

Massachusetts 2011 Periodic Emissions Inventory of VOC, NO_x, CO, SO₂, PM₁₀, PM_{2.5} and NH₃

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SECTION 3 STATIONARY AREA SOURCES (continued)

3.4 SMALL STATIONARY FUEL COMBUSTION AND FIRES

This section covers criteria pollutants and ammonia from area source fuel combustion and fires. The fuel combustion facilities addressed in this section are too small to be counted as point sources. The pollutants estimated are VOC, NO_x, CO, SO₂, PM₁₀, PM_{2.5} and NH₃.

Note that MassDEP adopted EPA emissions from these categories: residential wood-burning, open burning, commercial/residential food preparation, and wildfires.

This section is subdivided into the following categories.

1. FUEL CONSUMPTION

Residential - coal, oil, natural gas & liquid petroleum gas, and wood-burning.

Commercial/Institutional - coal, oil and natural & liquid petroleum gas and wood products.

Small Industrial - coal, oil, natural & liquid petroleum gas, and wood-products.

2. FIRES

Residential Open Burning: Municipal Solid Waste, Land Clearing Debris, and Yard Waste

Wildfires: Prescribed, Forest/Brush

Structural Fires

Vehicle Fires

3. FOOD PREPARATION
Backyard Charcoal Grills
Commercial Charbroiling and Deep Fat Frying

3.4-1 FUEL CONSUMPTION

Coal Consumption. Coal consumption is classified into two major types: bituminous and anthracite, and two minor types: sub-bituminous and lignite. Anthracite coal is a higher grade, has more fixed carbon and is less volatile than bituminous coal. Bituminous area source emission factors are used because MassDEP point source data show that bituminous coal use is more prevalent than anthracite coal in commercial/industrial boilers. Coal consumption has declined over the years in favor of natural gas.

Fuel Oil Consumption. Fuel oil consumption covers two major types of oil: distillate and residual. The lighter distillate oil includes #1, #2, and #4 oils and is used mainly in residential and commercial boilers. The heavier residual oil includes #5 and #6 oils and is used in industrial boilers. Kerosene is also a minor source of fuel used in the state.

Natural Gas and Liquefied Petroleum Gas (LPG) Consumption. Natural gas consumption is increasing in the state and is a large emitter of NO_x and CO. It also releases methane and varying amounts of ethane and propane. Combustion of natural gas produces small amounts of VOC, sulfur oxides, particulates, and NH₃. SO₂ is emitted because a sulfur-containing mercaptan is added to natural gas in order to detect leaks.

Wood-Burning. EPA/ERTAC developed a Microsoft Access Residential Wood Combustion (RWC) Tool to estimate indoor and outdoor residential wood-burning emissions for 2011.¹ E.H Pechan originally prepared the 2002 residential wood-burning estimates for the MANE-VU states and then provided updates for 2008 and incorporated into the EPA/ERTAC 2011 RWC tool. This report is a comprehensive survey of both indoor and outdoor residential wood-burning activities. The survey project methodology gives a full description of the sampling methods, data sources, and methods used to construct the emission estimates. The EPA/ERTAC 2011 residential wood-burning emissions are available in EPA's NEI website² and are summarized by SCC and county in Appendix Tables 3.1-7.

Residential wood-burning fireplaces and wood-stoves are primarily used as a supplemental heating source and for aesthetic effects. Catalytic wood-stoves are newer and are equipped with control devices to reduce emissions.

In addition to indoor wood-burning activity the EPA/ERTAC Wood-burning Tool includes emissions from outdoor residential wood-burning equipment such as fireplaces, woodstoves, fire pits, pellet stoves, and furnaces/boilers. Surveys used in the Wood-burning Tool indicated that activity is no longer confined to the winter heating season, but other seasons in the year mainly from outdoor wood-burning equipment. Outdoor wood-burning takes place even on a typical summer day for heating water, including swimming pools.

The US Department of Energy – Energy Information Administration (DOE-EIA) shows an increasing amount of biomass fuel such as wood and wood products being used not only in residences but in commercial/institutional and industrial facilities as well.

¹ EPA/ERTAC Residential Woodburning Combustion Tool V.1 12/06/2012,
ftp://ftp.epa.gov/EmisInventory/2011nei/doc/rwc_estimation_tool_2011v1_120612.zip

² EPA NEI website: <http://www.epa.gov/ttn/chief/net/2011inventory.html>

Appendix Table 3.1-7 is a summary of the emission estimates for all criteria pollutants and ammonia. The wood-burning emissions were adjusted seasonally using the monthly adjustment factors given in the Table 3c of Technical Memorandum #2 of the MANE-VU/Pechan survey report available at the MARAMA website.³ Wood burning Tool also adjusts emissions for proportion of single vs. multi-family dwellings.

3.4-2 EMISSIONS ESTIMATION METHOD

Emissions from residential, commercial/institutional and small industrial fuel use were estimated by multiplying the quantity and type of fuel by the appropriate emissions factor. The DOE-EIA provided total fuel use in its latest annual report entitled "State Energy Data Report-Consumption Estimates 1960–2010."⁴ This report provides data by the type and quantity of fuel used in the three consumption categories. Fuel use emission factors were derived from AP-42,⁵ EIIP Volume III⁶ and ERTAC.

Residential Fuel Emissions Estimation Method. Residential fuel consumption includes bituminous and anthracite coal, distillate oil, natural gas, wood-burning, kerosene, and liquid petroleum gas (LPG). MassDEP apportioned the DOE-EIA statewide residential fuel use to counties based on owner occupied units.

Appendix Tables 3.1-1 to 3.1-7 include the calculations for residential fuel use emissions. Any reported residential point source fuel use by SCC codes reported in MassDEP's Source Registration program was subtracted from the DOE-EIA total fuel use in order to prevent double counting. The annual fuel usage and emissions were apportioned seasonally based on state monthly sales data from EIA's fuel sales report. Natural gas and LPG are generally used throughout the year for cooking and hot water heating. The following is an example of the VOC and CO emissions calculation for residential distillate oil as shown in Table 3.4-1:

EIA 15,021,000 barrels * 42 gal/barrel = 630,882,000 gallons
630,882,000 gallons minus DEP-AQR point residential distillate of 1,194,340 gallons
= 629,687,660 gallons
629,687,660 gallons * 0.713 lb VOC/1,000 gallons = 448,967 lbs/2,000 lbs = 224.5 TPY
224.5 TPY VOC * 0.09 /92 days = 0.22 tons per summer day (TPSD) VOC
1,574.2 TPY CO * 0.46/90 days = 8.05 tons per winter day (TPWD) CO

Other residential fuel use emissions from other oils, natural gas and wood are estimated in Appendix Tables 3.1-1 to 3.1-7 for the criteria pollutants. Table 3.4-2 is a statewide summary that includes residential together with commercial and industrial fuel emissions.

Commercial/Institutional and Industrial Fuel Emissions Estimation Method.

Commercial/institutional and industrial fuel consumption emissions were estimated using a similar method to residential fuel use estimates. The annual fuel usage and emissions were apportioned seasonally based on monthly sales data from DOE-EIA's fuel report. The fuel combustion activity is

³ <http://www.marama.org/visibility/ResWoodCombustion/>

⁴ Energy Information Administration. "State Energy Data Report Consumption Estimates 1960-2010." U.S. Dept. of Energy DOE/EIA-0214(95) Wash. DC 9/26/2003. http://www.eia.doe.gov/emeu/states/sep_use/totaluse_tot_ma.html
<http://www.eia.gov/state/seds/seds-data-complete.cfm>

⁵ EPA "Compilation of Air Pollutant Emission Factors, AP-42 Volume 1 Stationary Point and Area Sources. OAQPS-RTP NC 5th Ed. January 1995 and Supplement A. <http://www.epa.gov/ttn/chief/ap42/index.html>.

⁶ Emissions Inventory Development - EIIP Volume III Area Sources Preferred and Alternative Products." EPA OAQPS MD-14 454/R-97-004c July 2001. <http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html>.

generally 5 or 6 days a week or an equivalent of 260 days or 312 days per year. These seasonal adjustments were used in Appendix Tables 3.2-1 to 3.3-7 for commercial and industrial fuel consumption.

Table 3.4-2 includes a statewide summary of total commercial/institutional fuel emissions. Tables 3.4-3 to 3.4-5 summarize the residential, commercial and industrial fuel use emissions by county for the criteria pollutants and NH₃.

3.4-3 FIRES

This category includes emissions from miscellaneous sources such as Open Burning, Wildfires, Structural, and Vehicle Fires.

Residential Open Burning. MassDEP adopted EPA/ERTAC 2011 residential open burning estimates⁷ that were originally developed by E.H. Pechan. EPA used the results of the Pechan open burning survey to state officials and residences. The survey was used to estimate the effectiveness of the state's open burning regulations that control seasonal open burning activity. The EPA 2011 Open Burning estimates can be obtained from EPA FTP website⁸ for the following three categories.

1. Residential Municipal Solid Waste (MSW) - non-hazardous refuse produced by households burned at residences.
2. Residential Land Clearing Debris – burning debris such as trees, shrubs, and brush from the clearing of land for new buildings and roads.
3. Yard Waste – Leaf and Brush from residences.

The EPA 2011 Open Burning survey was a follow-up to Pechan's 2008 study. The survey addressed activity data such as type and mass of waste burned, number of households that burn, number of burns per time period, and mass of waste burned per time period for each state. MA state fire wardens/chiefs, solid waste/environmental enforcement officials, and residents provided regulatory control information open burning data. Activity data was collected for census-tract areas classified as urban, suburban and rural so that RE could be determined based on the state regulation banning open burning for each county based on the level of urbanization Urban census tracts were adjusted by EPA/ERTAC especially for cities like Boston (Suffolk County), Worcester and Springfield.

The 2011 residential open burning emissions are available in EPA's NEI by county and are summarized in Tables 3.4-6 to 3.4-10 of this report. The annual emissions were apportioned to seasons by using the monthly adjustment factors given in Table II-2 of the Pechan report for 2008 assuming similar activity for 2011.

Wildfires: Forest/Brush. MassDEP adopted EPA's 2011 wildfire emissions that were developed using satellite imagery from the National Forestry Service. EPA records wildfires as daily and hourly 'event' emissions in its WEBFIRE9 emissions model and is more accurate than monthly averages previously estimated by MassDEP. Forest/brush and prescribed fires are major sources of organic emissions and occur mainly during the ozone season.

MassDEP supplemented EPA's WEBFIRE data with forest/brush fire acreage data obtained from the Massachusetts Department of Public Safety State Fire Marshall's Office.¹⁰ AP-42 Table 13.1-1 estimated

⁷ <http://ftp.epa.gov/EmisInventory/2011nei/doc/>. See files for Open burning - Land Clearing Debris, MSW, and Yard Waste.

⁸ <http://ftp.epa.gov/EmisInventory/2011nei/doc/>

⁹ <http://www.epa.gov/ttn/chief/net/2011inventory.html>

¹⁰ Massachusetts State Fire Marshall's Office, Department of Public Safety. Massachusetts Fire Incident and Reporting System, 2011. <http://www.mass.gov/eopss/agencies/dfs/dfs2/osfm/fire-data/>

the fuel-loading factor of 11 tons per acre for the Eastern/North Central Region of the U.S. Emission factors for forest wild fires are also available from AP-42 Table 13.1-2 for the North Central and Eastern Regions. The emissions factor for each pollutant was reported in kg/hectare and was converted to lb/acre. MassDEP applied these factors to the estimated county acreage of forest vegetation burned that was reported by the state Fire Marshall's Office as shown in Table 3.4-9. MassDEP provided these additional fire estimates that were not covered by EPA's WEBFIRE model. The Fire Marshall data showed that the summer (June, July and August) accounted for 15% of the annual total burned.

The following is the VOC emissions calculation for forest fires.

1 kg = 2.2046 lbs
 1 Mg = 1.1023 tons
 1 hectare = 2.471 acres
 1 acre = 0.4047 hectares

700.6 acres * 0.4047 = hectares = 283.5 hectares * 296 kg VOC per hectare =
 83,916 kg VOC * 2.2046 kg/lb = 185,003 lb /2,000 lbs =
 92.5 TPY VOC * 0.15 (summer)/92days = 0.15 TPSD VOC

Structural Fires. Building or structural fires are significant sources of organic emissions. As recommended in EIIP Chapter 18 (CARB estimate), the number of structural fires multiplied by a fuel-loading factor of 1.15 tons of material per fire provided the estimate of the amount of material burned.

The Massachusetts Department of Safety State Fire Marshall's Office provided structural fire data by county for 2011. EIIP Volume III Chapter 18 Table 18.3-2 provided seasonal adjustment factors for structural fires in lb/ton.

VOC: 11.0
 NOx: 1.4
 CO: 60
 PM10: 10.8

The following is an example calculation for VOC emissions from structural fires taken from Table 3.4-12.

18,213 structural fires * 1.15 tons fuel/fire = 20,945 tons fuel * 11.0 lb VOC/2,000 lb/ton = 115.2 tons VOC. Summer day emissions = 115.2 TPY * 0.208 (summer)/92 days = 0.26 TPSD

Vehicle Fires. The Massachusetts Department of Safety State Fire Marshall's Office provided data for vehicle fires by county. EIIP Volume III Method Abstracts provided emission factors for vehicle fires. The following is an example of the emission calculations for VOC vehicle fires that are apportioned by county in Table 3.4-13.

3,007 vehicle fires * 500 lb /fire/2000 lb = 752 tons fuel * 32.0 lb VOC/ton
 = 24,056 lb/2000 lbs = 12.0 TPY VOC * /365 days = 0.033 TPSD

3.4-4 FOOD PREPARATION

Commercial Cooking. MassDEP obtained 2011 emissions for commercial cooking from EPA's website.¹¹ EPA estimated emissions from conveyerized and underfed charbroiling, deep-fat frying, fat griddle frying, and clam-shell griddle frying. EPA used population as the activity data developed from CARB's estimates. Emissions are presented in Table 3.4-14.

Backyard Charcoal grills. Organic gases are emitted when charcoal lighter fluid is used to soak and light charcoal briquettes in residential backyard grills. The lighter fluid consists of volatile constituents from petroleum distillates. The majority of VOC's are emitted during the combustion of charcoal. EPA's Air and Energy Engineering Research Laboratory (AEERL),¹² together with the South Coast Air Quality Management District (SCAQMD) and the Barbecue Industry Association, provided a national 1990 emissions estimate as follows.

1,110 TPY VOC from lighter fluid
14,500 TPY VOC from evaporation and combustion combined

The per-capita emissions factor was 0.1166 lb VOC per year.

MassDEP applied the AEERL national per capita emissions factor to Massachusetts 2011 population. The number of single-family dwellings was used to apportion statewide emissions to counties. The AEERL report provided an estimate of 80% of the annual estimate of lighter fuel being consumed during the ozone season. The emissions estimate also includes charcoal grills used in parks and other recreational areas. The following is the emissions estimation procedure for Massachusetts as presented in Table 3.4-14.

14,500 tons VOC /248,709,873 US population 1990
= 0.1166 lb/yr * 6,587,536 MA population 2011
= 768,107 lb/2,000 lb = 384.1 TPY * 0.8 (summer)/92 days
= 3.34 TPSD VOC.

¹¹ <ftp://ftp.epa.gov/EmisInventory/2011nei/doc/>

¹² EPA Air and Energy Engineering Research Laboratory "Research and Development - Identification and Characterization of Missing or Unaccounted for Area Source Categories." EPA 600-R-92-006 RTP NC January 1992. <http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=30003VWI.txt>