2020 National Emissions Inventory Technical Support Document: Fuel Combustion – Residential Heating -Wood

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2020 National Emissions Inventory Technical Support Document: Fuel Combustion – Residential Heating – Wood

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27.1 Sector Description and Overview

Residential wood combustion (RWC) appliances, such as fireplaces, fireplace inserts, woodstoves, central heaters (indoor furnaces and hydronic heaters), and other outdoor wood-burning devices, are significant sources of air pollution in the United States—especially during winter months. RWC emits large amounts of fine particulate matter (PM25-PRI), volatile organic compounds (VOCs), and hazardous air pollutants (HAPs) that are known to contribute to poor human health, air quality, and visibility. We further differentiate freestanding woodstoves and inserts into three categories: conventional (not EPA-certified), EPA certified catalytic, and EPA-certified non-catalytic. Generally, the conventional units were produced before 1988. Units constructed after 1988 had to meet EPA emission standards. In addition, we characterize central heaters by type (furnace vs hydronic heater), fuel type (cordwood vs pellet-fired) and location (indoor vs outdoor for hydronic heaters). For shorthand, we refer to the Residential Wood Combustion sector as "RWC" in the remaining documentation.

Table 27-1 shows, for RWC, the SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 3 and 4 SCC descriptions are also provided. The SCC level 1 and 2 descriptions is "Stationary Source Fuel Combustion; Residential" for all SCCs.

Table 27-1 : RWC sector SCCs in the 2020 NEI

SCC	Description	EPA	S/L/T
2104008100	Wood; Fireplace: general	X	X
2104008210	Wood; Woodstove: fireplace inserts; non-EPA certified	X	X
2104008220	Wood; Woodstove: fireplace inserts; EPA certified; non-catalytic	X	X
2104008230	Wood; Woodstove: fireplace inserts; EPA certified; catalytic	X	X
2104008300	Wood; Woodstove: freestanding, general		X
2104008310	Wood; Woodstove: freestanding, non-EPA certified	X	X
2104008320	Wood; Woodstove: freestanding, EPA certified, non-catalytic	X	X
2104008330	Wood; Woodstove: freestanding, EPA certified, catalytic	X	X
2104008400	Wood; Woodstove: pellet-fired, general (freestanding or FP insert)	X	X
2104008510	Wood; Furnace: Indoor, cordwood-fired, non-EPA certified	X	X
2104008530	Wood; Furnace: Indoor, pellet-fired, general	X	X
2104008610	Wood; Hydronic heater: outdoor	X	X
2104008620	Wood; Hydronic heater: indoor	X	X
2104008630	Wood; Hydronic heater: pellet-fired	X	X
2104008700	Wood; Outdoor wood burning device, NEC (fire-pits, chimeneas, etc)	X	X
2104009000	Firelog; Total: All Combustor Types	X	X

27.2 Sources of data

When analyzing the difference in emissions between the 2017 and 2020 NEI cycles, in addition to dissecting the difference in methodology and emission factors between NEI cycles, it is also important to note the contribution of S/L/T-submitted emissions and input template activity data. Table 27-2

provides a comparison of S/L/T-submitted emissions and input template activity data for the 2017 and 2020 NEI cycles.

Table 27-2: Comparison of S/L/T-submitted emissions and input activity data for 2017 and 2020 NEI

2017 NEI	**2020 NEI**
Inputs: • Burn rate: AK, VT, WA • Housing: WA • Appliance Fraction: AK, UT, VT, WA • Wood density: AK • Distribution: AK	Inputs: • Burn rate: OR, WA • Housing: KS, OR, WA • Appliance Fraction: OR, VT • Wood density: KS • Distribution: OR
Emissions: • AK (no VOC) • CA • ID • IL • MN • OR • TX • Maricopa • Washoe • Nashville/Davidson • Southern Ute • Coeur d'Alene • Kootenai • Nez Perce • Northern Cheyenne • Shoshone-Bannock	Emissions: • AK (no VOC) • CA* • ID • MN • TX • Maricopa • Washoe • Nashville/Davidson • Southern Ute • Coeur d'Alene • Kootenai • Nez Perce • Northern Cheyenne • Shoshone-Bannock

*CA explained their emissions did not cover pellet stoves and EPA's emissions were used for this appliance

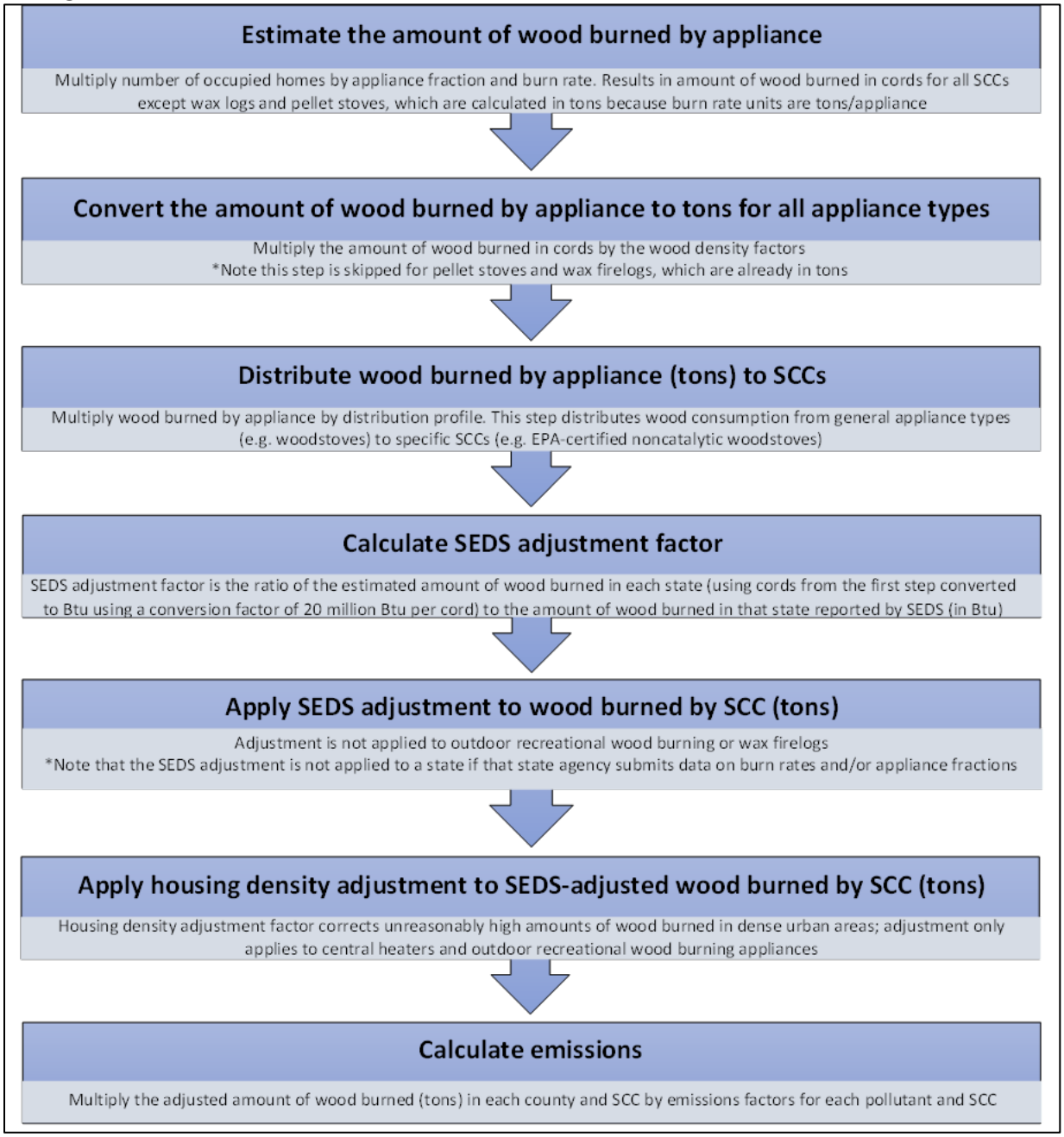
27.3 EPA-developed estimates

To improve estimates in this sector from the 2017 NEI forward, the EPA, along with the Commission on Environmental Cooperation (CEC), the Northeast States for Coordinated Air Use Management (NESCAUM), and Abt Associates, conducted a national survey of wood-burning activity in 2018. The results of this survey [ref 1] were used to estimate county-level burning activity, as discussed in more detail below.

The activity data for this category is the amount of wood burned in each county, which is based on data from the CEC survey on the fraction of homes in each county that use each wood-burning appliance and the average amount of wood burned in each appliance [ref 1]. These assumptions are used with the number of occupied homes in each county [ref 8] to estimate the total amount of wood burned in each county, in cords for cordwood appliances and tons for pellet appliances. Cords of wood are converted to tons using county-level density factors calculated based on USDA firewood density by tree species and USDA state surveys on county-level counts of trees [ref 2, 3]; these wood density factors are available in the file "RWC_Wood_Density_USDA_WW_feb2022.xlsx", and USDA state survey on tree populations in

the file "Number of trees by county and species CONUS most recent_Feb2022.xlsx" on the 2020 NEI Supplemental nonpoint data FTP site. Emissions are calculated by multiplying the tons of wood burned by emissions factors. To calculate emissions in this sector, some adjustments are made to the county-level tons of wood calculated. An overview of the calculations to estimate emissions can be found in Figure 27-1.

Figure 27-1: Overview of Calculations to Estimate Emissions from Residential Wood Combustion



27.3.1 Improvements/Changes in the 2020 NEI

The methodology used for the 2020 NEI is the same as was used for the 2017 NEI, though some of the input data has changed and the calculation tool was revised to explicitly show the adjustment factors applied for some of the appliance types.

The following EPA-generated activity-related data changed for the 2020 NEI:

- "SEDS" Adjustment used the 2020 EIA's State Energy Data System (SEDS) data (version published Spring 2022)
- Housing units are from the U.S. Census Bureau's 2016-2020 American Community Survey 5-Year Estimates released Spring 2022
- Cordwood density data as described below

The methodology to estimate default cord wood density factors was updated for the 2020 NEI. For the 2017 NEI, the methodology was based on the 2009 U.S. Forest Service Timber Products Output report. For the 2020 NEI, the methodology is based on USDA data on firewood density by tree species and a compilation of USDA state surveys with county-level counts of trees; the 2009 USFS factors are still used for Alaska and Hawaii counties due to a lack of data. For each county, weighted average factors from hardwood and pine trees were used. State-level wood density ratios were used for counties that do not have hardwood trees. A moisture content of 12% is assumed, based on data from USDA. Overall, the wood density factors resulting from the updated method were about 25% higher than those used in 2017.

For the 2020 NEI, an error in the default value for the distribution factor for indoor pellet furnaces was fixed. The 2017 NEI used an incorrect distribution factor of 0.37, and it was corrected to be 0.03.

HAP VOCs were computed as part of HAP augmentation as described in Section 6.4. The HAP augmentation values are different for some appliance types than the HAP EFs used in the 2017 NEI.

For PM, additional emission factors (and hence emissions) were provided for the filterable and condensible components (PM25-FIL, PM10-FIL, PMCON) whereas only primary PM (the sum of filterable and condensible) were provided in the 2017 NEI.

Note that the 2017 NEI used lower $PM_{2.5}$, VOC, NOx and SO_2 emission factors for certified woodstoves and fireplace inserts based on the Regulatory Impact Analysis (RIA) for the 2015 New Source Performance Standards (NSPS), [ref 16] which is based on the woodstove emissions standards from the state of Washington in 1995. Due to uncertainty in the NSPS-derived emissions factors, for the 2020 NEI, the Phase II emissions factors from AP-42 for these pollutants were used for certified woodstoves and fireplace inserts. Additional background information on why we transitioned to use AP-42 emissions factors for these devices is available in "NEI2020_certifiedwoodstovePM_EF_options5.pdf" on the 2020 NEI Supplemental nonpoint data FTP site.

In addition to using a different data year for SEDS, the methodology used by SEDS to estimate wood consumption changed since the 2017 NEI, and these methodology updates resulted in substantial changes to the residential wood combustion emissions estimates in the 2020 NEI. The methodology for estimating state-level residential wood consumption for SEDS was updated beginning in 2018. Previously, SEDS estimated residential wood consumption using state-level data from the 2009

Residential Energy Consumption Survey (RECS), and for states that did not have data, SEDS used the American Community Survey (ACS) data on housing units to allocate the national estimate of wood consumption from RECS. From 2018 forward, SEDS began using national-level data on wood consumption from the Monthly Energy Review (MER), which is based on data from the updated 2015 RECS, with projections based on the Annual Energy Outlook. SEDS allocates national-level wood consumption to the state level using housing units data and data on heating degree days. In particular, SEDS estimates the states by allocating the U.S. total to the states in proportion to the product of each states Heating Degree Days (HDD) ACS number of housing units that report using wood as their primary heating fuel:

- SEDS uses annual population-weighted HDDs from the National Oceanic and Atmospheric Administration (NOAA), as described in SEDS Consumption Technical Notes, Section 8.
    - SEDS uses the 1-year ACS home heating estimates, when available. But the ACS had some issues during COVID, so for the 2020 SEDS released Spring of 2022, the available 5-year ACS home heating estimates for 2020 were used.

With some exceptions, this change in SEDS methodology resulted in more residential wood consumption in northern states and less residential wood consumption in southern states compared to previous SEDS. Thus, generally RWC emissions for the 2020 NEI, which uses 2020 SEDS data, decreased for southern states compared to emissions in 2017, and many northern states' emissions increased.

27.3.2 Activity data

The activity data for RWC uses the regression results from the 2017 NEI. The documentation is repeated here for completeness. The approach relies on assumptions developed from the CEC survey. The survey received 2,984 responses, and it asked questions about whether and how often the respondent used the different wood burning appliances and how much wood they burned annually. It also asked demographic questions about the respondents. EPA used statistical regression approaches to develop appliance fractions and burn rates for each county, based on predictor variables from the survey responses. These predictor variables include:

- The number of heating degree days in 2017 associated with the climate zone where the respondent lives, from NOAA [ref 4].
- The population density in 2017 of the county the respondent lives in, from the Census Bureau [ref 5].
- Whether the zip code where the respondent lives is considered urban or rural, according to data from the Census Bureau [ref 6].
- The percentage of forest cover in the county where the respondent lives, according to the Biogenic Emissions Landuse Database (BELD, v4.1) [ref 7].
- The fraction of homes that use natural gas as a primary heat source in 2017 in the county where the respondent lives, according to data from the American Community Survey [ref 8].
- The type of home the respondent lives in (single family detached, single family attached, multifamily, mobile), based on responses in the CEC survey.

The regression analysis compared all respondents who said they used a given appliance, such as a woodstove, to develop an equation based on each of these predictor variables. For example, survey respondents who lived in areas with more heating degree days (i.e., colder climates) or areas where few

homes used natural gas as a primary heat source (i.e., they might not have much natural gas service) tended to be more likely to say that they used a given wood-burning appliance.

The regression equation estimates the probability that a home in each county, with a given set of predictor variables, will use each wood-burning appliance. Therefore, when values of the predictor variables from each county are plugged into the equation, the result is a county-specific appliance fraction, which represents the fraction of homes in that county that use each wood-burning appliance. For example, urban counties with a low number of heating degree days, high population density, low forest cover, and many homes using natural gas tend to have a low appliance fraction for most appliances. County-specific appliance fractions are calculated separately for six appliance types: fireplaces, fireplace inserts, woodstoves, pellet stoves, central heaters (e.g., wood boilers or furnaces), and outdoor recreational equipment (such as fire pits). The process for splitting these appliance types into each of the 15 SCCs is discussed below.

Burn rates, which represent the average amount of wood burned in each appliance, are also calculated using regression analysis and the same predictor variables listed above. When county-level values of the predictor variables are plugged into the burn rate regression equation, the result is county-specific burn rates for each appliance type. The burn rates include the same appliance types as the appliance fractions.

The appliance fractions and burn rates are multiplied by the number of occupied homes in each county from the American Community Survey (ACS) [ref 8] to estimate the amount of wood burned in each county, in cords or tons, depending on whether the appliance burns cordwood or pellets. For devices that burn cordwood, the estimated number of cords burned in each county is multiplied by a county-level wood density factor, which is calculated based on USDA firewood density by tree species and USDA state surveys on county-level counts of trees [ref 2, 3].

$$W_{c,a} = H_c \times AF_{c,a} \times BR_{c,a} \times D_c \quad (1)$$

Where:

- $W_{c,a}$ = Amount of wood burned in appliance type *a* in county *c*, in tons per year
- H_c = Number of occupied homes in county *c*
- $AF_{c,a}$ = Appliance fraction for appliance type *a* in county *c*, determined from the CEC survey
- $BR_{c,a}$ = Burn rate for appliance type *a* in county *c*, determined from the CEC survey, in cords or tons burned per appliance
- D_c = Wood density factor for county *c*, in tons per cord of wood (used only for cordwood appliance types)

As discussed above, the appliance fractions and burn rates are used to estimate wood-burning activity at the appliance level in each county. This activity for certain appliance types must be distributed from the appliance level to the specific SCC level. For example, wood burned in "woodstoves" must be apportioned to three SCCs: non-EPA certified stoves, EPA certified non-catalytic stoves, and EPA certified catalytic stoves. All distribution profiles were the same as were used as for the 2017 NEI except for those for indoor pellet furnaces; the data used to create the distribution profiles are described below.

For woodstoves and fireplace inserts, EPA used distribution profiles based on a combination of data from the 2015 EIA Residential Energy Consumption Survey (RECS) and the state of Minnesota's 2014/2015 residential wood survey.

Data from RECS is used to determine whether woodstoves or fireplace inserts are EPA certified. Although RECS does not specifically ask whether the woodstove is EPA certified, it does ask the age of the appliance. It is assumed that any appliance in the oldest age bin in RECS (20 years or older) is uncertified.[1] All appliances less than 20 years old are assumed to be EPA certified. The split between EPA certified non-catalytic and catalytic stoves is based on data provided by Minnesota from their 2014/2015 residential wood survey, which suggests that certified stoves are 60 percent non-catalytic and 40 percent catalytic. The distribution profiles for woodstoves and fireplace inserts are shown in Table 27-3.

The CEC survey data were seen to be more reliable for developing distribution profiles for central heaters, including wood boilers and furnaces. Survey respondents listed whether they owned a furnace or a boiler, whether it was located inside or outside the home, and whether it burned cordwood or pellets. These responses were used to develop distribution profiles for the central heaters. The distribution profiles for central heaters are shown in Table 27-4. For the 2020 NEI, an error in the default value for the distribution factor for indoor pellet furnaces was fixed. The 2017 NEI used an incorrect distribution factor of 0.37, and it was corrected to be 0.03.

The default distribution profiles are estimated at the Census Region level for woodstoves and fireplace inserts and nationally for central heaters, but the RWC tool allows the profiles to be adjusted for each county. Not all appliance types need to be distributed. Appliance populations of fireplaces, pellet stoves, and outdoor recreational equipment are estimated directly from the regression equations and are not multiplied distribution fractions.

The amount of wood-burning activity in each SCC in each county is determined by multiplying the county-level wood-burning activity by appliance type by the distribution profile for each SCC.

$$W_{c,SCC} = W_{c,a} \times DP_{SCC} \quad (2)$$

Where:

$W_{c,SCC}$ = Amount of wood burned in each SCC in county *c*, in tons per year

$W_{c,a}$ = Amount of wood burned in appliance type *a* in county *c*, in cords or tons per year, from equation 1

DP_{SCC} = Distribution profile for each SCC from Table 27-3 or Table 27-4, depending on the appliance type

[1] A 20-year-old appliance in the 2015 RECS would have been manufactured in 1995, which is after the 1988 NSPS for wood stoves. However, this is the oldest age bin in RECS. EPA lacks data on the fraction of appliances in this age bin that were manufacturer before or after 1988. Therefore, EPA assumed that all appliances in this age bin were uncertified.

Table 27-3: Distribution profiles for woodstoves and fireplace inserts by Census Region

Woodstove or Fireplace Insert Type	Census Region			
	NE	MW	S	W
Uncertified	0.16	0.12	0.31	0.31
Certified Catalytic	0.34	0.35	0.28	0.28
Certified Non-catalytic	0.50	0.53	0.41	0.41

Table 27-4: Distribution profiles for central heaters

Type of Central Heater	SCC	Distribution Profile
Indoor pellet boiler	2104008630	0.01
Indoor pellet furnace	2104008530	0.03
Indoor cordwood boiler	2104008620	0.23
Indoor cordwood furnace	2104008510	0.37
Outdoor cordwood boiler	2104008610	0.36

When developing the 2017 NEI, after an initial review of the wood-burning activity predicted by the appliance fractions and burn rates develop from the CEC survey data, EPA decided to make two adjustments to the estimates. These same adjustments were made for the 2020 NEI, though the data used to make these adjustments was updated.

The first adjustment corrects the total wood-burning activity in each state. When first implementing this method for the 2017 NEI, it was found that the amount of residential wood-burning activity initially predicted by the appliance fractions and burn rates was significantly higher than the state-level totals reported by EIA's State Energy Data System (SEDS) [ref 9] for most states. As a result, EPA developed an adjustment factor to normalize the state-level residential wood-burning activity predicted by the tool to the amount predicted by SEDS. While the 2020 SEDS compares differently than the 2017 SEDS, the wood-burning activity derived from the CEC survey data is still very different in some states, so an adjustment factor was also employed for the 2020 NEI. The SEDS adjustment factor is developed by summing the predicted amount of wood-burning activity (in cords for all appliances except pellet stoves which measure wood consumption in tons) to the state level in each state and dividing it by the state-level amount of residential wood consumption reported by SEDS. SEDS reports wood consumption in Btu, rather than cords; therefore, the wood-burning activity predicted by the RWC tool is converted from cords to billion Btu (BBTU) using a conversion factor of 20 million Btu per cord, from the SEDS documentation [ref 10]. (Note that by summing the cordwood and pellet stove wood consumption together, this calculation assumes that the energy value of one ton of pellets from pellet stoves is equal to one cord of cordwood. Pellet stoves account for approximately 6% of national-level wood consumption.) In addition, SEDS only includes wood consumption for residential heating; therefore, predicted wood consumption from outdoor recreational wood-burning (2104008700) and wax firelogs (2104009000) are not summed to calculate the SEDS adjustment.

$$SAF_s = \frac{\sum W_{c,SCC}}{W_{s,SEDS}} \quad (3)$$

Where:

SAF_s = SEDS adjustment factor for state *s*

$W_{c,SCC}$ = Amount of wood burned in each SCC in county *c*, in Btu per year
$W_{s,SEDS}$ = Amount of wood consumption in state *s* reported by SEDS

The second adjustment EPA made to the predicted wood consumption relates to central heaters and outdoor recreational equipment. After an initial review of predicted wood-burning activity, EPA felt that the estimated amount of wood burned in these appliances in dense urban areas was unreasonably high. Therefore, EPA developed a second adjustment factor based on the housing density (homes/mi^2) in each county, based on the equation for a sigmoid curve. The inputs for this calculation are the number of occupied homes in each county [ref 8] and the land area in each county [ref 17]. The housing density adjustment factor is calibrated such that it approaches 0 when county-level housing density approaches 1,000 homes/mi^2. The housing density adjustment factor is multiplied by the predicted wood-burning activity only for central heating appliances (wood boilers and furnaces) and outdoor recreational wood-burning appliances.

$$HAF_c = -\frac{1}{1 + e^{-0.01\ (HD_c - 500)}} + 1 \quad (4)$$

Where:
HAF_s = Housing density adjustment factor for county *c*
HD_c = Housing density in county *c,* in homes/mi^2

The SEDS and housing density adjustment factors are multiplied by the county-level predicted wood-burning activity to develop the adjusted wood-burning activity in each county.

$$AW_{c,SCC} = W_{c,SCC} \times SAF_s \times HAF_c \quad (5)$$

Where:
$AW_{c,SCC}$ = Adjusted amount of wood burned in each SCC in county *c*, in tons per year
SAF_s = SEDS adjustment factor for state *s*
HAF_s = Housing density adjustment factor for county *c*

Note that the appliance fractions and burn rates provided in the input templates already take into account the housing density and SEDS adjustments. Therefore, the input templates for RWC do not ask SLT agencies to submit values for the housing density or SEDS adjustments. Rather, SLT agencies need only to submit revisions to the appliance fractions and burn rates themselves. Equations 4 and 5 are included here only to provide more information about how the appliance fractions and burn rates were adjusted. If SLT agencies submit appliance fractions and/or burn rates in input templates, the SEDS adjustment is not applied. Similarly, the housing density adjustment factor is not applied if the SLT submitted appliance fractions.

27.3.3 Allocation procedure

Appliance fractions and burn rates are calculated at the county-level. There is no need to allocate data to the county level for this category.

27.3.4 Emission factors

Emissions factors for RWC come primarily from AP-42 [ref 11] and Houck and Eagle (2006) [ref 12], but also from Houck et al. (2001) [ref 13]. Many of the HAP emissions factors are from Hays et al. (2003) [ref 14]. Emissions factors for wax firelogs are from Li and Rosenthal (2006) [ref 15]. Additional emission factors are taken from Houck et al. (2001) [ref 13] and Aurell et al. (2012) [ref 16].

For certified woodstoves and fireplace inserts for the 2020 NEI, EPA began using emissions factors for $PM_{2.5}$ primary from AP-42 [ref 11]; this change was made due to uncertainty in the NSPS-derived emissions factors used for the 2017 NEI. The 2017 NEI used the emissions factors from the Regulatory Impact Analysis (RIA) for the 2015 New Source Performance Standards (NSPS) [ref 16], which is based on the woodstove emissions standards from the state of Washington in 1995. The RIA notes that the emissions factors for woodstove, fireplace inserts, and pellet stoves will not decrease from that level until the Step 2 standards become effective in 2020. Therefore, EPA used the Washington state emissions factors to estimate 2017 emissions for these categories.

While the NSPS was expected to decrease emissions for hydronic heaters and furnaces in 2015, EPA lacks data on the fraction of these appliances in use that were manufactured after the 2015 NSPS went into effect. Therefore, EPA made no changes to the emissions factors for hydronic heaters or furnaces.

Emission factors for CAPs and HAPs other than VOC HAPs for these sources are provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site. HAP VOC emission factors are available as discussed in the nonpoint overview HAP Augmentation section of the TSD (Section 6.4).

27.3.5 Controls

There are no controls assumed for this category. However, SLT agencies may submit state- or county-level control factors that will adjust the emissions by SCC.

27.3.6 Emissions

For pollutants that are not estimated by HAP augmentation, emissions from RWC are calculated by multiplying the adjusted amount of wood burned in each SCC in each county by SCC- and pollutant-specific emissions factors.

$$E_{c,SCC,p} = AW_{c,SCC} \times EF_{SCC,p} \quad (6)$$

Where:

$E_{c,SCC,p}$ = Emissions of pollutant *p* from each SCC in county *c*

$AW_{c,SCC}$ = Adjusted amount of wood burned in each SCC in county *c*, in tons per year

$EF_{SCC,p}$ = Emissions factor for pollutant *p* for each SCC, the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site.

27.3.7 Example calculations

Table 27-5 lists sample calculations for the estimation of emissions of PM25-PRI from non-EPA certified freestanding woodstoves in Delaware County, OH.

Note that the appliance fractions and burn rates provided in the input templates already take into account the housing density and SEDS adjustments. Therefore, the input templates for RWC do not ask SLT agencies to submit values for the housing density or SEDS adjustments. Rather, SLT agencies need only to submit revisions to the appliance fractions and burn rates themselves. Equations 4 and 5 are included here only to provide more information about how the appliance fractions and burn rates were adjusted.

Table 27-5: Sample calculations for PM25-PRI emissions from non-EPA certified freestanding woodstoves (SCC 2104008310) in Delaware County, OH

Eq. #	Equation	Values for Delaware County, OH	Result
1	$W_{c,a} = H_c \times AF_{c,a} \times BR_{c,a} \times D_c$	71,521 homes × 0.0751 × 1.9304 × 1.6431 tons/cord	17,037 tons of wood burned in woodstoves
2	$W_{c,SCC} = W_{c,a} \times DP_{SCC}$	17,037 × 0.12	2,044 tons of wood burned in non-EPA certified freestanding woodstoves
3	$SAF_s = \frac{W_{s,SEDS}}{\sum W_{c,SCC}}$	$\frac{18{,}147\ BBtu}{30{,}654\ BBtu}$	0.59 SEDS adjustment factor
4	$HAF_c = -\frac{1}{1+e^{-0.01\,(HD_c-500)}} + 1$	N/A	N/A; housing adjustments are not applied to this appliance
5	$AW_{c,SCC} = W_{c,SCC} \times SAF_s \times HAF_c$	2,044 × 0.59	1,206 adjusted tons of wood burned in non-EPA certified freestanding woodstoves
6	$E_{c,SCC,p} = AW_{c,SCC} \times EF_{SCC,p}$	1,206 × 30.6 lb/ton	36,904 lbs. (18.45 tons) PM25-PRI from non-EPA certified freestanding woodstoves in Delaware County, OH

27.3.8 Puerto Rico and U.S. Virgin Islands

Insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, so emissions are based on two proxy counties in Florida: 12011, Broward County for Puerto Rico and 12087, Monroe County for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island County, the tons per capita emission factor is multiplied by the county

population (from the same year as the inventory's activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

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