion of wood by the residential sector in the San Joaquin Valley Air Basin. An area source category is a collection of similar emission units within a geographic area (i.e., a County) that are small and numerous and may not have been inventoried as specific point, mobile, or biogenic sources. The California Air Resources Board (CARB) has grouped these individual sources with other like sources into area source categories. These source categories are grouped in such a way that they can be estimated collectively using one methodology.

### II. Applicability

The emission calculations from this Area Source Methodology apply to sources that are identified by the following Category of Emission Source (CES) codes and Reconciliation Emission Inventory Codes (REIC):

**Table 1. Emission inventory codes.**

CES	REIC	Description
82115	610-600-0230-0000	Residential Wood Combustion – Wood Stoves
82123	610-602-0230-0000	Residential Wood Combustion – Fireplaces
47225	610-604-0230-0000	Residential Wood Combustion – Unspecified

### III. Point Source Reconciliation

Emissions from the area source inventory and point source inventory are reconciled against each other to prevent double counting. This is done using relationships created by the California Air Resources Board (CARB) between the area source REIC and the point sources' Standard Industry Classification (SIC) code and emissions process Source Category Code (SCC) combinations. The area source in this methodology is not represented within the San Joaquin Valley Unified Air Pollution Control District's (SJVUAPCD or District) point source inventory so reconciliation is not necessary.

## IV. Methodology Description

This area source methodology, based on CARB's initial work (ARB, 2015), is a top down estimation of emissions from the combustion of wood by the residential sector in the SJVUAPCD. The methodology is used to estimate the criteria pollutant emissions from the various types of residential wood combustion for each county throughout the SJVUAPCD. This document contains emissions estimates for wood-burning devices (which includes fireplaces, wood burning stoves, fireplace inserts, and pellet stoves). This methodology does not include emissions estimates for the category "Residential Wood Combustion (Unspecified)" or for fireplaces or other similar devices that burn natural gas.

## V. Activity Data

Sources. The types of devices that burn wood in a typical residence are fireplaces, wood-burning stoves, fireplace inserts, and pellet stoves. The most common wood-burning device in a home is the fireplace. A **fireplace** is generally a masonry or prefabricated (metal) enclosure with the side facing the interior of the house left open and a chimney to exhaust the flue gas. The combustion air can be supplied from the outside air or from the inside air.

**Wood stoves** are enclosed stand-alone devices that vent exhaust gas through an existing chimney or flue. Wood stoves radiate heat from their exterior surfaces and they are commonly used in residences as space heaters. They are used both as the primary source of residential heat and to supplement conventional heating systems. Wood stoves control burning or burn time by restricting the amount of air that can be used for combustion (U.S. EPA, 1996a). This methodology estimates emissions for four different types of wood stoves: (1) the conventional wood stove; (2) the noncatalytic wood stove; (3) the catalytic wood stove; and (4) the pellet stove.

Conventional wood stoves do not have any emission reduction technology or design features and, in most cases, were manufactured before July 1, 1986 (U.S. EPA, 1996a). Noncatalytic wood stoves do not contain catalysts but they do have emission reducing technology or features. Older, noncatalytic wood stoves reduce emissions by directing unburned hydrocarbons and carbon monoxide (CO) into a secondary chamber, where mixing with fresh, preheated makeup air enhances further combustion (U.S. EPA, 1996a). Newer noncatalytic wood stoves have three internal characteristics that create a good environment for complete combustion: firebox insulation; a large baffle to produce a longer, hotter gas flow path; and pre-heated combustion air introduced through small holes above the fuel in the firebox. The baffle and some other internal parts of a non-catalytic stove need replacement periodically as they deteriorate with the high heat of efficient combustion (WHO, 2013).

Catalytic wood stoves are equipped with a ceramic or metal honeycomb device, called a combustor or converter that is coated with a noble metal such as platinum

or palladium. The catalyst material reduces the ignition temperature of the unburned hydrocarbons and CO in the exhaust gases, which allows these pollutants to be burned at normal stove operating temperatures. As these pollutants burn, the temperature inside the catalyst increases to a point where the ignition of the gases is essentially self-sustaining (U.S. EPA, 1996a). All catalytic stoves have a lever-operated catalyst bypass damper which is opened for starting and reloading. The catalytic honeycomb degrades over time and must be replaced, but its durability is largely in the hands of the stove user. The catalyst can last more than six seasons if the stove is used properly, but if the stove is over-fired, garbage is burned and regular cleaning and maintenance are not done, the catalyst may break down in as little as two years (WHO, 2013).

Residential wood stoves are classified as Phase I, Phase II and Pre-Phase I. Phase II stoves are those certified to meet the July 1, 1990, EPA standards; Phase I stoves meet only the July 1, 1988, EPA standards; and Pre-Phase I stoves do not meet any of the EPA standards (U.S. EPA, 2006). Some Pre-Phase I stoves may use older catalytic technology; however, for the purposes of this methodology, we make the conservative assumption that all Pre-Phase I stoves are conventional devices.

**Fireplace inserts** can be described as wood stoves that fit into the firebox of a fireplace. These devices are used to heat a house, or a portion of the house. Inserts are generally more effective at providing heat than a fireplace. They radiate the heat to the interior house space, or with the aid of a fan, circulate air around the insert and vent the heated air into the house. Since fireplace inserts share operating and combustion characteristics with wood stoves, the same emission factors are used for both fireplace inserts and wood stoves (HPBA, 2009a; U.S. EPA, 1996a; WHO, 2013).

**Pellet stoves** are fueled with pellets of sawdust, wood products, and other biomass materials pressed into manageable shapes and sizes. These stoves have active air flow systems and unique grate designs to accommodate pelleted fuel. Some pellet stove models are subject to the 1988 New Source Performance Standards (NSPS), while others are exempt due to a high air-to-fuel ratio (i.e., greater than 35-to-1) (U.S.EPA,1996a).

## VI. Emission Factors

Table 2 contains default values for emission factors: CO, NO<sub>x</sub>, SO<sub>x</sub>, VOC, PM, and NH<sub>3</sub>. The emission factors for residential wood combustion reflect data used by U.S. EPA to develop the 2002 National Emission Inventory (NEI) and information from other wood combustion studies. It is important to note that U.S. EPA emission factors assume that Total PM, PM<sub>10</sub> and PM<sub>2.5</sub> are all equivalent. However, this is not consistent with ARB's designated particulate size fractions for residential wood combustion ([PM<sub>10</sub>] = 0.935\*[Total PM]; [PM<sub>2.5</sub>] = 0.9001\*[Total PM]). To ensure consistency with ARB size fractions, emission factors have been adjusted to correspond to the appropriate size fraction. For example, if U.S. EPA provided an

emission factor for the PM10 size fraction, we determined the corresponding PM2.5 emission factor by applying the ratio of size fractions (PM2.5/PM10 = 0.9001/0.935). Using this approach, PM2.5 emission factors are 96.3% of PM10 emission factors.

The emission factors provided in Table 2 are based on the mass of fuel burned and they may not provide an accurate basis for comparison among different types of wood burning devices or different fuels. For example, the emission factors for manufactured logs may be higher than for cord wood, but fireplace users may burn only one manufactured log to provide the same type of fire that would otherwise require several pieces of cord wood. Similarly, the emission factors for wood stoves may be higher than those for fireplaces, but wood stoves are much more efficient for heating purposes and studies show that certified wood stoves produce lower emissions per unit of heat delivered when compared to fireplaces or conventional stoves (Houck, 1998; Houck, 2005).

**Table 2. Residential wood combustion emission factors.**

Device Description	Fuel Type	Emissions (lbs/ton fuel burned)						
		CO	NO <sub>x</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	SO <sub>2</sub>	VOC / ROG	NH <sub>3</sub>
Fireplace	Cord Wood, Bundles	149 <sup>4</sup>	2.6 <sup>2</sup>	22.7 <sup>7</sup>	23.6 <sup>1</sup>	0.4 <sup>2</sup>	18.9 <sup>4,8</sup>	1.8 <sup>3</sup>
Fireplace	Manufactured Log	137 <sup>4</sup>	6.5 <sup>4</sup>	46.4 <sup>7</sup>	48.2 <sup>4</sup>	4.2 <sup>4</sup>	33.8 <sup>4</sup>	0.004 <sup>4</sup>
Woodstove: Conventional (non-EPA certified)	Cord Wood	230.8 <sup>5</sup>	2.8 <sup>5</sup>	29.5 <sup>7</sup>	30.6 <sup>5</sup>	0.4 <sup>5</sup>	53 <sup>5</sup>	1.7 <sup>3</sup>
Woodstove: Phase II EPA certified, Non-Catalytic	Cord Wood	140.8 <sup>5</sup>	2.28 <sup>4</sup>	14.1 <sup>7</sup>	14.6 <sup>5</sup>	0.4 <sup>5</sup>	12 <sup>5</sup>	0.9 <sup>3</sup>
Woodstove: Phase II EPA certified, Catalytic	Cord Wood	104.4 <sup>1</sup>	2 <sup>5</sup>	19.6 <sup>7</sup>	20.4 <sup>5,9</sup>	0.4 <sup>5</sup>	15 <sup>5</sup>	0.9 <sup>3</sup>
Fireplace Inserts: Conventional (non-EPA certified)	Cord Wood, Bundles	230.8 <sup>5</sup>	2.8 <sup>5</sup>	29.5 <sup>7</sup>	30.6 <sup>5</sup>	0.4 <sup>5</sup>	53 <sup>5</sup>	1.7 <sup>3</sup>
Fireplace Inserts: Phase II EPA certified; Non-Catalytic	Cord Wood, Bundles	140.8 <sup>5</sup>	2.28 <sup>4</sup>	14.1 <sup>7</sup>	14.6 <sup>5</sup>	0.4 <sup>5</sup>	12 <sup>5</sup>	0.9 <sup>3</sup>
Fireplace Inserts: Phase II EPA certified; Catalytic	Cord Wood, Bundles	104.4 <sup>1</sup>	2 <sup>5</sup>	19.6 <sup>7</sup>	20.4 <sup>5,9</sup>	0.4 <sup>5</sup>	15 <sup>5</sup>	0.9 <sup>3</sup>
Fireplace Inserts: All	Compressed Wood Log	201.2 <sup>6</sup>	2.8 <sup>5</sup>	25.0 <sup>7</sup>	26.0 <sup>6,7</sup>	0.4 <sup>5</sup>	15.1 <sup>6</sup>	1.7 <sup>3</sup>
Pellet Stove	Pellets	15.9 <sup>4</sup>	3.8 <sup>4</sup>	2.9 <sup>7</sup>	3.06 <sup>4</sup>	0.32 <sup>4</sup>	0.04 <sup>4</sup>	0.3 <sup>3,4</sup>

References and Notes:

- 1.2002 National Emission Inventory (Pechan, 2006; Broderick, 2005)
- 2.U.S. EPA AP-42 Section 1.9 (U.S EPA, 1996b)
- 3.U.S. EPA Emission Inventory Improvement Program (EC/R, 2002; EIIP, 2004)
- 4.Mid-Atlantic Regional Air Management Association (MARAMA) study (Houck, 2006)
- 5.U.S. EPA AP-42 Section 1.10 (U.S EPA, 1996a) and (Houck, 2001c).
- 6.Oregon Department of Energy study (Barnett, 1992). Note: ARB PM Speciation Profile #424 was used to convert from Total PM to PM10 (ARB, 2005).
- 7.This emission factor was adjusted to match ARB's particulate size fractions.
- 8.U.S. EPA 2005 NEI Technical Support Document (U.S. EPA, 2010)

9. For wood stoves classified as "Catalytic - Phase II", U.S. EPA AP-42 lists a PM10 emission factor of 16.2 lb/ton. Since the deterioration of the catalyst in these stoves can result in higher emissions, ARB staff are using the more conservative AP-42 emission factor for "Catalytic - All" wood stoves (20.4 lb/ton).
10. The EIIP document did not include an ammonia emission factor for Phase II Catalytic wood stoves. Therefore, it was assumed that the ammonia emission factor for Phase II Non-Catalytic wood stoves was appropriate for Phase II Catalytic wood stoves.
11. The Oregon Dept. of Energy study did not include NOX or SO2 emission factors for fireplace inserts burning compressed wood logs. Therefore, it was assumed that the emission factors for conventional fireplaces with inserts were appropriate for estimating emissions.
12. [Total PM] = [PM10]/[0.935]; [Total Organic Gases, TOG] = [ROG]/0.4385 [ARB Speciation Profile #424]
13. Ammonia emission factors were generally estimated by using a molar ratio of ammonia to carbon monoxide, based on emissions data from the combustion of forest fuels (EC/R, 2002; EIIP, 2004).

## VII. Burn Cleaner Program

The Burn Cleaner Program is a significant part of the District's overall strategy to reduce the impacts of residential wood burning, as the program encourages Valley residents to change out old, high-polluting devices and open hearth fireplaces with new, cleaner burning devices, such as EPA Phase II Certified wood and pellet burning devices and gas burning devices. The Burn Cleaner Program is also complementary to the Check Before You Burn Program, which is vital to further reduce emissions during the wood burning season. For several years, the District has offered meaningful financial assistance through this program, which not only reduces emissions on "No Burn Days," but also reduces emissions on "Burn Days" as more polluting devices are replaced. Given the potential high cost to replace older, high-polluting units, the program includes a specific focus on low-income residents by making the purchase of new, cleaner devices more economically feasible through higher incentives, flexible payment through participating retailers, and expanded eligibility criteria. This program has continued to grow with support from the District's Environmental Justice Advisory Group, Valley residents, participating retailers, and other agencies.

## VIII. Emissions Calculations

Residential wood combustion emissions are estimated using emission factors, calculation approaches, and compiled local activity data from residential wood combustion surveys. Detailed calculations and non-default values for variables for each county can be found in Appendix A. Sample calculations are provided below.

### A. Wood-Burning Fireplaces

#### 1. Determine the number of wood-burning fireplaces that are actually used.

$$\text{Equation 1: } FP_{\text{all}} = ([H_{\text{total}}] * [P_{\text{wbd}}] * [P_{\text{fp,wbd}}] * [P_{\text{fp,u}}] * [M_{\text{fp}}]) - [BC_{\text{OH}}]$$

Where

$FP_{\text{all}}$  = Number of fireplaces that are actually in use

$H_{\text{total}}$  = Number of occupied housing units/homes in 2003 (State of California, 2016)\*

$P_{\text{wbd}}$  = Percent of wood burning devices by region (SJVUAPCD, 2014)

$P_{\text{fp,wbd}}$  = Air Basin-wide percent of wood-burning fireplaces/percent of all wood burning devices (25%/32% = 78%) (SJVUAPCD, 2014)

$P_{\text{fp,u}}$  = Percent of homes that use their fireplace, among those who use their wood-burning device (SJVUAPCD, 2014).

$M_{\text{fp}}$  = Average number of fireplaces per home (to account for multiple fireplaces in some homes) = 1.1, default (OMNI, 2003)

$BC_{\text{OH}}$  = Number of open hearth fireplaces removed through the District's Burn Cleaner Program

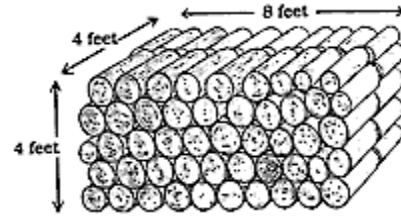
*\* The number of occupied housing units/homes is based on the 2003 number of occupied housing units/homes due to the District's moratorium on new wood-burning fireplaces after 2003. This is in accordance with CARB's original methodology.*

#### 2. Determine the amount of wood burned in fireplaces.

For fireplaces, we assume that three types of fuel are burned: (1) cord wood; (2) bundle wood; and (3) wax/sawdust manufactured logs (e.g., Duraflame, Pine Mountain, Hearthlog, etc.). Provided below are methods for estimating the consumption rates for the different fireplace fuels.

## 2.1. Fireplaces – Cord Wood & Bundle Wood

A standard cord of wood is defined as a stack of wood with a volume of 128 cubic feet (4 ft. x 4 ft. x 8 ft.)



Bundle wood is typically purchased from a retail store, either packaged in a box or wrapped in plastic. Fireplaces burn cord wood and bundle wood for aesthetic purposes and for heating purposes. This methodology assumes wood consumption rates that include both cord wood and bundle wood. In addition, it is assumed that fireplaces burn more wood when they are used for heating purposes, as compared to aesthetic purposes (Houck, 2001a).

Provided below is a method to determine the percentage of fireplaces used for aesthetic and heating purposes, and the associated wood consumption rate for each of these uses. For fireplaces, the total amount of wood consumed is based on the number of individual fireplace units, rather than the number of homes that have fireplaces.

$$\text{Equation 2: } FP_{\text{aes}} = [FP_{\text{all}}] * [P_{\text{fp,cord}}] * [P_{\text{fp,aes}}]$$

$$\text{Equation 3: } F_{\text{aes}} = [FP_{\text{aes}}] * [N_{\text{cord,aes}}] * [W_{\text{cord}}]$$

Where

- $FP_{\text{aes}}$  = Number of fireplaces being used primarily for aesthetic purposes
- $FP_{\text{all}}$  = Number of fireplaces that are actually in use
- $P_{\text{fp,cord}}$  = Percent of people who used their fireplaces and primarily used cord wood = 88%, default (Houck, 2001b)
- $P_{\text{fp,aes}}$  = Percent of fireplace use that is for aesthetic purposes (SJVUAPCD, 2014)
- $F_{\text{aes}}$  = Amount of cord wood burned in fireplaces for aesthetic purposes, tons wood/year
- $N_{\text{cord,aes}}$  = Number of cords burned in fireplaces – aesthetics = 0.143 cords/fireplace/year, default (OMNI, 2006 and SJVUAPCD, 2014)
- $W_{\text{cord}}$  = Weight of an average cord of wood = 1.54 tons/cord, default (OMNI, 2006)

Equation 4:  $FP_{heat} = [FP_{all}] * [P_{fp, cord}] * [P_{fp, heat}]$

Equation 5:  $F_{heat} = [FP_{heat}] * [N_{cord, heat}] * [W_{cord}]$

Where

- $FP_{heat}$  = Number of fireplaces being used primarily for heating purposes
- $FP_{all}$  = Number of fireplaces that are actually in use
- $P_{fp, heat}$  = Percent of fireplace use that is for heating purposes (non-aesthetic) (SJVUAPCD, 2014)
- $F_{heat}$  = Amount of cord wood burned in fireplaces for heating purposes, tons wood/year
- $N_{cord, heat}$  = Number of cords burned in fireplaces for heating purposes = 0.656 cords/fireplace/year, default (Houck, 2001a)
- $W_{cord}$  = Weight of an average cord of wood = 1.54 tons/cord, default (OMNI, 2006)

## 2.2. Fireplaces - Manufactured Wax/Sawdust Logs

Manufactured Wax/Sawdust Logs (e.g., Pine Mountain, Hearthlog, etc.) are made from a mixture of sawdust, wax, and binders. Statewide sales data can be used to determine the District’s total consumption, which can then be distributed among the various counties. Provided below is a method to determine the manufactured log consumption rate for fireplaces.

Equation 6:  $H_{fp, ml} = [FP_{all}] * [P_{fp, ml}]$  for each county

Equation 7:  $F_{ml} = ([H_{fp, ml, each county}] / [H_{fp, ml, Statewide total}]) * [Statewide Total Sales]$

Where

- $H_{fp, ml}$  = Number of homes with fireplaces that primarily burn manufactured logs
- $FP_{all}$  = Number of fireplaces that are actually in use
- $P_{fp, ml}$  = Percent of active fireplaces that primarily burn manufactured logs = 12%, default (Houck, 2001b)
- $F_{ml}$  = Amount of manufactured logs burned in fireplaces, tons/year
- $H_{fp, ml, each county}$  = Number of homes with fireplaces that primarily burn manufactured logs for each county
- $H_{fp, ml, statewide total}$  = Statewide total for all homes with fireplaces that primarily burn manufactured logs (ARB, 2015)
- Statewide Total Sales = Total sales of manufactured logs in California, tons/year



## B. Wood Stoves

### 1. Determine the number of homes with wood stoves that are actually used.

$$\text{Equation 8: } H_{w,u} = [H_{\text{total}}] * [P_w] * [P_{w,u}]$$

Where

- $H_{w,u}$  = Number of homes with wood stoves that are actually in use
- $H_{\text{total}}$  = Number of occupied housing units in the county in 2003 (State of California, 2016)\*
- $P_w$  = Regional percent of homes with wood stoves (SJVUAPCD, 2014)
- $P_{w,u}$  = Percent of homes that use their wood stove, among those who use their wood-burning device (SJVUAPCD, 2014)

*\* The number of occupied housing units/homes is based on the 2003 number of occupied housing units/homes due to the District's moratorium on new wood-burning fireplaces after 2003. This is in accordance with CARB's original methodology.*

### 2. Determine the amount of wood burned in wood stoves.

For wood stoves, it is assumed that only cord wood is burned, because survey data indicates that wood stove owners do not purchase bundles of wood (OMNI, 2003). In addition, wax/sawdust manufactured logs are not recommended for use in wood stoves (HPBA, 2009b). There are three types of wood stoves that are addressed in this methodology: 1) Conventional Wood Stoves, 2) Phase II Catalytic Wood Stoves, and 3) Phase II Non-Catalytic Wood Stoves.

Provided below are methods for estimating the consumption rates for wood stoves.

#### 2.1. Wood Stoves – Cord Wood

This methodology assumes that all wood stoves in use burn cord wood. In addition, it is assumed that wood stoves are used for heating purposes only. Provided below is a method to determine the cord wood consumption rate for wood stoves.

## Total Cord Wood Consumption for All Wood Stoves

Equation 9:  $F_w = [H_{w,u}] * [N_{cord}] * [W_{cord}]$

Where

- $F_w$  = Total amount of cord wood burned in wood stoves, tons wood/year  
 $H_{w,u}$  = Number of homes with wood stoves that are actually in use  
 $N_{cord}$  = Number of cords burned in wood stoves, cords/home/year (ARB, 2015)  
 $W_{cord}$  = Weight of an average cord of wood = 1.54 tons/cord (OMNI, 2006)

## Cord Wood Consumption for Conventional Non-Catalytic Wood Stoves

Equation 10:  $F_{w,con} = [F_w] * [100\% - P_{ph}]$

Where

- $F_{w,con}$  = Amount of cord wood burned in conventional wood stoves, tons wood/year  
 $F_w$  = Total amount of cord wood burned in wood stoves, tons wood/year  
 $P_{ph}$  = Percent of wood stoves that are Phase II (ARB, 2015)

**Note:** It is assumed that all wood stoves purchased prior to 1 July 1990 were conventional non-catalytic units and all wood stoves purchased on or after 1 July 1990 are Phase II EPA-certified units (catalytic and non-catalytic). Therefore, the estimated percentage of conventional wood stoves is  $[100\% - P_{ph}]$ .

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-6, Footnote 1.

## Cord Wood Consumption for Phase II Catalytic Wood Stoves

Equation 11:  $F_{w,cat} = [F_w] * [P_{ph}] * [P_c]$

Where

- $F_{w,cat}$  = Amount of cord wood burned in Phase II catalytic wood stoves, tons wood/year  
 $F_w$  = Total amount of cord wood burned in wood stoves, tons wood/year  
 $P_{ph}$  = Percent of wood stoves that are Phase II (ARB, 2015)  
 $P_c$  = Percent of wood stoves that are catalytic (ARB, 2015)

**Note:** It is assumed that all wood stoves purchased prior to 1 July 1990 were conventional non-catalytic units. Therefore, the percentage of catalytic wood stoves was only applied to Phase II wood stoves purchased on or after 1 July 1990.

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-6, Footnote 1.

### **Cord Wood Consumption for Phase II Non-Catalytic Wood Stoves**

Equation 12:  $F_{w,ncat} = [F_w] * [P_{ph}] * [100\% - P_c]$

Where

- $F_{w,ncat}$  = Amount of cord wood burned in Phase II non-catalytic wood stoves, tons wood/year
- $F_w$  = Total amount of cord wood burned in wood stoves, tons wood/year
- $P_{ph}$  = Percent of wood stoves that are Phase II (i.e., purchased after 1 July 1990) (ARB, 2015)
- $P_c$  = Percent of wood stoves that are non-catalytic (ARB, 2015)

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-6, Footnote 1.

### **C. Fireplace Inserts**

Consistent with the original CARB methodology, this methodology assumes that fireplace inserts burn cord wood and are included in the calculations for wood stoves and/or fireplaces based on the District's 2010 survey.

#### **1. Determine the number of homes with fireplace inserts that are actually used.**

Equation 13:  $H_{fi,u} = [H_{total}] * [P_{fi}] * [P_{fi,u}]$

Where

- $H_{fi,u}$  = Number of homes with fireplace inserts that are actually in use
- $H_{total}$  = Number of occupied housing units in the county in 2003 (State of California, 2016)\*
- $P_{fi}$  = Percent of homes with fireplace inserts
- $P_{fi,u}$  = Percent of homes that use their fireplace insert. (OMNI, 2003)

*\* The number of occupied housing units/homes is based on the 2003 number of occupied housing units/homes due to the District's moratorium on new wood-burning fireplaces after 2003. This is in accordance with CARB's original methodology.*

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table D-8, Footnote 1.

## 2. Determine the amount of wood burned in fireplace inserts.

For fireplace inserts, we assume that three types of fuel are primarily burned: 1) cord wood, 2) bundle wood, and 3) compressed sawdust logs which are 100% sawdust and wood shavings with no wax or binders (e.g., Pres-to Logs, Eco-Logs, etc.). Similar to wood stoves, there are three types of fireplace inserts that are addressed in this methodology: 1) Conventional Fireplace Inserts, 2) Phase II Catalytic Fireplace Inserts, and 3) Phase II Non-Catalytic Fireplace Inserts. Emissions for fireplace inserts are reported under EIC 610-600-0230-0000, the general wood stove category. Provided below are methods for estimating the consumption rates for fireplace inserts.

### 2.1. Fireplace Inserts - Cord Wood

This methodology assumes that fireplace inserts burn cord wood for heating purposes only. Provided below is a method to determine the cord wood consumption rate for fireplace inserts.

#### **Total Cord Wood Consumption for All Fireplace Inserts**

$$\text{Equation 14: } F_{\text{fi,cord}} = [H_{\text{fi,u}}] * [N_{\text{cord}}] * [W_{\text{cord}}]$$

Where

- $F_{\text{fi,cord}}$  = Total amount of cord wood burned in fireplace inserts, tons wood/year
- $H_{\text{fi,u}}$  = Number of homes with fireplace inserts that are actually in use
- $N_{\text{cord}}$  = Number of cords burned in fireplace inserts, cords/home/year (OMNI, 2003)
- $W_{\text{cord}}$  = Weight of an average cord of wood = 1.54 tons/cord (OMNI, 2006)

#### **Cord Wood Consumption for Conventional Non-Catalytic Fireplace Inserts**

$$\text{Equation 15: } F_{\text{fi,con}} = [F_{\text{fi,cord}}] * [100\% - P_{\text{ph}}]$$

Where

- $F_{\text{fi,con}}$  = Amount of cord wood burned in conventional fireplace inserts, tons wood/year
- $F_{\text{fi,cord}}$  = Total amount of cord wood burned in fireplace inserts, tons wood/year
- $P_{\text{ph}}$  = Percent of fireplace inserts that are Phase II

**Note:** It is assumed that all fireplace inserts purchased prior to 1 July 1990 are conventional non-catalytic units and all fireplace inserts purchased on or after 1 July 1990 are Phase II

EPA-certified units (catalytic and non-catalytic). Therefore, the estimated percentage of conventional fireplace inserts is  $[100\% - P_{ph}]$ .

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-8, Footnote 1.

### **Cord Wood Consumption for Phase II Catalytic Fireplace Inserts**

Equation 16:  $F_{fi,cat} = [F_{fi,cord}] * [P_{ph}] * [P_c]$

Where

$F_{fi,cat}$  = Amount of cord wood burned in Phase II catalytic fireplace inserts, tons wood/year

$F_{fi,cord}$  = Total amount of cord wood burned in fireplace inserts, tons wood/year

$P_{ph}$  = Percent of fireplace inserts that are Phase II

$P_c$  = Percent of fireplace inserts that are catalytic

**Note:** It is assumed that all fireplace inserts purchased prior to 1 July 1990 were conventional non-catalytic units. Therefore, the percentage of catalytic fireplace inserts was only applied to Phase II fireplace inserts purchased on or after 1 July 1990.

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-8, Footnote 1.

### **Cord Wood Consumption for Phase II Non-Catalytic Fireplace Inserts**

Equation 17:  $F_{fi,ncat} = [F_{fi,cord}] * [P_{ph}] * [100\% - P_c]$

Where

$F_{fi,ncat}$  = Amount of cord wood burned in Phase II non-catalytic fireplace inserts, tons wood/year

$F_{fi,cord}$  = Total amount of cord wood burned in fireplace inserts, tons wood/year

$P_{ph}$  = Percent of fireplace inserts that are Phase II (i.e., purchased after 1 July 1990)

$P_c$  = Percent of fireplace inserts that are catalytic

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-8, Footnote 1.

## **2.2. Fireplace Inserts - Bundle Wood**

Bundle wood is typically purchased from a retail store, either packaged in a box or wrapped in plastic. Depending on the type of survey data available, bundle wood may be included with cord wood or it may be broken out separately. At the current time, the District does not have enough information

to segregate out the usage of bundle wood, therefore, the data in CARB's methodology (ARB, 2015) was retained and used.

### **Total Bundle Wood Consumption for All Fireplace Inserts**

Equation 18:  $F_{fi,bundle} = [H_{fi,u}] * [P_{fi,bundle}] * [N_{bundle}] * [W_{bundle}]$

Where

- $F_{fi,bundle}$  = Amount of bundle wood burned in fireplace inserts, tons wood/year
- $H_{fi,u}$  = Number of homes with fireplace inserts that are actually in use
- $P_{fi,bundle}$  = Percent of fireplace inserts that burn bundle wood
- $N_{bundle}$  = Number of bundles burned in fireplaces, bundles/home/year
- $W_{bundle}$  = Weight of an average bundle of wood = 0.024 ton/bundle (assuming 1 bundle = 1/64 of a cord or 1ft.x1ft.x2ft.) (OMNI, 2003)

### **Bundle Wood Consumption for Conventional Non-Catalytic Fireplace Inserts**

Equation 19:  $F_{fi,con,b} = [F_{fi,bundle}] * [100\% - P_{ph}]$

Where

- $F_{fi,con,b}$  = Amount of bundle wood burned in conventional fireplace inserts, tons wood/year
- $F_{fi,bundle}$  = Total amount of bundle wood burned in fireplace inserts, tons wood/year
- $P_{ph}$  = Percent of fireplace inserts that are Phase II (ARB, 2015)

**Note:** It is assumed that all fireplace inserts purchased prior to 1 July 1990 are conventional non-catalytic units and all fireplace inserts purchased on or after 1 July 1990 are Phase II EPA-certified units (catalytic and non-catalytic). Therefore, the estimated percentage of conventional fireplace inserts is  $[100\% - P_{ph}]$ .

### **Bundle Wood Consumption for Phase II Catalytic Fireplace Inserts**

Equation 20:  $F_{fi,cat,b} = [F_{fi,bundle}] * [P_{ph}] * [P_c]$

Where

- $F_{fi,cat,b}$  = Amount of bundle wood burned in Phase II catalytic fireplace inserts, tons wood/year
- $F_{fi,bundle}$  = Total amount of bundle wood burned in fireplace inserts, tons wood/year
- $P_{ph}$  = Percent of fireplace inserts that are Phase II (ARB, 2015)
- $P_c$  = Percent of fireplace inserts that are catalytic (ARB, 2015)

**Note:** It is assumed that all fireplace inserts purchased prior to 1 July 1990 were conventional non-catalytic units. Therefore, the percentage of catalytic fireplace inserts was only applied to Phase II fireplace inserts purchased on or after 1 July 1990.

### **Bundle Wood Consumption for Phase II Non-Catalytic Fireplace Inserts**

Equation 21:  $F_{fi,ncat,b} = [F_{fi,bundle}] * [P_{ph}] * [100\% - P_c]$

Where

$F_{fi,ncat,b}$  = Amount of bundle wood burned in Phase II non-catalytic fireplace inserts, tons wood/year

$F_{fi,bundle}$  = Total amount of bundle wood burned in fireplace inserts, tons wood/year

$P_{ph}$  = Percent of fireplace inserts that are Phase II

$P_c$  = Percent of fireplace inserts that are catalytic

### **2.3. Fireplace Inserts – Compressed Wood Logs**

Compressed Wood Logs are made from 100% compressed sawdust and wood shavings (e.g., Pres-to Logs, Eco-Logs, etc.). The use of compressed wood logs is very limited, when compared to the other fuels, and emissions from compressed wood logs often represent a negligible part of the emissions inventory. For that reason, this methodology estimates an overall consumption rate, rather than allocating the compressed wood log usage among different types of fireplace inserts (conventional, catalytic, non-catalytic). Provided below is a method to determine the overall compressed wood log consumption rate for fireplace inserts.

Equation 22:  $F_{fi,cwl} = [H_{fi,u}] * [P_{fi,cwl}] * [N_{cwl}] * [W_{cwl}]$

Where

$F_{fi,cwl}$  = Amount of compressed wood logs burned in fireplace inserts, tons/year

$H_{fi,u}$  = Number of homes with fireplace inserts that are actually in use

$P_{fi,cwl}$  = Percent of fireplace inserts that burn compressed wood logs

$N_{cwl}$  = Number of compressed wood logs burned in fireplace inserts, logs/home/year

$W_{cwl}$  = Weight of an average compressed wood log = 5 lbs/log or 0.0025 tons/log (OMNI, 2003)

### **D. Pellet Stoves**

Consistent with the original CARB methodology, this methodology assumes that pellet stoves burn cord wood and are included in the calculations for wood stoves and/or fireplaces based on the District's 2010 survey.

## 1. Determine the number of homes with wood-burning pellet stoves that are actually used.

$$\text{Equation 23: } H_{ps,u} = [H_{total}] * [P_{ps}] * [P_{ps,u}]$$

Where

- $H_{ps,u}$  = Number of homes with pellet stoves that are actually in use
- $H_{total}$  = Number of occupied housing units in the county in 2003 (State of California, 2016)\*
- $P_{ps}$  = Percent of homes that use their pellet stove, among those who use their wood-burning device (SJVUAPCD, 2014)
- $P_{ps,u}$  = Percent of homes that use their pellet stove, among those who use their wood-burning device (SJVUAPCD, 2014)

*\* The number of occupied housing units/homes is based on the 2003 number of occupied housing units/homes due to the District's moratorium on new wood-burning fireplaces after 2003. This is in accordance with CARB's original methodology.*

## 2. Determine the amount of wood burned in pellet stoves.

The methodology assumes that all pellet stoves in use burn only one type of fuel – compressed wood pellets. Survey data are available to estimate average consumption rates for sacks of pellets (OMNI, 2003). Provided below is a method to determine the consumption rate for sacks of pellets used in pellet stoves:

$$\text{Equation 24: } F_{ps} = [H_{ps,u}] * [N_{sacks}] * [W_{sack}]$$

$$\text{Equation 25: } F_{ps,all} = [F_{ps}] + [BC_{PE}]$$

Where

- $H_{ps,u}$  = Number of homes with pellet stoves that are actually in use
- $F_{ps}$  = Amount of pellets burned in pellet stoves, tons/year
- $N_{sacks}$  = Number of sacks of pellets burned in pellet stoves, sacks/home/year (OMNI, 2003)
- $W_{sack}$  = Weight of an average sack of pellets = 40 lbs/sack or 0.02 tons/sack (HPBA, 2009c)
- $F_{ps,all}$  = Total amount of pellets burned in pellet stoves (tons/year)
- $BC_{PE}$  = Number of pellets burned in pellet stoves added through the District's Burn Cleaner program (tons/year)

**Note:** Adjustments are made per the District's Burn Cleaner Program as noted in Appendix A, Table A-11, Footnote 1.

Emissions for pellet stoves are reported under EIC 610-600-0230-0000, the general wood stove category.



## E. Emissions Calculations

After fuel consumption data are determined as described above, emissions are calculated using the following general equation:

$$\text{Equation 26: } E = [EF] * [F] / 2000 \text{ lbs/ton}$$

Where

E = Emissions, tons/year

F = Amount of fuel burned, tons/year

EF = Emission Factor, lbs pollutant/ton fuel burned

Detailed data on fuel use and emissions are presented in Appendix A. Table A-4 contains 2015 estimated fuel use and emissions for fireplaces. Table A-12 contains 2015 estimated fuel use and emissions for wood stoves (including wood stoves, fireplace inserts, and pellet stoves).

## F. Sample Calculations

### Estimating Annual Emissions for Residential Fireplaces: Tulare County

In 2003, Tulare County had 114,640 houses. A survey was conducted in 2014 that gathered data for the San Joaquin Valley area, including Tulare County (SJVUAPCD, 2014). Based on the survey data and adjustments for the District's Burn Cleaner Program, the emission calculations for wood-burning fireplaces are provided below for Tulare County (Note: Numbers may not add up exactly due to rounding):

From Equation 1, determine the number of fireplaces that are actually being used in Tulare County:

$$FP_{\text{all}} = ([H_{\text{total}}] * [P_{\text{wbd}}] * [P_{\text{fp,wbd}}] * [P_{\text{fp,u}}] * [M_{\text{fp}}]) - [BC_{\text{OH}}]$$

From the 2014 survey data: 28% of homes in Tulare County have a wood-burning device, 78% of those devices are wood burning fireplaces, and 41% of homes use their wood burning device (SJVUAPCD, 2014). The average number of fireplaces per home is 1.1, to account for the fact that some homes have multiple fireplaces (OMNI, 2003). Also, the number of fireplaces changed-out through the District's Burn Cleaner Program are removed from the total.

$$FP_{\text{all}} = ([114,640] * [28\%] * [78\%] * [41\%] * [1.1]) - [283] = \\ 11,027 \text{ fireplaces in use}$$

For cord wood and bundle wood, use Equations 2 and 4 to determine the number of fireplaces being used for aesthetic and heating purposes:

$$FP_{aes} = [FP_{all}] * [P_{fp,cord}] * [P_{fp,aes}]$$

$$FP_{heat} = [FP_{all}] * [P_{fp,cord}] * [P_{fp,heat}]$$

Survey data indicate that 69.5% of the fireplaces in Tulare County are used for aesthetic purposes and the remaining 30.5% are used for heating purposes (SJVUAPCD, 2014). Also, it is estimated that 88% of fireplaces burn primarily cord wood (Houck, 2001b).

$$\begin{aligned} FP_{aes} &= [11,027 \text{ fireplaces}] * [88\%] * [69.5\%] \\ &= 6,744 \text{ fireplaces used for aesthetic purposes} \end{aligned}$$

$$\begin{aligned} FP_{heat} &= [11,027 \text{ fireplaces}] * [88\%] * [30.5\%] \\ &= 2,960 \text{ fireplaces used for heating purposes} \end{aligned}$$

Use Equations 3 and 5 to determine the amount of cord wood and bundle wood burned in fireplaces for aesthetic and heating purposes:

$$F_{aes} = [FP_{aes}] * [N_{cord,aes}] * [W_{cord}]$$

$$F_{heat} = [FP_{heat}] * [N_{cord,heat}] * [W_{cord}]$$

The methodology for U.S. EPA's 2002 National Emission Inventory assumes that the cord wood burn rate for fireplaces used for heating purposes is 0.656 cords/fireplace/year (Houck, 2001a). For fireplaces used for aesthetic purposes, a manual calculation using data from the OMNI report (OMNI, 2006) estimated a cord wood burn rate of 0.143 cords/fireplace/year. The average weight for a cord of wood is assumed to be 1.54 tons/cord (OMNI, 2006).

$$\begin{aligned} F_{aes} &= [6,744 \text{ fireplaces}] * [0.143 \text{ cords/fireplace/year}] * [1.54 \text{ tons/cord}] \\ &= 1,490 \text{ tons burned/year for aesthetic purposes} \end{aligned}$$

$$\begin{aligned} F_{heat} &= [2,960 \text{ fireplaces}] * [0.656 \text{ cords/fireplace/year}] * [1.54 \text{ tons/cord}] \\ &= 2,990 \text{ tons burned/year for heating} \end{aligned}$$

Using Equation 26, calculate emissions from fireplaces burning cord wood:

$$E = [EF] * [F] / 2000 \text{ lbs/ton}$$

From Table 2, the PM<sub>2.5</sub> emission factor is 22.7 lbs PM<sub>2.5</sub>/ton burned

$$\begin{aligned} E &= [22.7 \text{ lbs PM}_{2.5}/\text{ton}] * [1,490 \text{ tons burned/year}] / 2000 \text{ lbs/ton} \\ &= 16.9 \text{ tons PM}_{2.5}/\text{year for aesthetic purposes} \end{aligned}$$

$$\begin{aligned} E &= [22.7 \text{ lbs PM}_{2.5}/\text{ton}] * [2,990 \text{ tons burned/year}] / 2000 \text{ lbs/ton} \\ &= 33.9 \text{ tons PM}_{2.5}/\text{year for heating} \end{aligned}$$

For manufactured logs, use Equations 6 and 7 to determine the number of fireplaces being used for aesthetic and heating purposes:

$$H_{fp,ml} = [FP_{all}] * [P_{fp,ml}] \text{ for each county}$$

$$F_{ml} = ([H_{fp,ml,each\ county}] / [H_{fp,ml,statewide\ total}]) * [\text{Statewide Total Sales}]$$

It is estimated that 12% of homes that use their fireplace primarily burn manufactured logs (Houck, 2001b).

$$H_{fp,ml} = [11,027 \text{ homes}] * [12\%] = 1,323 \text{ homes for Tulare County}$$

$$H_{fp,ml,statewide\ total} = 372,371 \text{ homes statewide}$$

$$F_{ml} = ([H_{fp,ml,each\ county}] / [H_{fp,ml,statewide\ total}]) * [\text{Statewide Total Sales}]$$

$$F_{ml} = ([1,323 \text{ homes}] / [372,371 \text{ homes}]) * [60,825 \text{ tons/yr}] = 216 \text{ tons burned/year}$$

Using Equation 26, calculate emissions from fireplaces burning manufactured logs:

$$E = [EF] * [F] / 2000 \text{ lbs/ton}$$

From Table 2, the PM<sub>2.5</sub> emission factor is 46.4 lbs PM<sub>2.5</sub>/ton burned

$$E = [46.4 \text{ lbs PM}_{2.5}/\text{ton}] * [216 \text{ tons burned/year}] / 2000 \text{ lbs/ton} \\ = 5.0 \text{ tons PM}_{2.5}/\text{year}$$

Total emissions from fireplaces in Tulare County:

$$E = 16.9 + 33.9 + 5.0 = 56 \text{ tons PM}_{2.5}/\text{year}$$

Detailed data on fuel use and emissions are presented in Appendix A.

## IX. Temporal Variation

### 1. Daily

CARB Code 33. Max Activity 7-9 AM & 7-11 PM, Average During Day, Low at Night (Residential Fuel Combustion)

### 2. Weekly

CARB Code 7. 7 days per week - uniform activity every day of the week.

## **Monthly**

Most residential wood burning occurs during the cold season (typically in the fall, winter and early spring). To determine monthly emissions throughout the year, multiply annual average emissions by the monthly temporal factors. The SJVAPCD has established the monthly temporal profiles provided below:

**Table 3: Monthly Temporal Profiles (% of annual activity)**

<b>County</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
FRESNO	25.2	16.6	1.1	0.5	0.4	0.5	0	0	0.2	1.7	27.5	26.3
KERN	25.7	16	2.6	0.5	0.5	0.3	0	0	0	2	23.5	28.9
KINGS	24.9	16.1	1.8	0.5	0.5	0.3	0	0	0.1	1.8	26	28
MADERA	25	16.3	1.8	0.5	0.5	0.5	0	0	0.2	1.8	27.5	25.9
MERCED	25	17.3	1.8	0.5	0.5	0.4	0	0	0.1	1.8	26.6	26
SAN JOAQUIN	23.6	16.9	1.8	0.5	0.5	0.5	0	0	0.3	1.8	28	26.1
STANISLAUS	25.4	17	1.8	0.5	0.5	0.5	0	0	0.2	1.8	25.3	27
TULARE	25	16.3	1.8	0.5	0.5	0.5	0	0	0.1	1.8	26.3	27.2

## **X. Spatial Variation**

The District has developed spatial surrogates that identify incorporated and unincorporated areas within the SJVUAPCD. Additionally, the District has developed spatial surrogates based on residential wood combustion during curtailment periods.

In the future, performing this methodology on zip code by zip code basis could improve the spatial allocation of emissions.

## **XI. Growth Factor**

Growth factors are developed by either the District's Strategies and Incentives Department or CARB for each EIC. These factors are used to estimate emissions in future years. The growth factors associated with this emissions category may be obtained from the District's Strategies and Incentives Department.

## **XII. Control Level**

Control levels are developed by either the District's Strategies and Incentives Department or CARB for each EIC. Control levels are used to estimate emissions reductions in future years due to implementation of District rules. These control levels take into account the effect of control technology, compliance and exemptions at full implementation of the rules. Control levels associated with this emissions category may be obtained from the District's Strategies and Incentives Department.

### XIII. CARB Chemical Speciation

CARB has developed organic gas profiles in order to calculate reactive organic gasses (ROG), volatile organic compounds (VOC) or total organic gas (TOG) given any one of the three values. For each speciation profile, the fraction of TOG that is ROG and VOC is given. The organic gas profile codes can also be used to lookup associated toxics. Organic gas profile #549 is applied to REIC 610-600-0230-0000 (Residential Wood Combustion – Wood Stoves), REIC 610-602-0230-0000 (Residential Wood Combustion – Fireplaces), and REIC 610-604-0230-0000 (Residential Wood Combustion – Unspecified).

CARB has also developed particulate matter speciation profiles in order to calculate particulate matter (PM), particulate matter with a diameter less than or equal to 10 microns (PM<sub>10</sub>) or particulate matter with a diameter less than or equal to 2.5 microns (PM<sub>2.5</sub>) given any one of the three values. For each speciation profile, the fraction of PM that is PM<sub>10</sub> and PM<sub>2.5</sub> is given. The particulate matter profile codes can also be used to lookup associated toxics. Particulate matter profile #424 is applied to REIC 610-600-0230-0000 (Residential Wood Combustion – Wood Stoves), REIC 610-602-0230-0000 (Residential Wood Combustion – Fireplaces), and REIC 610-604-0230-0000 (Residential Wood Combustion – Unspecified).

CARB’s speciation profiles for residential wood combustion processes are presented in the tables below

**Table 4. CARB organic gas speciation profiles for 610-600-0230-0000, 610-602-0230-0000, and 610-604-0230-0000.**

Profile Description	CARB Organic Gas Profile#	Fractions	
		ROG	VOC
Red Oak Combustion - Wood Stove (w/o catalyst)	549	0.4385	0.4385

**Table 5. CARB particulate matter speciation profiles for 610-600-0230-0000, 610-602-0230-0000, and 610-604-0230-0000.**

Profile Description	CARB PM Profile#	Fractions	
		PM <sub>10</sub>	PM <sub>2.5</sub>
Fireplaces and Woodstoves	424	0.935	0.9001

## **XIV. Assessment Of Methodology**

This area source estimate is based on a CARB methodology (ARB, 2015) for residential wood combustion. The refinements below were made to the CARB methodology in order to improve on the data collected and to more accurately reflect the conditions within the SJVUAPCD.

- In the CARB methodology, a key component of the emissions calculation is to determine the number of homes (occupied housing units) with respective wood burning devices in use (fireplaces, wood stoves, fireplace inserts, and pellet stoves). As an update to the CARB methodology, this method uses new survey results (SJVUAPCD, 2014) to provide more representative data of the SJV Air Basin that allows for a regional distribution of wood burning devices and their use.

Information collected through the 2014 SJVUAPCD survey (SJVUAPCD, 2014) also provided additional data points that were used to refine the fuel usage rates for several types of wood burning devices. The information collected allowed for a refinement of the speciation of wood burning devices.

- Information gathered through the SJVUAPCD's Burn Cleaner program (see Appendix B) was used to further refine the population of wood burning devices in the SJVUAPCD. Open hearth and wood stoves replaced by the program were removed from their respective estimated populations and replaced by newer, cleaners units. These replacements units have lower emission factors associated with them, resulting in additional reductions in emissions.

Using these refinements, estimated emissions from residential wood combustion were lowered throughout each of the eight counties in the SJVUAPCD.

Although the refinements in this section improve upon the existing CARB methodology, they are not without their limitations. The following deficiencies and enhancements should be examined in order to improve on this methodology.

- The 2014 SJVUAPCD survey did not necessarily ask for information that was specific to the needs of this methodology, therefore most of the data from the survey that was used in this methodology was extrapolated from regional data rather than at the county level. An improvement on this would be to perform a new survey where the questions would be updated to fit the needs of this methodology.
- In order to improve on the spatial allocation of emissions, this methodology could be performed on a zip code by zip code basis. The emissions could then be placed in a modeling grid for further refinement.

- To identify the number of homes that have a fireplace unit, a parcel search tool can be used. The CoreLogic RealQuest Professional product can be utilized to identify the number of homes within a given zip code that have a fireplace unit, including, but not limited to a conventional wood-burning fireplace, a natural gas fireplace, a wood stove, a pellet stove, etc. (CoreLogic, 2016). This search tool allows for refined search criteria based on land use type. This refinement ensures that the total number of homes would not be inflated by land use types that would not have a fireplace, such as commercial or industrial operations.

## IX. Emissions

### Fireplaces

Following is the 2015 area source emissions inventory for REIC 610-602-0230-0000 (Fireplaces) estimated by this methodology. Emissions are reported for each county in the District.

**Table 6. Area source emissions for REIC 610-602-0230-0000 updated (2015).**

County	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NOx	CO	SOx	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fresno	15	788	3	104	131	126	18,222
Kern	10	547	2	72	91	88	12,666
Kings	2	110	0	15	18	18	2,544
Madera	2	115	0	15	19	18	2,653
Merced	5	272	1	36	45	44	6,289
San Joaquin	14	771	3	102	129	124	17,847
Stanislaus	12	616	2	81	103	99	14,256
Tulare	7	349	1	46	58	56	8,065
<b>Total</b>	<b>67</b>	<b>3,567</b>	<b>14</b>	<b>471</b>	<b>594</b>	<b>572</b>	<b>82,542</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.

Following is the 2015 area source emissions inventory for REIC 610-602-0230-0000 estimated by the previous methodology performed by CARB (ARB, 2015). Emissions are reported for each county in the District.

**Table 7. Area source emissions for REIC 610-602-0230-0000 CARB (2015).**

County	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NOx	CO	SOx	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fresno	12	928	2	181	118	113	18,000
Kern	5	405	1	79	51	50	8,000
Kings	1	62	0	12	8	8	2,000
Madera	5	388	1	76	49	47	8,000
Merced	9	703	1	137	89	86	14,000
San Joaquin	6	444	1	87	56	54	8,000
Stanislaus	11	859	2	168	109	105	16,000
Tulare	23	1,771	4	346	225	217	34,000
<b>Total</b>	<b>73</b>	<b>5,560</b>	<b>11</b>	<b>1,085</b>	<b>706</b>	<b>680</b>	<b>110,000</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.



Following is the net change in total unreconciled emissions between this update (2015 inventory year) and the previous methodology performed by CARB for REIC 610-602-0230-0000. The change in emissions are reported for each county in the District.

**Table 8. Net emissions change for REIC 610-602-0230-0000 (2015).**

County	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NOx	CO	SOx	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fresno	3	-140	1	-77	13	13	222
Kern	5	142	1	-7	40	38	4,666
Kings	1	48	0	3	10	10	544
Madera	-3	-273	-1	-61	-30	-29	-5,347
Merced	-4	-431	0	-101	-44	-42	-7,711
San Joaquin	8	327	2	15	73	70	9,847
Stanislaus	1	-243	0	-87	-6	-6	-1,744
Tulare	-16	-1,422	-3	-300	-167	-161	-25,935
<b>Total</b>	<b>-9</b>	<b>-2,139</b>	<b>2</b>	<b>-633</b>	<b>-135</b>	<b>-131</b>	<b>-30,990</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.

## Wood Stoves

Following is the 2015 area source emissions inventory for REIC 610-600-0230-0000 (wood stoves) estimated by this methodology. Emissions are reported for each county in the District.

**Table 9. Area source emissions for REIC 610-600-0230-0000 updated (2015).**

County	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NOx	CO	SOx	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fresno	26	1,155	3	205	150	144	17,575
Kern	15	627	2	114	82	79	9,701
Kings	3	88	0	16	12	11	1,400
Madera	4	195	1	31	25	25	2,945
Merced	10	520	1	96	67	65	7,796
San Joaquin	18	631	2	110	83	80	10,050
Stanislaus	17	706	2	128	92	89	10,933
Tulare	12	588	2	107	76	73	8,866
<b>Total</b>	<b>107</b>	<b>4,510</b>	<b>13</b>	<b>806</b>	<b>587</b>	<b>565</b>	<b>69,265</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.

Following is the 2015 area source emissions inventory for REIC 610-600-0230-0000 estimated by the previous methodology performed by CARB (ARB, 2015). Emissions are reported for each county in the District.

**Table 10. Area source emissions for REIC 610-600-0230-0000 CARB (2015).**

County	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NOx	CO	SOx	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fresno	19	1,068	3	137	172	165	32,000
Kern	12	690	2	89	111	107	22,000
Kings	3	141	0	18	23	22	4,000
Madera	5	269	1	35	43	42	8,000
Merced	6	357	1	46	57	55	10,000
San Joaquin	31	1,743	5	224	281	270	50,000
Stanislaus	16	920	3	118	148	143	26,000
Tulare	13	740	2	95	119	115	20,000
<b>Total</b>	<b>106</b>	<b>5,928</b>	<b>18</b>	<b>761</b>	<b>954</b>	<b>918</b>	<b>170,000</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.

Following is the net change in total unreconciled emissions between this update (2015 inventory year) and the previous methodology performed by CARB for REIC 610-600-0230-0000. The change in emissions are reported for each county in the District.

**Table 11. Net emissions change for REIC 610-600-0230-0000 (2015).**

County	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NOx	CO	SOx	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fresno	7	87	0	68	-22	-21	-14,425
Kern	3	-63	0	25	-29	-28	-12,299
Kings	0	-53	0	-2	-11	-11	-2,600
Madera	-1	-74	0	-4	-18	-17	-5,055
Merced	4	163	0	50	10	10	-2,204
San Joaquin	-13	-1,112	-3	-114	-198	-190	-39,950
Stanislaus	1	-214	-1	10	-56	-54	-15,067
Tulare	-1	-152	0	12	-43	-42	-11,134
<b>Total</b>	<b>1</b>	<b>-1,418</b>	<b>-5</b>	<b>45</b>	<b>-367</b>	<b>-353</b>	<b>-100,735</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.

Area source emissions inventory for REIC 610-600-0230-0000 were not estimated by this methodology.

## Summary of Emissions

**Table 12. Area source emissions summary for REICs 610-600-0230-0000 (wood stoves) and REICs 610-602-0230-0000 (fireplaces) (2015).**

	Criteria Emissions (tons/year)						Toxic Emissions (lb/year)
	NO <sub>x</sub>	CO	SO <sub>x</sub>	VOC <sup>(1)</sup>	PM <sub>10</sub>	PM <sub>2.5</sub> <sup>(2)</sup>	NH <sub>3</sub>
Fireplaces (CARB)	73	5,560	11	1,085	706	680	110,000
Fireplaces (District)	67	3,567	14	471	594	572	82,542
Change in Emissions	-6	-1,993	3	-614	-112	-108	-27,458
Wood Stoves (CARB)	106	5,928	18	761	954	918	170,000
Wood Stoves (District)	107	4,510	13	806	587	565	69,265
Change in Emissions	1	-1418	-5	45	-367	-353	-100,735
<b>Net Total</b>	<b>-5</b>	<b>-3,411</b>	<b>-2</b>	<b>-570</b>	<b>-479</b>	<b>-461</b>	<b>-128,193</b>

(1) The District only reports ROG to CARB. As noted in Section XIV, ROG is the same as VOC.

(2) PM<sub>2.5</sub> emissions can be estimated using the speciation profiles found in Section XIV.

## **XV. Revision History**

2016. This is a new District methodology based on CARB's Residential Wood Combustion methodology (ARB, 2015). The previous estimate used CARB's Residential Wood Combustion methodology.

## **XVI. Update Schedule**

Emissions estimates for these source categories will be updated as needed by the District for planning purposes.

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## **XVIII. Appendices**

Appendix A. Calculations

Appendix B. Burn Cleaner Program/District Survey



## Appendix A - Calculations

Table A-1 Regional Fireplaces - Number of Devices - Regionally Distributed

County (AB)	H <sub>total</sub>	P <sub>wbd</sub>	P <sub>fp,wbd</sub>	P <sub>fp</sub>	P <sub>fp,u</sub>	[P <sub>fp</sub> ]x[P <sub>fp,u</sub> ]	H <sub>fp,u</sub>	M <sub>fp</sub>	BC <sub>OH</sub>	FP <sub>all</sub>
	# of homes in 2003 <sup>1</sup>	Regional % of homes with wood burning devices <sup>2</sup>	% of wood burning devices that are fireplaces <sup>2</sup>	Regional % of homes with fireplaces	% of homes that use their wood burning fireplace <sup>2</sup>	% of homes with wood burning fireplaces that are in use	# of homes with fireplaces in use	# of fireplaces per home <sup>3</sup>	# of fireplaces removed <sup>4</sup>	# of fireplaces in use
Fresno	261,554	28%	78%	21.9%	41%	8.97%	23,458	1.1	1,602	24,202
Kern (SJV)	181,734	28%	78%	21.9%	41%	8.97%	16,299	1.1	1,289	16,640
Kings	35,812	28%	78%	21.9%	41%	8.97%	3,212	1.1	110	3,423
Madera	38,051	28%	78%	21.9%	41%	8.97%	3,413	1.1	189	3,565
Merced	67,116	37%	78%	28.9%	41%	11.85%	7,954	1.1	248	8,502
San Joaquin	193,423	37%	78%	28.9%	41%	11.85%	22,924	1.1	1,401	23,815
Stanislaus	153,742	37%	78%	28.9%	41%	11.85%	18,221	1.1	1,018	19,025
Tulare	114,640	28%	78%	21.9%	41%	8.97%	10,282	1.1	619	10,691
<b>Total</b>	<b>1,046,072</b>							<b>Total</b>	<b>6,476</b>	<b>109,863</b>

H<sub>total</sub> : Number of occupied housing units/homes in 2003 (State of California, 2016).

P<sub>wbd</sub>: = % wood burning devices by region (SJVUAPCD, 2014, Figure 5)

P<sub>fp,wbd</sub>: Air Basin-wide percent of wood-burning fireplaces/percent of all woodburning devices (25%/32% = 78%) (SJVUAPCD, 2014, Figure 1)

P<sub>fp</sub> : Percent of homes with wood-burning fireplaces, by region (SJVUAPCD, 2014). [P<sub>fp</sub>] = [P<sub>wbd</sub>] \* [P<sub>fp,wbd</sub>]

P<sub>fp,u</sub> : Percent of homes that use their fireplace, among those who use their wood-burning device (SJVUAPCD, 2014, Figure 2).

H<sub>fp,u</sub> : Number of homes with fireplaces that are actually being used. H<sub>fp,u</sub> = [H<sub>total</sub>]\*[P<sub>fp</sub>]\*[P<sub>fp,u</sub>]

M<sub>fp</sub> : 1.1 fireplaces per home (OMNI, 2003)

FP<sub>all</sub> : Total number of fireplaces that are actually being used. FP<sub>all</sub> = ([H<sub>fp,u</sub>]\*[M<sub>fp</sub>]) - BC<sub>OH</sub>

BC<sub>OH</sub> : Number of open hearth fireplaces removed through the District's Burn Cleaner Program

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- 4 District Burn Cleaner Program

**Table A-2 Regional Fireplaces – Amount of Cord Wood Burned**

County (AB)	$P_{fp,cord}$ % of people who use their fireplaces and primarily burned cord wood <sup>1</sup>	$P_{fp,aes}$ % of fireplace use that is for aesthetic purposes <sup>2</sup>	$P_{fp,heat}$ % of fireplace use that is for heating purposes <sup>2</sup>	$FP_{aes}$ # of fireplaces being used for aesthetic purposes	$N_{cord,aes}$ # of cords burned in fireplaces – aesthetics (cord/fireplace/yr) <sup>3</sup>	$F_{aes}$ Cord wood burned in fireplaces for aesthetics, tons/yr	$FP_{heat}$ # of fireplaces being used for heating purposes	$N_{cord,heat}$ # of cords burned in fireplaces – heating (cord/fireplace/yr) <sup>4</sup>	$F_{heat}$ Cord wood burned in fireplaces for heating, tons/yr	$F_{aes} + F_{heat}$ Total cord wood burned in fireplaces, tons/yr
Fresno	88.00%	69.5%	30.5%	15,239	0.143	3,367	6,687	0.656	6,756	10,123
Kern (SJV)	88.00%	69.5%	30.5%	10,592	0.143	2,340	4,648	0.656	4,696	7,036
Kings	88.00%	69.5%	30.5%	2,127	0.143	470	934	0.656	943	1,413
Madera	88.00%	69.5%	30.5%	2,219	0.143	490	974	0.656	984	1,474
Merced	88.00%	69.5%	30.5%	5,260	0.143	1,162	2,308	0.656	2,332	3,494
San Joaquin	88.00%	69.5%	30.5%	14,924	0.143	3,297	6,550	0.656	6,617	9,914
Stanislaus	88.00%	69.5%	30.5%	11,921	0.143	2,634	5,232	0.656	5,285	7,919
Tulare	88.00%	69.5%	30.5%	6,744	0.143	1,490	2,960	0.656	2,990	4,480
			<b>Total</b>	<b>69,026</b>		<b>Total</b>	<b>30,292</b>		<b>Total</b>	<b>45,852</b>

$P_{fp,cord}$ : Percent of people who used their fireplaces who primarily used cord wood = 88%, default (Houck, 2001b)

$P_{fp,aes}$ : Percent of fireplace use that is for aesthetic purposes (28.5%) divided by 41% who use their fireplace (SJVUAPCD, 2014)

(28.5% based on 100% of responses "less than once a week" (17%) and "once a week" (8%); 50% of responses "several days a week" (7%/2 =3.5%))

$P_{fp,heat}$ : Percent of fireplace use that is for heating purposes (assumed to be to 1- $P_{fp,aes}$ , or 12.5% divided by 41% who use their fireplace) (SJVUAPCD, 2014)

(100% of responses "nearly every day" (8%), 50% of responses "several days a week" (7%/2 = 3.5%), and the remaining 1% unaccounted for due to rounding, as a conservative assumption) (SJVUAPCD, 2014)

$FP_{aes}$ : Number of fireplaces used for aesthetic purposes.  $FP_{aes} = [FP_{all}] * [P_{fp,cord}] * [P_{fp,aes}]$ .

$N_{cord,aes}$ : Number of cords burned in fireplaces for aesthetic purposes = 0.143 cords/fireplace/year (OMNI, 2006 and SJVUAPCD, 2014)

$F_{aes}$ : Amount of cord wood burned in fireplaces for aesthetics, tons/yr ( $F_{aes} = [FP_{all}] * [P_{fp,cord}] * [P_{fp,aes}] * [N_{cord,aes}] * [W_{cord}]$ ), where  $W_{cord} = 1.54$  tons/cord (OMNI, 2006)

$FP_{heat}$ : Number of fireplaces used for heating purposes.  $[F_{heat}] = [FP_{all}] * [P_{fp,cord}] * [P_{fp,heat}]$

$N_{cord,heat}$ : Number of cords burned in fireplaces for heating purposes = 0.656 cords/fireplace/year, default (Houck, 2001a).

$F_{heat}$ : Amount of cord wood burned in fireplaces for heating, tons/yr ( $F_{heat} = [FP_{all}] * [P_{fp,cord}] * [P_{fp,heat}] * [N_{cord,heat}] * [W_{cord}]$ ), where  $W_{cord} = 1.54$  tons/cord (OMNI, 2006)

$[F_{aes}] + [F_{heat}]$ : Total amount of cord wood burned in fireplaces, tons/yr.

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**Table A-3: Regional Fireplaces – Amount of Manufactured Logs Burned**

County (AB)	P <sub>fp,ml</sub>	H <sub>fp,ml</sub>	County share of all CA homes that burn manufactured logs	F <sub>ml</sub>
	% of people who used their fireplaces who primarily used manufactured logs <sup>1</sup>	# of homes with fireplaces that burn manufactured logs		Manufactured logs burned in fireplaces tons/year
Fresno	12.0%	2,990	0.8%	488
Kern (SJV)	12.0%	2,078	0.6%	339
Kings	12.0%	417	0.1%	68
Madera	12.0%	435	0.1%	71
Merced	12.0%	1,032	0.3%	169
San Joaquin	12.0%	2,928	0.8%	478
Stanislaus	12.0%	2,339	0.6%	382
Tulare	12.0%	1,323	0.4%	216
<b>Total SJV</b>		<b>13,543</b>	<b>3.6%</b>	<b>2,212</b>
<b>California</b>		<b>372,371<sup>2</sup></b>	<b>Statewide Total Sales (tons)</b>	<b>60,825</b>

**Notes:**

Estimated Statewide Total Sales in 2005 (60,825 tons/yr) were distributed to counties based on the percentage of homes with fireplaces that burn manufactured logs.

**P<sub>fp,ml</sub>**: Percent of people who used their fireplaces and who primarily used manufactured logs. (Houck, 2001a)

**H<sub>fp,ml</sub>**: Number of homes with fireplaces that burn manufactured wax/sawdust logs.  $[H_{fp,ml}] = [FP_{all}] * [P_{ml}]$

$[County\ Share] = [H_{fp,ml,each\ County}] / [H_{fp,ml,statewide\ total}]$

**F<sub>ml</sub>**: Amount of manufactured wax/sawdust logs burned in fireplaces, tons/year =  $[Statewide\ Total\ Sales, tpy] * [County\ Share]$ .

**References:**

- 1 Houck, 2001b. Houck, James E. (OMNI Consulting, Inc.), "Recommended Procedure for Compiling Emission Inventory Data for Manufactured Wax/Sawdust Fireplace Logs", prepared for Roy Huntley (U.S. EPA, OAQPS); October 10, 2001; <http://www.omni-test.com/publications/actfire.pdf>
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**Table A-4: Regional Fireplaces – Fuel Use and Emissions Estimates**

County (Air Basin)	Fuel Use (Tons/Yr)			Emissions (Tons/Year)						
	Cord Wood	Mfrd. Logs	Total All Fuels	CO	NOX	PM <sub>2.5</sub>	PM <sub>10</sub>	SO <sub>2</sub>	ROG	NH <sub>3</sub>
Fresno	10,123	488	10,611	788	15	126	131	3	104	9
Kern (SJV)	7,036	339	7,375	547	10	88	91	2	72	6
Kings	1,413	68	1,481	110	2	18	18	0	15	1
Madera	1,474	71	1,545	115	2	18	19	0	15	1
Merced	3,494	169	3,662	272	5	44	45	1	36	3
San Joaquin	9,914	478	10,392	771	14	124	129	3	102	9
Stanislaus	7,919	382	8,301	616	12	99	103	2	81	7
Tulare	4,480	216	4,696	349	7	56	58	1	46	4
<b>Total (Tons/Yr)</b>	<b>45,852</b>	<b>2,212</b>	<b>48,064</b>	<b>3,567</b>	<b>67</b>	<b>572</b>	<b>594</b>	<b>14</b>	<b>471</b>	<b>41</b>
<b>Total (Tons/Day)</b>	<b>126</b>	<b>6.1</b>	<b>132</b>	<b>9.77</b>	<b>0.18</b>	<b>1.57</b>	<b>1.63</b>	<b>0.04</b>	<b>1.29</b>	<b>0.11</b>

PM profile code #424 Organic profile code #549	Fireplace Emission Factors (lb/ton fuel burned)						
	CO	NOX	PM <sub>2.5</sub>	PM <sub>10</sub>	SO <sub>2</sub>	ROG	NH <sub>3</sub>
Cord Wood / Bundles	149	2.6	22.7	23.6	0.4	18.9	1.8
Mfrd. Log	137	6.5	46.4	48.2	4.2	33.8	0.004

[Emissions, tons/yr] = [Emission Factor, lb/ton fuel burned]\*[Fuel Use, tons/yr]/[2000 lbs/ton]

[Total PM] = [PM<sub>10</sub>]/[0.935], per ARB particulate matter profile code #424

[PM<sub>2.5</sub>] = [Total PM]\*[0.9001] = [PM<sub>10</sub>]\*[0.9001/0.935] = [PM<sub>10</sub>]\*[0.963], per ARB particulate matter profile code #424

[Total Organic Gases, TOG] = [ROG]/0.4385, per ARB organic profile code #549

**References:**

- 1 ARB, 2015. California Air Resources Board; Section 7.1: Residential Wood Combustion. Table A-11. Accessed online on July 12, 2016 at [http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1\\_2011.pdf](http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1_2011.pdf)

**Table A-5: Wood Stoves – Number of Devices**

County (AB)	H <sub>total</sub>	P <sub>wbd</sub>	P <sub>w,wbd</sub>	P <sub>w</sub>	P <sub>w,u</sub>	[P <sub>w</sub> ] $\times$ [P <sub>w,u</sub> ]	H <sub>w,u</sub>
	# of homes in 2003 <sup>1</sup>	Regional % of homes with wood burning devices <sup>2</sup>	% of wood burning devices that are wood stoves <sup>2</sup>	Regional % of homes with wood stoves	% of homes that use their wood stoves <sup>2</sup>	% of homes with wood stoves that are in use	# of homes with wood stoves in use
Fresno	261,554	28.00%	12.50%	3.50%	41%	1.44%	3,753
Kern (SJV)	181,734	28.00%	12.50%	3.50%	41%	1.44%	2,608
Kings	35,812	28.00%	12.50%	3.50%	41%	1.44%	514
Madera	38,051	28.00%	12.50%	3.50%	41%	1.44%	546
Merced	67,116	37.00%	12.50%	4.63%	41%	1.90%	1,273
San Joaquin	193,423	37.00%	12.50%	4.63%	41%	1.90%	3,668
Stanislaus	153,742	37.00%	12.50%	4.63%	41%	1.90%	2,915
Tulare	114,640	28.00%	12.50%	3.50%	41%	1.44%	1,645
<b>Total</b>							<b>16,922</b>

**H<sub>total</sub>** : Number of occupied housing units/homes in 2003 (State of California, 2016).

**P<sub>wbd</sub>**: = % wood burning devices by region (SJVUAPCD, 2014)

**P<sub>w,wbd</sub>**: Air Basin-wide percent of wood stoves/percent of all woodburning devices (4%/32% = 12.5%) (SJVUAPCD, 2014, Figure 1)

**P<sub>w</sub>** : Percent of homes with wood stoves, by region (SJVUAPCD, 2014). [P<sub>w</sub>] = [P<sub>wbd</sub>] \* [P<sub>w,wbd</sub>]

**P<sub>w,u</sub>** : Percent of homes that use their wood stove, among those who use their wood-burning device (SJVUAPCD, 2014, Figure 2).

**H<sub>w,u</sub>**: Number of homes with wood stoves actually being used. H<sub>w,u</sub> = [H<sub>total</sub>] $\times$ [P<sub>w</sub>] $\times$ [P<sub>w,u</sub>]

**References:**

- 1 State of California, 2016. State of California, Department of Finance; E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark; May 2010; For the San Joaquin Valley, the data represent the number of Occupied Housing Units during 2003, because of a district moratorium on new wood-burning fireplaces after 2003. <http://www.dof.ca.gov/Forecasting/Demographics/Estimates/>
- 2 SJVUAPCD, 2014. San Joaquin Valley Unified Air Pollution Control District. Residential Wood Burning, Lawn Care, and Commuting Survey, Final Report, February 2014.

**Table A-6: Wood Stoves – Amount of Cord Wood Burned**

County (AB)	P <sub>ph</sub>	P <sub>c</sub>	N <sub>cord</sub>	F <sub>w</sub>	F <sub>w,con</sub>	F <sub>w,cat</sub>	F <sub>w,ncat</sub>	BC <sub>R</sub>	BC <sub>RT</sub>	BC <sub>A</sub>	BC <sub>AT-C</sub>	BC <sub>AT-NC</sub>	F <sub>w,all</sub>
	% of wood stoves that are Phase II (i.e., purchased after 1 July 1990) <sup>1</sup>	% of Phase II wood stoves that are catalytic <sup>1</sup>	# of cords of wood burned in wood stoves (cords/home/yr) <sup>1</sup>	Cord wood burned in wood stoves, tons/yr	Cord wood burned in conventional wood stoves, tons/yr	Cord wood burned in Phase II catalytic wood stoves, tons/yr	Cord wood burned in Phase II non-catalytic wood stoves, tons/yr	# Non-Cert. Stoves Removed <sup>3</sup>	Cord wood Removed in conventional wood stoves, tons/year	# Phase II wood stoves Added <sup>3</sup>	Cord wood burned in Phase II catalytic wood stoves, tons/yr	Cord wood burned in Phase II non-catalytic wood stoves, tons/yr	Total, all cord wood burned in wood stoves, tons/yr
Fresno	35.2%	8.7%	2.09	12,080	7,828	370	3,882	127	409	84	135	135	11,942
Kern (SJV)	35.2%	8.7%	1.57	6,305	4,086	193	2,026	46	111	30	36	36	6,267
Kings	35.2%	8.7%	1.16	918	595	28	295	9	16	7	6	6	914
Madera	35.2%	8.7%	2.61	2,195	1,422	67	705	113	454	91	183	183	2,106
Merced	35.2%	8.7%	2.67	5,233	3,391	160	1,682	34	140	30	62	62	5,217
San Joaquin	35.2%	8.7%	1.15	6,496	4,209	199	2,088	62	110	26	23	23	6,432
Stanislaus	35.2%	8.7%	1.55	6,959	4,509	213	2,236	43	103	27	32	32	6,921
Tulare	35.2%	8.7%	2.40	6,080	3,940	186	1,954	68	251	49	91	91	6,010
				46,266	29,981	1,417	14,869	502	1594	344	568	568	45,809

**Note:** To obtain the total amount of fuel use for conventional stoves, cord wood removed through the Burn Cleaner Program [BC<sub>RT</sub>] is subtracted from the total conventional cord wood [F<sub>w,con</sub>]. To account for wood stoves added to the system, half of the stoves added are assumed to be catalytic and the other half non-catalytic. Cord wood burned for each category is then added to the respective totals, [F<sub>w,cat</sub>] and [F<sub>w,ncat</sub>], to calculate total fuel use. It is assumed that all wood stoves removed or added through the Burn Cleaner Program were/are being used.

**P<sub>ph</sub>:** Percent of wood stoves that are EPA certified Phase II (i.e., purchased after 1 July 1990) (ARB, 2015).

**P<sub>c</sub>:** Percent of Phase II wood stoves that are catalytic (ARB, 2015).

**N<sub>cord</sub>:** Number of cords of wood burned in wood stoves (cords/home/yr) (ARB, 2015).

**F<sub>w</sub>:** Total amount of cord wood burned in wood stoves, tons/year. [F<sub>w</sub>] = [H<sub>w,u</sub>]\*[N<sub>cord</sub>]\*[W<sub>cord</sub>], where H<sub>w,u</sub> is the number of homes with wood stoves actually being used and W<sub>cord</sub> = Weight of an average cord of wood in California = 1.54 tons/cord (OMNI, 2006)

**F<sub>w,con</sub>:** Amount of cord wood burned in conventional wood stoves, tons/year. [F<sub>w,con</sub>] = [F<sub>w</sub>]\*[100% - P<sub>ph</sub>]

**F<sub>w,cat</sub>:** Amount of cord wood burned in EPA certified Phase II catalytic wood stoves, tons/year. [F<sub>w,cat</sub>] = [F<sub>w</sub>]\*[P<sub>ph</sub>]\*[P<sub>c</sub>]

**F<sub>w,ncat</sub>:** Amount of cord wood burned in EPA certified Phase II non-catalytic wood stoves, tons/year. [F<sub>w,ncat</sub>] = [F<sub>w</sub>]\*[P<sub>ph</sub>]\*[100% - P<sub>c</sub>]

**BC<sub>R</sub>:** Number of non-certified conventional stoves removed through the District's Burn Cleaner Program.

**BC<sub>RT</sub>:** Amount of cord wood removed in conventional wood stoves (tons/year) [BC<sub>RT</sub>] = [BC<sub>R</sub>]\*[N<sub>cord</sub>]\*[W<sub>cord</sub>]

**BC<sub>A</sub>:** Number of Phase-II wood stoves added through the District's Burn Cleaner Program.

**BC<sub>AT-C</sub>:** Amount of cord wood burned in Phase II catalytic wood stoves added (tons/year) [BC<sub>AT-C</sub>] = [BC<sub>A</sub>]/2\*[N<sub>cord</sub>]\*[W<sub>cord</sub>]

**BC<sub>AT-NC</sub>:** Amount of cord wood burned in Phase II non-catalytic wood stoves added (tons/year) [BC<sub>AT-NC</sub>] = [BC<sub>A</sub>]/2\*[N<sub>cord</sub>]\*[W<sub>cord</sub>]

**F<sub>w,all</sub>:** Total, all cord wood burned in wood stoves, tons/year. [F<sub>w,all</sub>] = [F<sub>w</sub>]-[BC<sub>RT</sub>]+[BC<sub>AT-C</sub>]+[BC<sub>AT-NC</sub>]



**References:**

- 1 ARB, 2015. California Air Resources Board; Section 7.1: Residential Wood Combustion. Table A-5. Accessed online on July 12, 2016 at [http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1\\_2011.pdf](http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1_2011.pdf)
- 2 OMNI, 2006. J.E. Houck and B.N. Eagle; OMNI Environmental Services, Inc.; "Residential Wood Combustion Emission Inventory South Coast Air Basin and Coachella Valley Portion of Salton Sea Air Basin, 2002 Base Year", Table 4.6; October 24, 2006; <http://www.omni-test.com/publications/SCAQMD-RWC4.pdf>
- 3 District Burn Cleaner Program

**Table A-7: Fireplace Inserts – Number of Devices**

County (AB)	$H_{total}$	$P_{fi}$	$P_{fi,u}$	$[P_{fi}] \times [P_{fi,u}]$	$H_{fi,u}$
	# of homes in 2003 <sup>1</sup>	% of homes w/fireplace inserts	% of homes that use their fireplace inserts <sup>2</sup>	% of homes w/fireplace inserts in use	# of homes w/fireplace inserts in use
Fresno	261,554	0%	87%	0	0
Kern (SJV)	181,734	0%	87%	0	0
Kings	35,812	0%	87%	0	0
Madera	38,051	0%	87%	0	0
Merced	67,116	0%	87%	0	0
San Joaquin	193,423	0%	87%	0	0
Stanislaus	153,742	0%	87%	0	0
Tulare	114,640	0%	87%	0	0

$H_{total}$  : Number of occupied housing units/homes in 2003 (State of California, 2016).

$P_{fi}$ : Percent of homes with fireplace inserts

$P_{fi,u}$ : Percent of homes that use their fireplace insert. (OMNI, 2003, Table 5.1)

$H_{fi,u}$ : Number of homes with fireplace inserts actually being used.  $H_{fi,u} = [H_{total}] * [P_{fi}] * [P_{fi,u}]$

**References:**

- 1 State of California, 2016. State of California, Department of Finance; E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark; May 2010; For the San Joaquin Valley, the data represent the number of Occupied Housing Units during 2003, because of a district moratorium on new wood-burning fireplaces after 2003. <http://www.dof.ca.gov/Forecasting/Demographics/Estimates/>
- 2 OMNI, 2003. D. Broderick and J. Houck; OMNI Consulting Services, Inc.; "Results of Wood Burning Survey - Sacramento, San Joaquin, and San Francisco Areas, University of California Berkeley/California Air Resources Board - GIS Study", Table 5.1; Jan. 15, 2003; <http://www.omni-test.com/publications/final.pdf>

**Table A-8. Fireplace Inserts – Amount of Cord Wood & Bundle Wood Burned**

County (AB)	P <sub>ph</sub>	P <sub>c</sub>	N <sub>cord</sub>	P <sub>fi,bundle</sub>	N <sub>bundle</sub>	F <sub>fi,con</sub>	F <sub>fi,con</sub>	F <sub>fi,cat</sub>	F <sub>fi,ncat</sub>	F <sub>fi,bundle</sub>	F <sub>fi,con,b</sub>	F <sub>fi,cat,b</sub>	F <sub>fi,ncat,b</sub>
	% of fireplace inserts that are Phase II (purchased after 1 July 1990)	% of Phase II fireplace inserts that are catalytic	# of cords of wood burned in fireplace inserts (cords/home/yr) <sup>1</sup>	% of people with fireplace inserts who use bundles in addition to cord wood	# of bundles of wood burned in fireplace inserts (bundles/home/yr)	Total cord wood burned in fireplace inserts, tons/year	Cord wood burned in conventional fireplace inserts, tons/year	Cord wood burned in Phase II catalytic fireplace inserts, tons/year	Cord wood burned in Phase II non-catalytic fireplace inserts, tons/year	Total bundles burned in fireplace inserts, tons/year	Bundles burned in conventional fireplace inserts, tons/year	Bundles burned in Phase II catalytic fireplace inserts, tons/year	Bundles burned in Phase II non-catalytic fireplace inserts, tons/year
Fresno	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kern (SJV)	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kings	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Madera	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Merced	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
San Joaquin	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stanislaus	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tulare	0.0%	0.0%	2.1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

**Table A-8 (Continued). Fireplace Inserts – Amount of Cord Wood & Bundle Wood Burned**

County (AB)	BC <sub>RI</sub>	BC <sub>RI</sub> T	BC <sub>AI</sub>	BC <sub>AIT-C</sub>	BC <sub>AIT-NC</sub>
	# of conventional fireplace inserts removed <sup>2</sup>	Cord wood removed in conventional fireplace inserts, tons/year	# of certified fireplace inserts added <sup>2</sup>	Cord wood burned in Phase II catalytic fireplace inserts, tons/year	Cord wood burned in Phase II non-catalytic fireplace inserts, tons/year
Fresno	314	1,015	312	505	505
Kern (SJV)	67	217	24	39	39
Kings	23	74	3	5	5
Madera	45	146	89	144	144
Merced	40	129	49	79	79
San Joaquin	181	585	108	175	175
Stanislaus	77	249	94	152	152
Tulare	83	268	75	121	121
<b>Total</b>	<b>830</b>	<b>2,684</b>	<b>754</b>	<b>1,219</b>	<b>1,219</b>

**Note:** To obtain the total amount of fuel use for fireplace inserts, cord wood removed through the District's Burn Cleaner Program is subtracted from the total conventional cord wood [F<sub>fi,con</sub>]. To account for fireplace inserts added to the system, half of the fireplace inserts added are assumed to be catalytic and the other half non-catalytic. Cord wood burned in each category is then added to the respective totals, [F<sub>fi,cat</sub>] and [F<sub>fi,ncat</sub>], to calculate total fuel use. It is assumed that all wood inserts removed or added through the Burn Cleaner Program were/are being used.

**P<sub>ph</sub>:** Percent of fireplace inserts that are EPA certified Phase II (i.e., purchased after 1 July 1990).

**P<sub>c</sub>:** Percent of fireplace inserts that are catalytic.

**N<sub>cord</sub>**: Number of cords of wood burned in fireplace inserts (cords/home/yr) (OMNI, 2003).

**W<sub>cord</sub>**: Weight of an average cord of wood in California = 1.54 tons/cord (OMNI, 2006).

**P<sub>fi,bundle</sub>**: Percent of people with fireplaces who use bundles in addition to cord wood.

**N<sub>bundle</sub>**: Number of bundles of wood burned in fireplace inserts (bundles/home/yr).

**W<sub>bundle</sub>**: Weight of an Average Bundle of Wood (ton/bundle) (assuming 1 bundle = 1/64 of a cord) = 0.024 ton/bundle (OMNI, 2003).

**F<sub>fi,cord</sub>**: Total amount of cord wood burned in fireplace inserts, tons/year.  $[F_{fi,cord}] = [H_{fi,u}] * [N_{cord}] * [W_{cord}]$ , where  $H_{fi,u}$  is number of homes with fireplace inserts actually being used.

**F<sub>fi,con</sub>**: Amount of cord wood burned in conventional non-catalytic fireplace inserts, tons/year.  $[F_{fi,con}] = [F_{fi,cord}] * [100\% - P_{ph}]$

**F<sub>fi,cat</sub>**: Amount of cord wood burned in EPA certified Phase II catalytic fireplace inserts, tons/year.  $[F_{fi,cat}] = [F_{fi,cord}] * [P_{ph}] * [P_c]$

**F<sub>fi,ncat</sub>**: Amount of cord wood burned in EPA certified Phase II non-catalytic fireplace inserts, tons/year.  $[F_{fi,ncat}] = [F_{fi,cord}] * [P_{ph}] * [100\% - P_c]$

**F<sub>fi,bundle</sub>**: Total amount of bundle wood burned in fireplace inserts, tons/year.  $[F_{fi,bundle}] = [H_{fi,u}] * [P_{fi,bundle}] * [N_{bundle}] * [W_{bundle}]$ , where  $H_{fi,u}$  is number of homes with fireplace inserts actually being used.

**F<sub>fi,con,b</sub>**: Amount of bundle wood burned in conventional, non-catalytic fireplace inserts, tons/year.  $[F_{fi,con,b}] = [F_{fi,bundle}] * [100\% - P_{ph}]$

**F<sub>fi,cat,b</sub>**: Amount of bundle wood burned in EPA certified Phase II catalytic fireplace inserts, tons/year.  $[F_{fi,cat,b}] = [F_{fi,bundle}] * [P_{ph}] * [P_c]$

**F<sub>fi,ncat,b</sub>**: Amount of bundle wood burned in EPA certified Phase II non-catalytic fireplace inserts, tons/year.  $[F_{fi,ncat,b}] = [F_{fi,bundle}] * [P_{ph}] * [100\% - P_c]$

**BC<sub>RI</sub>**: Number of conventional, non-catalytic fireplace inserts removed through the District's Burn Cleaner Program.

**BC<sub>RIIT</sub>**: Cord wood removed from conventional, non-catalytic fireplace inserts that were removed through the District's Burn Cleaner Program.  $[BC_{RIIT}] = [BC_{RI}] * [N_{cord}] * [W_{cord}]$

**BC<sub>AI</sub>**: Number of EPA certified Phase II fireplace inserts (catalytic and non-catalytic) added through the District's Burn Cleaner Program.

**BC<sub>AIT-C</sub>**: Cord wood burned in EPA certified Phase II catalytic fireplace inserts (tons/yr).  $[BC_{AIT-C}] = [BC_{AI}] / 2 * [N_{cord}] * [W_{cord}]$

**BC<sub>AIT-NC</sub>**: Cord wood burned in EPA certified Phase II non-catalytic fireplace inserts (tons/yr).  $[BC_{AIT-NC}] = [BC_{AI}] / 2 * [N_{cord}] * [W_{cord}]$

## References:

- 1 OMNI, 2003. D. Broderick and J. Houck; OMNI Consulting Services, Inc.; "Results of Wood Burning Survey - Sacramento, San Joaquin, and San Francisco Areas, University of California Berkeley/California Air Resources Board - GIS Study", Table 5.2 and Section 3 (Wood Burning Fireplace Questions); Jan. 15, 2003; <http://www.omni-test.com/publications/final.pdf>
- 2 District Burn Cleaner Program

**Table A-9. Fireplace Inserts – Amount of Compressed Wood Logs Burned**

County (AB)	$P_{fi,cwl}$ % of people who used their fireplace inserts with compressed wood logs	$N_{cwl}$ # of compressed wood logs burned in fireplace inserts (logs/home/yr)	$H_{fi,cwl}$ # of homes with fireplace inserts that burn compressed wood logs	$F_{fi,cwl}$ Compressed wood logs burned in fireplace inserts, tons/year
Fresno	0.0	0.0	0.0	0.0
Kern (SJV)	0.0	0.0	0.0	0.0
Kings	0.0	0.0	0.0	0.0
Madera	0.0	0.0	0.0	0.0
Merced	0.0	0.0	0.0	0.0
San Joaquin	0.0	0.0	0.0	0.0
Stanislaus	0.0	0.0	0.0	0.0
Tulare	0.0	0.0	0.0	0.0

$P_{fi,cwl}$ : Percent of people who used their fireplace inserts who used compressed wood logs.

$N_{cwl}$ : Number of compressed wood logs burned in fireplace inserts (logs/home/yr).

$H_{fi,cwl}$ : Number of homes with fireplace inserts that burn compressed wood logs.  $[H_{fi,cwl}] = [H_{fi,u}] * [P_{fi,cwl}]$ , where  $H_{fi,u}$  is number of homes with fireplace inserts actually being used.

$W_{cwl}$  = Weight of an average compressed wood log (tons/log) (assuming 5 lbs/log) = 0.0025 ton/log (OMNI, 2003)

$F_{fi,cwl}$ : Amount of compressed wood logs burned in fireplace inserts, tons/year.  $[F_{fi,cwl}] = [H_{fi,cwl}] * [N_{cwl}] * [W_{cwl}]$

**References:**

- 1 OMNI, 2003. D. Broderick and J. Houck; OMNI Consulting Services, Inc.; "Results of Wood Burning Survey - Sacramento, San Joaquin, and San Francisco Areas, University of California Berkeley/California Air Resources Board - GIS Study"; Jan. 15, 2003; <http://www.omni-test.com/publications/final.pdf>

**Table A-10: Pellet Stoves – Number of Devices**

County (AB)	$H_{total}$	$P_{wbd}$	$P_{p,wbd}$	$P_{ps}$	$P_{ps,u}$	$[P_{ps}] \times [P_{ps,u}]$	$H_{ps,u}$
	# of homes in 2003 <sup>1</sup>	Regional % of homes with wood burning devices <sup>2</sup>	% of wood burning devices that are pellet stoves <sup>2</sup>	Regional % of homes with wood burning pellet stoves	% of homes that use their wood burning pellet stove <sup>2</sup>	% of homes with pellet stoves that are in use	# of homes with pellet stoves in use
Fresno	261,554	28.00%	9.4%	2.6%	41%	1.08%	2,815
Kern (SJV)	181,734	28.00%	9.4%	2.6%	41%	1.08%	1,956
Kings	35,812	28.00%	9.4%	2.6%	41%	1.08%	385
Madera	38,051	28.00%	9.4%	2.6%	41%	1.08%	410
Merced	67,116	37.00%	9.4%	3.5%	41%	1.42%	955
San Joaquin	193,423	37.00%	9.4%	3.5%	41%	1.42%	2,751
Stanislaus	153,742	37.00%	9.4%	3.5%	41%	1.42%	2,186
Tulare	114,640	28.00%	9.4%	2.6%	41%	1.08%	1,234

$H_{total}$  : Number of occupied housing units/homes in 2003 (State of California, 2016).

$P_{wbd}$ : = % wood burning devices by region (SJVUAPCD, 2014)

$P_{p,wbd}$ : Air Basin-wide percent of pellet stoves/percent of all woodburning devices (3%/32% = 9.4%) (SJVUAPCD, 2014)

$P_{ps}$ : Percent of homes with wood burning pellet stoves, by region.  $[P_{ps}] = [P_{wbd}] * [P_{p,wbd}]$

$P_{ps,u}$ : Percent of homes that use their pellet stove, among those who use their wood-burning device (SJVUAPCD, 2014)

$H_{ps,u}$ : Number of homes with pellet stoves actually being used.  $[H_{ps,u}] = [H_{total}] * [P_{ps}] * [P_{ps,u}]$

**References:**

- 1 State of California, 2016. State of California, Department of Finance; E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark; May 2010; For the San Joaquin Valley, the data represent the number of Occupied Housing Units during 2003, because of a district moratorium on new wood-burning fireplaces after 2003.  
<http://www.dof.ca.gov/Forecasting/Demographics/Estimates/>
- 2 SJVUAPCD, 2014. San Joaquin Valley Unified Air Pollution Control District. Residential Wood Burning, Lawn Care, and Commuting Survey, Final Report, February 2014.

**Table A-11: Pellet Stoves – Amount of Pellets Burned**

County (AB)	$N_{\text{sacks}}$	$F_{\text{ps}}$	$BC_P$	$BC_{PE}$	$F_{\text{ps,all}}$
	# of sacks of pellets burned in pellet stoves (sacks/home/yr) <sup>1</sup>	Pellets burned in pellet stoves, tons/year	# pellet stoves added <sup>3</sup>	Pellets burned in pellet stoves, tons/year	Total pellets burned, tons/year
Fresno	100	5,630	35	70	5,700
Kern (SJV)	100	3,912	10	20	3,932
Kings	100	771	1	2	773
Madera	100	819	29	58	877
Merced	100	1,909	7	14	1,923
San Joaquin	100	5,502	20	40	5,542
Stanislaus	100	4,373	28	56	4,429
Tulare	100	2,468	6	12	2,480
<b>Totals</b>		<b>25,383</b>	<b>136</b>	<b>272</b>	<b>25,655</b>

**Note:** To obtain the total amount of fuel use for pellet stoves, burned pellets removed through the Burn Cleaner Program would be subtracted from the total burned pellets [ $F_{\text{ps}}$ ]; however, the base rate at the time of this inventory was zero. To account for pellet stoves added to the system, pellets burned through the added stoves ( $BC_{PE}$ ) were added to [ $F_{\text{ps}}$ ] to calculate total fuel use ( $F_{\text{ps,all}}$ ). It is assumed that all pellet stoves added through the Burn Cleaner Program are being used.

$N_{\text{sacks}}$ : Number of sacks of pellets burned in pellet stoves (sacks/home/yr).

$W_{\text{sack}}$ : Weight of an average sack of pellets (tons/sack) (assuming 40 lbs/sack, = 0.02 tons/sack) (HPBA, 2009)

$F_{\text{ps}}$ : Amount of pellet sacks burned in pellet stoves, tons/year. [ $F_{\text{ps}}$ ] = [ $H_{\text{ps,u}}$ ]\*[ $N_{\text{sacks}}$ ]\*[ $W_{\text{sack}}$ ], where  $H_{\text{ps,u}}$  is number of homes with pellet stoves actually being used. Based on survey data, it is assumed that 100% of people who used their pellet stoves burned pellets.

$BC_P$ : Number of pellet stoves added through the District's Burn Cleaner Program

$BC_{PE}$ : Number of pellets burned in pellet stoves added through the District's Burn Cleaner Program (tons/year)

$$[BC_{PE}] = [BC_P] * [N_{\text{sacks}}] * [W_{\text{sack}}]$$

$F_{\text{ps,all}}$ : Total amount of pellets burned in pellet stoves (tons/year) [ $F_{\text{ps,all}}$ ] = [ $F_{\text{ps}}$ ] + [ $BC_{PE}$ ]

**References:**

- 1 OMNI, 2003. D. Broderick and J. Houck; OMNI Consulting Services, Inc.; "Results of Wood Burning Survey - Sacramento, San Joaquin, and San Francisco Areas, University of California Berkeley/California Air Resources Board - GIS Study", Table 6.7; Jan. 15, 2003; <http://www.omni-test.com/publications/final.pdf>
- 2 HPBA, 2009b. Hearth, Patio, & Barbecue Association; "Hearth Product Fuels Fact Sheet." Accessed online on June 29, 2016 at [http://www.hpba.org/fileadmin/factsheets/product/FS\\_HearthProductFuels.pdf](http://www.hpba.org/fileadmin/factsheets/product/FS_HearthProductFuels.pdf)
- 3 District Burn Cleaner Program

**Table A-12. All Wood Stoves – 2005 Fuel Use and Emissions Estimates**

County (AB)	Fuel Use (Tons/Yr)						Emissions (Tons/Year)						
	Cord Wood: Conventional	Cord Wood: Phase II, Non-Catalytic	Cord Wood: Phase II, Catalytic	Compressed Wood Logs	Pellets	Total for All Fuels	CO	NO <sub>x</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	SO <sub>2</sub>	ROG	NH <sub>3</sub>
Fresno	6,404	4,522	1,010	0.0	5,700	17,635	1,155.37	25.96	144.50	150.01	3.30	204.52	8.79
Kern (SJV)	3,758	2,101	268	0.0	3,932	10,059	626.87	15.40	78.57	81.59	1.85	114.28	4.85
Kings	504	306	39	0.0	773	1,623	87.95	2.56	11.10	11.54	0.29	15.51	0.70
Madera	822	1,032	394	0.0	877	3,126	195.11	4.39	24.54	25.48	0.59	30.96	1.47
Merced	3,122	1,823	301	0.0	1,923	7,169	519.59	10.40	64.64	67.08	1.36	95.96	3.90
San Joaquin	3,514	2,285	397	0.0	5,542	11,737	631.15	18.45	79.86	82.97	2.13	109.92	5.02
Stanislaus	4,158	2,421	397	0.0	4,429	11,405	706.16	17.39	88.71	92.11	2.10	127.77	5.47
Tulare	3,420	2,166	398	0.0	2,480	8,464	587.66	12.37	73.21	75.99	1.59	106.67	4.43
<b>Total (Tons/Yr)</b>	25,703	16,656	3,204	0	25,655	71,218	4,510	107	565	587	13	806	35
<b>Total (Tons/Day)</b>	70	46	9	0	70	195	12.36	0.29	1.55	1.61	0.04	2.21	0.09

PM profile code #424 Organic profile code #549	Wood Stoves Emission Factors (lb/ton fuel burned) <sup>1</sup>						
	CO	NO <sub>x</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	SO <sub>2</sub>	ROG	NH <sub>3</sub>
Conventional (non-EPA certified)	230.8	2.8	29.5	30.6	0.4	53	1.7
Phase II EPA certified, Non-Catalytic	140.8	2.28	14.1	14.6	0.4	12	0.9
Phase II EPA certified, Catalytic	104.4	2	19.6	20.4	0.4	15	0.9
All - Compressed Wood Logs	201.2	2.8	25	26	0.4	15.1	1.7
Pellet Stoves	15.9	3.8	2.9	3.06	0.32	0.04	0.3

**References:**

- 1 ARB, 2015. California Air Resources Board; Section 7.1: Residential Wood Combustion. Table A-12. Accessed online on July 12, 2016 at [http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1\\_2011.pdf](http://www.arb.ca.gov/ei/areasrc/fullpdf/full7-1_2011.pdf)



## Appendix B - Burn Cleaner Program

The Burn Cleaner Program is a significant part of the District’s overall strategy to reduce the impacts of residential wood burning, as the program encourages Valley residents to change out old, high-polluting devices and open hearth fireplaces with new, cleaner burning devices, such as EPA Phase II Certified wood and pellet burning devices and gas burning devices. The Burn Cleaner Program is also complementary to the Check Before You Burn Program, which is vital to further reduce emissions during the wood burning season. For several years, the District has offered meaningful financial assistance through this program, which not only reduces emissions on “No Burn Days,” but also reduces emissions on “Burn Days” as more polluting devices are replaced. Given the potential high cost to replace older, high-polluting units, the program includes a specific focus on low-income residents by making the purchase of new, cleaner devices more economically feasible through higher incentives, flexible payment through participating retailers, and expanded eligibility criteria. This program has continued to grow with support from the District’s Environmental Justice Advisory Group, Valley residents, participating retailers, and other agencies.

Tables B-1 through B-3 summarize the number of devices converted through the District’s Burn Cleaner program from 2009-2015. Tables B-4 through B-18 provide the number of devices converted for each year between 2009-2015.

**Table B-1. Number of open hearth fireplaces converted into specific device (2014-2015)**

County	Natural Gas	Certified Wood Stove	Certified Wood Insert	Certified Pellet Stove	Total
Fresno	712	0	156	20	888
Kern	587	0	17	7	611
Kings	54	0	0	1	55
Madera	53	0	53	20	126
Merced	116	0	30	4	150
San Joaquin	746	0	53	15	814
Stanislaus	471	0	59	21	551
Tulare	236	0	44	3	283
<b>SJV Total</b>	2975	0	412	91	3478

**Table B-2. Number of EPA non-certified wood stoves converted into specific device (2014-2015)**

County	Natural Gas	Certified Wood Stove	Certified Wood Insert	Certified Pellet Stove	Total
Fresno	25	83	4	15	127
Kern	13	30	0	3	46
Kings	2	7	0	0	9
Madera	11	90	3	9	113
Merced	1	30	0	3	34
San Joaquin	30	26	1	5	62
Stanislaus	9	27	0	7	43
Tulare	16	49	0	3	68
<b>SJV Total</b>	107	342	8	45	502

**Table B-3. Number of EPA non-certified wood stove inserts converted into specific device (2014-2015)**

<b>County</b>	<b>Natural Gas</b>	<b>Certified Wood Stove</b>	<b>Certified Wood Insert</b>	<b>Certified Pellet Stove</b>	<b>Total</b>
Fresno	161	1	152	0	314
Kern	60	0	7	0	67
Kings	20	0	3	0	23
Madera	11	1	33	0	45
Merced	21	0	19	0	40
San Joaquin	127	0	54	0	181
Stanislaus	42	0	35	0	77
Tulare	52	0	31	0	83
<b>SJV Total</b>	<b>494</b>	<b>2</b>	<b>334</b>	<b>0</b>	<b>830</b>