DEVELOPING A TOOL TO ESTIMATE NONPOINT EMISSIONS FROM INDUSTRIAL, COMMERCIAL, AND INSTITUTIONAL FUEL COMBUSTION

Jonathan G. Dorn* and David M. Cooley
Abt Associates, Durham, NC, USA

Jennifer Snyder and Roy Huntley
U.S. Environmental Protection Agency, Research Triangle Park, NC, USA

1. INTRODUCTION

Emissions from Industrial, Commercial, and Institutional (ICI) fuel combustion are often a significant portion of most areas' total emissions inventory. Unless all ICI combustion emission sources are covered in a geographic area's point source inventory, it is necessary for inventory preparers to estimate ICI combustion nonpoint source emissions. Because there are specific challenges associated with estimating ICI nonpoint source emissions, the U.S. EPA in conjunction with Abt Associates developed a Microsoft® Access-based ICI Combustion Tool to assist State, Local, and Tribal agencies in estimating nonpoint emissions from ICI fuel combustion for the 2014 National Emission Inventory.

The primary data source behind the ICI Combustion Tool is total state-level ICI energy consumption data released annually as part of the Energy Information Administration's State Energy Data System (SEDS). The ICI Combustion Tool processes the SEDS data and adjusts the data to account for the fraction of fuel consumed by nonroad mobile sources whose emissions are included in the nonroad inventory and by non-fuel combustion uses of energy, such as product feedstocks. Through a user-friendly interface, users can update the underlying assumptions in the adjustment methodology. The ICI Combustion Tool also includes a nonpoint source to point source crosswalk and allows the user to perform point source activity subtractions to avoid double counting of emissions between their point and nonpoint inventories. The ICI Combustion Tool generates outputs in EPA's Emissions Inventory System (EIS) format, ready for submission to the EIS. This paper will provide an overview of the ICI Combustion Tool and the procedures for developing a credible estimate of nonpoint emissions from ICI fuel-combustion sources.

**Corresponding author:* Jonathan Dorn, Abt Associates, 5001 South Miami Boulevard, Suite 210, Durham, NC 27703; e-mail: jonathan_dorn@abtassoc.com

2. SOURCE CLASSIFICATION CODES AND POLLUTANTS INCLUDED IN ICI TOOL

Table 1 displays the source categories included in the ICI Combustion Tool and Table 2 displays the pollutant types covered.

Table 1. Source Categories Included in ICI Tool

SCC	Description
Industrial	
2102001000	Anthracite Coal /Total: All Boiler Types
2102002000	Bituminous/Subbituminous Coal /Total: All Boiler Types
2102004001	Distillate Oil /Boilers
2102004002	Distillate Oil /IC Engines
2102005000	Residual Oil /Total: All Boiler Types
2102006000	Natural Gas /Total: Boilers and IC Engines
2102007000	Liquified Petroleum Gas /Total: All Boiler Types
2102008000	Wood /Total: All Boiler Types
2102011000	Kerosene /Total: All Boiler Types
Commercial/Institutional	
2103001000	Anthracite Coal /Total: All Boiler Types
2103002000	Bituminous/Subbituminous Coal /Total: All Boiler Types
2103004001	Distillate Oil /Boilers
2103004002	Distillate Oil /IC Engines
2103005000	Residual Oil /Total: All Boiler Types
2103006000	Natural Gas /Total: Boilers and IC Engines
2103007000	Liquified Petroleum Gas /Total: All Combustor Types
2103008000	Wood /Total: All Boiler Types
2103011000	Kerosene /Total: All Combustor Types

Table 2. Pollutants Included in ICI Tool

Category	Pollutant(s)
Criteria	Carbon monoxide
	Nitrogen oxides
	PM_{10}
	$PM_{2.5}$
	Sulfur dioxide
	Volatile organic compounds
Hazardous	Polycyclic organic matter
	Metals
	Dioxins/furans
	Other HAPs emitted from fuel combustion
PM Precursor	Ammonia

3. OVERVIEW OF CALCULATIONS

ICI combustion nonpoint source emissions are calculated using Equation 1. The sector reference represents Industrial or Commercial/Institutional, and fuel types include: coal, natural gas, distillate oil, residual oil, liquefied petroleum gas, kerosene and wood.

$$E_{s,f} = A_{s,f} * F_{s,f} \quad (1)$$

where E is emissions, A is emissions activity, F is emission factor, S is sector, and f is fuel type.

The key emissions activity data inputs in the emissions estimation methodology are:

1. Total Industrial and total Commercial/Institutional energy consumption by fuel type and state for a given year;
2. Industrial energy consumed for non-fuel purposes by fuel type and state in that year;
3. ICI distillate oil and liquefied petroleum gas (LPG) consumption by state from nonroad mobile sources for the year of interest;
4. ICI energy consumption by sector, state, and fuel type for point sources for the given year; and
5. County-level employment by ICI sector and state for the year of interest.

The ICI Tool also relies on emission factors relating emission rates to the volume of energy burned by sector/fuel type, and the sulfur content of coal consumed in each sector by state for the given year.

ICI combustion emissions are directly related to the sector, type, and volume of fuel burned. The EIA is responsible for developing official federal government estimates of energy consumption. The EIA estimates annual energy consumption at the state-level as part of the State Energy Data System (SEDS) (EIA, 2014). The SEDS reports energy consumption estimates by state, sector, fuel type, and year. The SEDS provides data for each of five consuming sectors, including Industrial and Commercial (note that the SEDS' definition of "Commercial" includes Institutional sector use). The EIA also publishes additional detailed estimates of state-level fuel oil and kerosene consumption estimates in their *Fuel Oil and Kerosene Sales* publication (EIA, 2013a). This publication provides state-level annual end use sales of No.1, No. 2, and No. 4 distillate fuel oil for commercial, industrial, oil company, farm, off-highway construction, and other uses – these data are used to differentiate stationary from mobile source distillate fuel consumption.

3. ACTIVITY DATA ADJUSTMENTS

3.1 Fuel Specific Data Adjustments

Coal – For coal combustion, it is necessary to compile data representing a subset of total sector coal consumption. Data representing non-coke plant consumption are compiled from EIA because coal consumed by coke plants is accounted for in the point source inventory. The SEDS data do not provide coal consumption estimates by type of coal (i.e., anthracite versus bituminous/subbituminous). Therefore, state-level ICI coal distribution data for 2011 from the EIA's *Annual Coal Distribution Report 2011* are used to allocate coal consumption between the two types of coal (EIA, 2013b). The 2011 ratio of anthracite coal consumption to total coal consumption is used for this allocation procedure.

Distillate Oil and LPG – The SEDS ICI distillate oil and LPG consumption data include consumption estimates for equipment that are typically included in the nonroad sector inventory. In particular, SEDS considers the following nonroad source category activities to be part of the industrial sector: farming, logging, mining, and construction.

In order to avoid double-counting of distillate oil consumption between the nonpoint and

nonroad sector emission inventories, the more detailed distillate oil consumption estimates reported in EIA's *Fuel Oil and Kerosene Sales* are combined with assumptions used in the regulatory impact analysis (RIA) for EPA's nonroad diesel emissions rulemaking (EIA, 2013c; EPA, 2003).

In order to avoid double-counting of LPG consumption, the ICI Tool uses data from the EPA National Mobile Inventory Model (NMIM) for 2006 to calculate the national volume of nonroad LPG consumption from agriculture, logging, mining, and construction source categories. This estimate is then divided into the SEDS total LPG consumption estimate to yield the proportion of total ICI LPG consumption attributable to the nonroad sector in that year (8.72% for industrial sources and 17.72% for commercial/institutional sources). It is assumed that these proportions are appropriate for future inventory years. This estimate of the nonroad portion of LPG consumption is subtracted from each state's ICI LPG consumption estimate reported in SEDS.

3.2 Non-fuel Use Energy Adjustment

Some industrial sector energy is consumed for non-fuel purposes, such as natural gas that is used as a feedstock in chemical manufacturing plants and to make nitrogenous fertilizer, and LPG that is used to create intermediate products that are ultimately made into plastics. In order to estimate the volume of fuel that is associated with industrial combustion, it is necessary to subtract the volume of fuel consumption for non-energy uses from the volume of total fuel consumption. The identification of feedstock usage was initially based upon the non-fuel use assumptions incorporated into the EIA's GHG emissions inventory for 2005 (EIA, 2007). The following fuels are assumed to be used entirely for non-fuel purposes: asphalt and road oil, feedstocks (naphtha <401 °F), feedstocks (other oils >401 °F), lubricants, miscellaneous petroleum products, pentanes plus, special naphthas, and waxes. In addition, it is also assumed that kerosene and motor gasoline are used entirely as fuel without any non-fuel purposes. The remaining fuels (i.e., coal [non-coke], distillate oil, LPG, natural gas, and residual oil) are used both for fuel and non-fuel purposes. The regional non-fuel fractions for distillate oil, LPG, natural gas, and residual oil are derived from non-fuel (feedstock) and total energy use statistics contained in EIA's *2010 Manufacturing Energy Consumption Survey (MECS)* (EIA, 2013d). This approach could not be used for non-coke coal because the 2010 MECS treats coal that is used to produce coke as a feedstock. Because of the limitations of the MECS data for non-coke coal, EIA previously provided a rough estimate of the percentage of non-coking coal that is used for non-fuel purposes (as well as treating "synthetic coal" as a fuel use). The estimate provided by EIA was that 5-10% of non-coke coal is used for non-fuel purposes (Lorenz, 2009); it was assumed that the midpoint of this range (i.e., 7.5%) is a reasonable estimate for the fraction of non-coke plant industrial sector coal consumption that is for non-fuel purposes.

3.3 Point Source Energy Adjustment

To ensure that fuel consumption is not double-counted in the point source inventory, it is also necessary to subtract point source inventory fuel use from the fuel consumption estimates developed from the above steps. Equation 2 illustrates the approach to performing point source subtractions.

$$N_{s,f} = T_{s,f} - P_{s,f} \qquad (2)$$

where N is nonpoint fuel consumption, T is total fuel consumption, P is point source fuel consumption, s is sector, and f is fuel type.

The first step in the point source subtraction procedure is to identify how each ICI combustion nonpoint source classification code (SCC) links to associated ICI combustion point SCCs. The ICI Combustion Tool includes two such crosswalks: one between each Industrial fuel combustion nonpoint SCC and related point SCCs, and an analogous crosswalk developed for Commercial/Institutional fuel combustion SCCs. One issue to note is that natural gas consumed as pipeline fuel is not included by the SEDS within the Industrial sector. Therefore, it is necessary to exclude pipeline natural gas consumption in performing natural gas combustion subtraction. This consumption may be included within industrial sector natural gas internal combustion engine records (SCC 202002xx).

An issue that must be considered is the geographic resolution at which point source subtractions should be performed. While the locations of point sources is accurately known at (and below) the county-level, total ICI combustion activity is much less clear. Because of the level of uncertainty associated with the county distribution of total ICI fuel consumption, it is most appropriate to perform the ICI combustion point source subtractions at the state-level, and then allocate

the resulting nonpoint source fuel consumption to counties.

4. COUNTY ALLOCATION OF STATE ACTIVITY

Because the EIA only reports energy consumption down to the state-level, it is necessary to develop a procedure to allocate EIA's fuel consumption estimates (after adjustments noted in sections above) to counties. For the NEI, the procedure relies on the use of allocation factors developed from the county-level number of employees in the Industrial sector and the county number of employees in the Commercial/Institutional sector. Because EIA fuel consumption data originate from fuel sector-specific surveys of energy suppliers,[1] we reviewed these survey forms/instructions for further details on what individual economic sectors EIA considers to comprise the Industrial and Commercial sector. Based on this review, we compiled employment data for manufacturing sector North American Industrial Classification System (NAICS) codes (i.e., NAICS 31-33) for use in allocating Industrial fuel combustion. The only source of NAICS-code based EIA definitions of the Commercial energy sector is a "rough crosswalk" between Commercial building types and NAICS codes developed for EIA's Commercial Building Energy Consumption Survey (CBECS) (EIA, 2013e). With the exception of NAICS code 814 (Private Households), this crosswalk links all NAICS codes between 42 and 92 with Commercial building energy consumption. The NEI uses total county-level employment in NAICS codes 42 through 92 (excluding 814) to allocate state-level Commercial/Institutional consumption estimates.

The ICI Combustion Tool compiles employment data for these NAICS codes from two Bureau of the Census publications – *County Business Patterns* (for private sectors) and *Census of Governments* (for public administration sectors) (Bureau of the Census, 2014a; Bureau of the Census, 2014b). For NAICS code 92, county-level employment is estimated from local government employment data in the *Census of Governments*.[2] Employment estimates from each source are then combined to estimate total Commercial/ Institutional sector employment by county. The state-level fuel combustion by fuel type estimates in each sector are then allocated to each county using the ratio of the number of Industrial or Commercial/Institutional employees in each county in a given state.

5. EMISSION FACTORS

The criteria and hazardous air pollutant emission factors for each nonpoint source fuel combustion category included in the ICI Combustion Tool are primarily EPA emission factors. The majority of the emission factors are from the EPA/ERTAC2 database and EPA's *AP-42* report, Compilation of Air Pollutant Emission Factors (Huntley, 2009; EPA, 2010). The ammonia emission factors for wood combustion are from an Emission Inventory Improvement Program (EIIP) guidance document (EPA, 2004).

For coal combustion, the SO_2 emission factors are based on the sulfur content of the coal burned, and some of the PM emission factors for anthracite coal require information on the ash content of the coal. For the industrial and commercial/institutional sectors, state-specific coal sulfur contents for bituminous coal are obtained from the EIA's quarterly coal report (EIA, 2012). For anthracite coal, an ash content value of 13.38% and a sulfur content of 0.89% are applied to all states.

6. RUNNING THE ICI TOOL

The ICI Combustion Tool includes a user-friendly graphical interface that walks the user through the development of their nonpoint ICI combustion emissions inventory. The ICI Combustion Tool allows the user to select the state(s) of interest, import state- or county-level point source inventory data, modify the default assumptions used in the Tool, and export their final nonpoint ICI emissions inventory in EIS staging format. Figures 1 through 5 below show snapshots of the user interface.

[1] For natural gas, for example – EIA-176 "Annual Report of Natural and Supplemental Gas Supply and Disposition."

[2] County-level federal and state government employment data are not available from the Bureau of the Census.

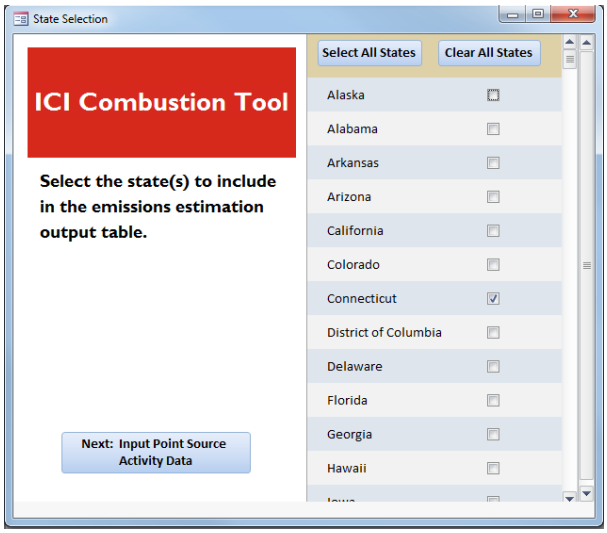

Fig. 1. Snapshot of state selection interface.

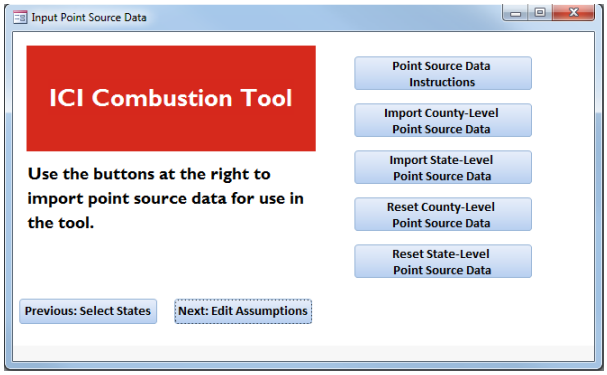

Fig. 2. Snapshot of point source import interface.

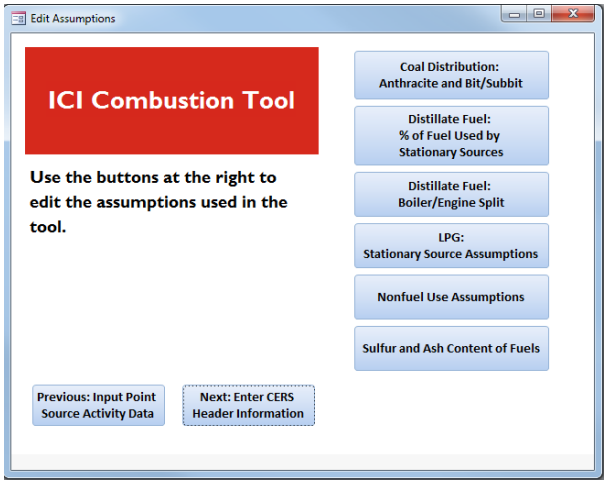

Fig. 3. Snapshot of assumptions interface.

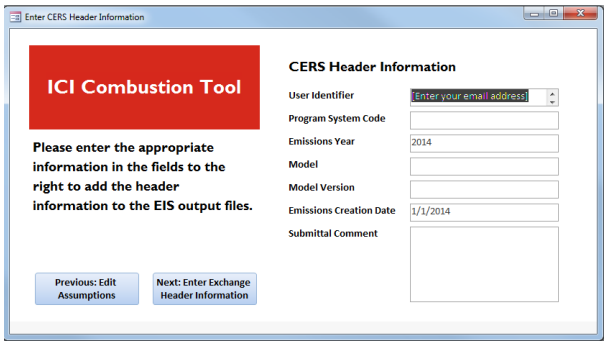

Fig. 4. Snapshot of CERS Header interface

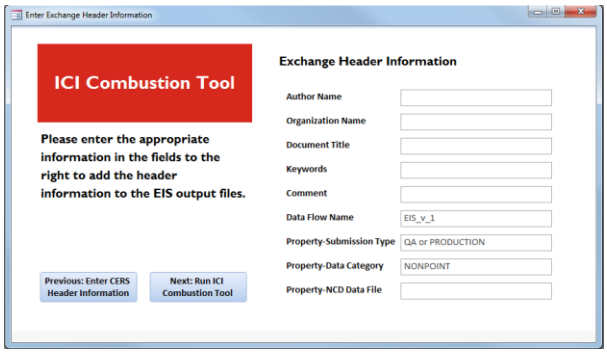

Fig. 5. Snapshot of Exchange Header interface.

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