A National Methodology and Emission Inventory for Residential Fuel Combustion

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Project Goals

- To develop an innovative and consistent approach to estimating emissions from residential fuel combustion (RFC)
  - Approach had to rely on publicly-available data sources
- To develop a list of fuel-specific emission factors suitable for estimating emissions from RFC
- To develop a national emission inventory with county-level resolution
- To compare emissions to the draft 1999 NEI, version 2

Project Goals

- **To estimate emissions from the following fuel types**
  - Natural gas,
  - Liquefied propane gas,
  - No. 2 fuel oil (distillate fuel oil),
  - Kerosene,
  - Anthracite coal, and,
  - Bituminous coal

Project Goals

- **Emissions were estimated for the following pollutants**
  - Carbon Monoxide,
  - Nitrogen oxides,
  - Sulfur oxides,
  - Volatile organic compounds,
  - Filterable PM 10 and PM2.5,
  - Condensable PM

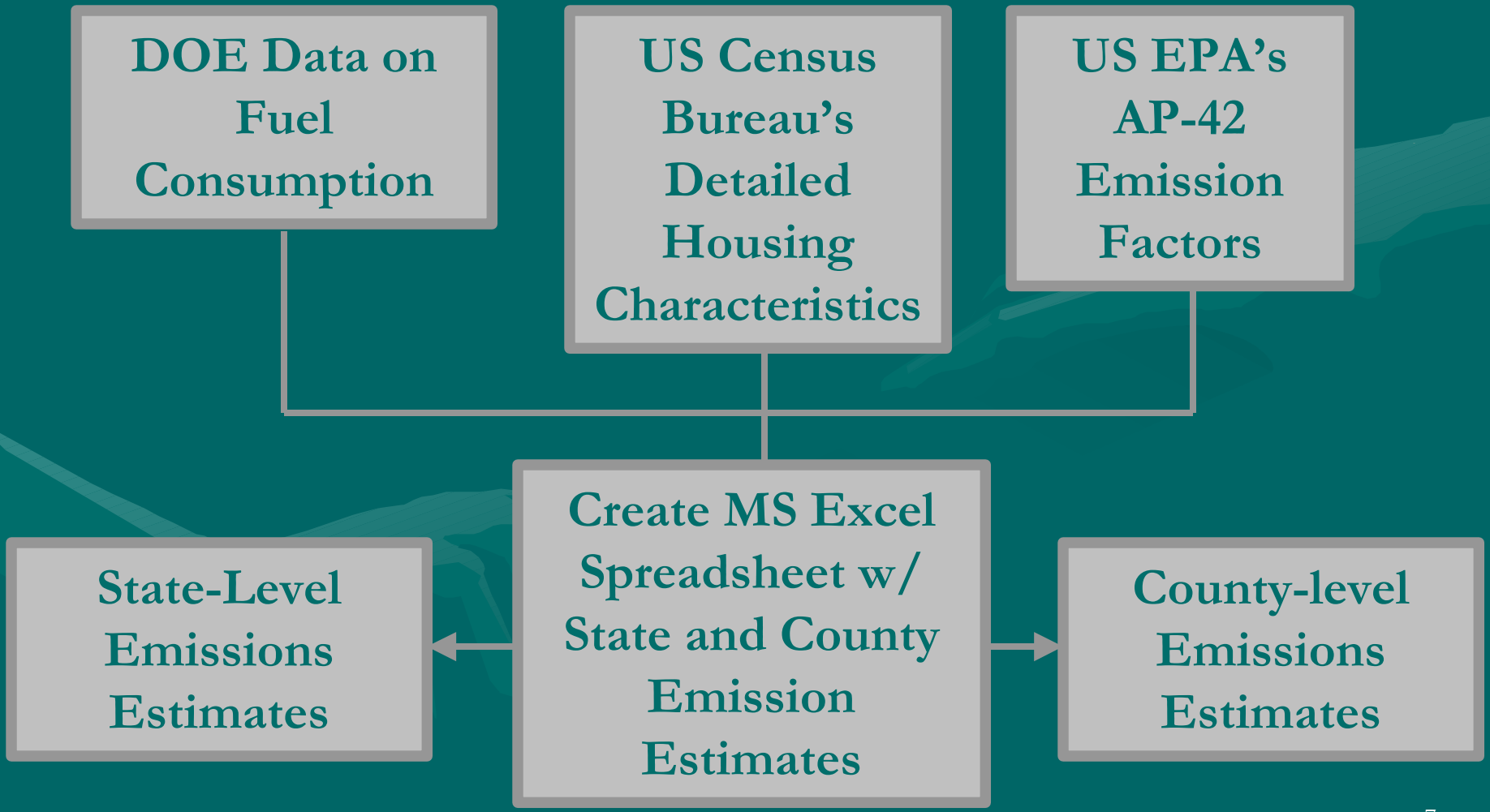
Data Sources

- **Department of Energy's Energy Information Administration**
  - 1999 Fuel usage on the State level
- **Census Bureau's 1990 Detailed Housing Characteristics**
  - Number of houses per county burning a particular fuel type
- **US EPA**
  - Emission factors from AP-42

Data Sources

- **USGS COALQUAL Database**
  - Was accessed to obtain State-specific sulfur content for anthracite and bituminous coal
- **Federal Energy Regulatory Commission (FERC) 423 Database**
  - Was accessed to obtain State-specific fuel oil sulfur contents
- **National Acid Precipitation Assessment Program**
  - Background documentation accessed for State-specific fuel oil sulfur contents
  - Found that FERC and NAPAP had similar sulfur content values

Methodology



Methodology

- **Spreadsheets were created in MS Excel**
  - Two sets of worksheets were developed
    - One set of fuel-specific worksheets was developed for State-level emission estimates
    - One set of fuel-specific worksheets was developed for County-level emission estimates
  - County level emission estimate worksheets were linked to State-specific worksheets
    - To obtain emission factors
    - To obtain fuel throughput data for the State

Methodology

- **Fuel consumption was apportioned from the State level to County level by**
  - Dividing the number of houses burning a fuel type by the total number of houses burning a fuel type in the State
  - Ex. 43 houses burning Coal in County A / 5,200 houses burning Coal in State
  - Fuel throughput values were multiplied by applicable AP-42 emission factor

Emission Factors for Natural Gas

Pollutant	Emission Factor ($lb/10^6\ ft^3$)	AP-42 Table	Publication Date
CO	40	1.4-1	July 1998
NOx	94	1.4-1	July 1998
SOx	0.6	1.4-2	July 1998
VOC	5.5	1.4-2	July 1998
PM 10 Filterable	1.9	1.4-2	July 1998
PM 2.5 Filterable	1.9	1.4-2	July 1998
PM Condensible	5.7	1.4-2	July 1998

Emission Factors for LPG

Pollutant	Emission Factor ($lb/10^3$ gal)	AP-42 Table	Publication Date
CO	3.2	1.5-1	October 1996
NOx	13.0	1.4-2	July 1998
SOx	0.10	1.5-1	October 1996
VOC	0.5	1.5-1	October 1996
PM 10 Filterable	0.17	1.4-2	July 1998
PM 2.5 Filterable	0.17	1.4-2	July 1998
PM Condensible	0.51	1.4-2	July 1998

Emission Factors for Distillate Fuel Oil

Pollutant	Emission Factor ($lb/10^3$ gal)	AP-42 Table	Publication Date
CO	5.0	1.3-1	September 1998
NOx	18.0	1.3-1	September 1998
SOx	42.6	1.3-1	September 1998
VOC	0.7	1.3-3	September 1998
PM 10 Filterable	1.08	1.3-7	September 1998
PM 2.5 Filterable	0.83	1.3-7	September 1998
PM Condensible	1.3	1.3-2	September 1998

Emission Factors for Kerosene

Pollutant	Emission Factor ($lb/10^3$ gal)	AP-42 Table	Publication Date
CO	4.8	1.3-1	September 1998
NOx	17.4	1.3-1	September 1998
SOx	41.1	1.3-1	September 1998
VOC	0.7	1.3-3	September 1998
PM 10 Filterable	1.08	1.3-7	September 1998
PM 2.5 Filterable	0.83	1.3-7	September 1998
PM Condensible	1.3	1.3-2	September 1998

Emission Factors for Anthracite Coal

Pollutant	Emission Factor (lb/ton)	AP-42 Table	Publication Date
CO	275	1.1-3	September 1998
NOx	3.0	1.2-1	October 1996
SOx	39S	1.2-1	October 1996
VOC	10	1.1-19	September 1998
PM 10 Filterable	10.0	1.2-3	October 1996
PM 2.5 Filterable	0.6A	1.2-4	October 1996
PM Condensible	0.08A	1.2-3	October 1996

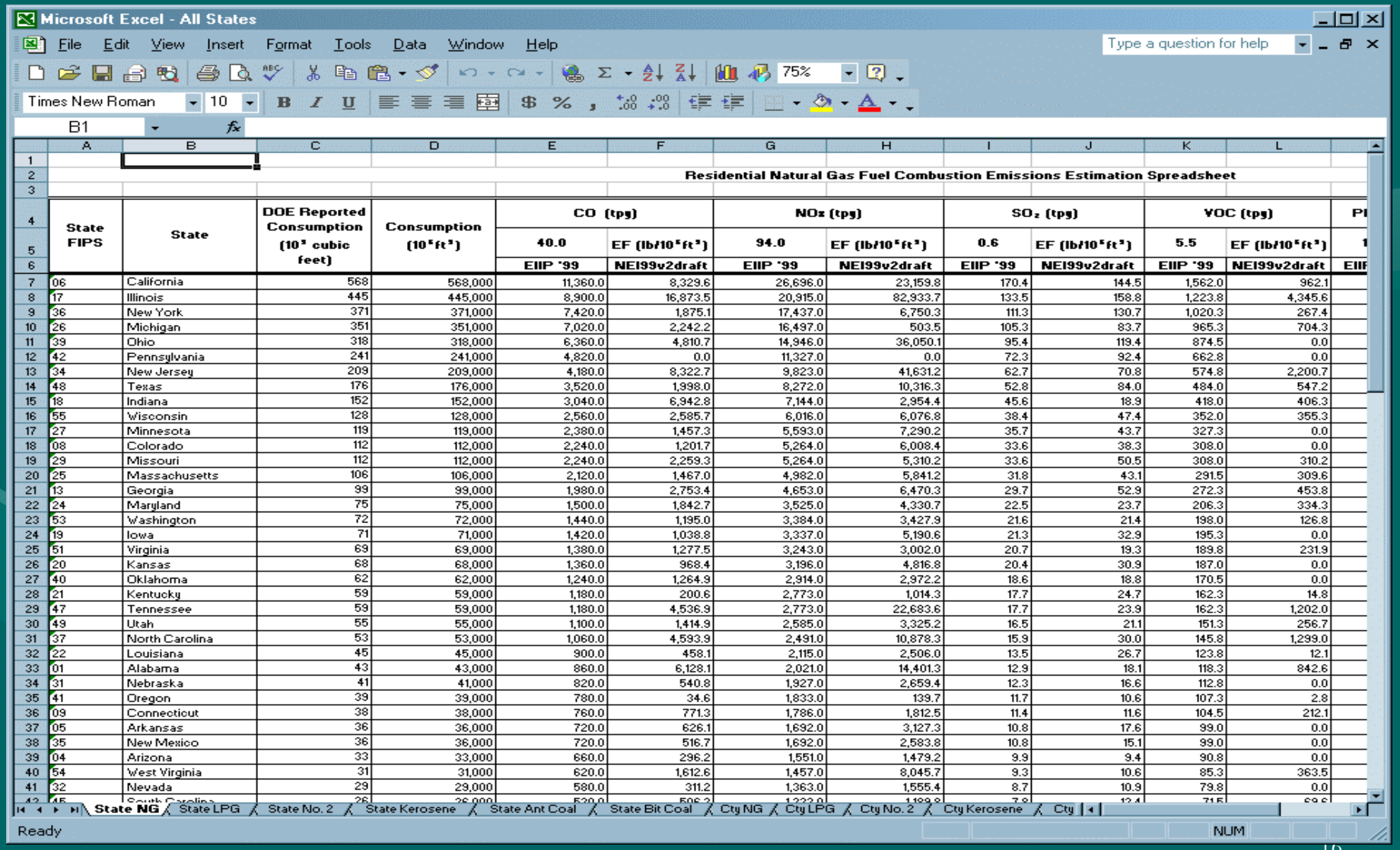
A = Ash, S = Sulfur Content

Emission Factors for Bituminous Coal

Pollutant	Emission Factor (lb/ton)	AP-42 Table	Publication Date
CO	275	1.1-3	September 1998
NOx	9.1	1.1-3	September 1998
SOx	31S	1.1-3	September 1998
VOC	10	1.1-19	September 1998
PM 10 Filterable	6.2	1.1-4	September 1998
PM 2.5 Filterable	3.8	1.1-10	September 1998
PM Condensible	0.04	1.1-5	September 1998

S = Sulfur Content

Sample Excel Worksheet


Microsoft Excel - All States

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Residential Natural Gas Fuel Combustion Emissions Estimation Spreadsheet

State FIPS	State	DOE Reported Consumption (10^3 cubic feet)	Consumption ($10^6 ft^3$)	CO (tpy)		NOx (tpy)		SO_2 (tpy)		VOC (tpy)		PI
				40.0	EF ($lb/10^6 ft^3$)	94.0	EF ($lb/10^6 ft^3$)	0.6	EF ($lb/10^6 ft^3$)	5.5	EF ($lb/10^6 ft^3$)	1
				EIIP '99	NEI99v2draft	EIIP '99	NEI99v2draft	EIIP '99	NEI99v2draft	EIIP '99	NEI99v2draft	EIIP
06	California	568	568,000	11,360.0	8,329.6	26,696.0	23,159.8	170.4	144.5	1,562.0	962.1	
17	Illinois	445	445,000	8,900.0	16,873.5	20,915.0	82,933.7	133.5	158.8	1,223.8	4,345.6	
36	New York	371	371,000	7,420.0	1,875.1	17,437.0	6,750.3	111.3	130.7	1,020.3	267.4	
26	Michigan	351	351,000	7,020.0	2,242.2	16,497.0	503.5	105.3	83.7	965.3	704.3	
39	Ohio	318	318,000	6,360.0	4,810.7	14,946.0	36,050.1	95.4	119.4	874.5	0.0	
42	Pennsylvania	241	241,000	4,820.0	0.0	11,327.0	0.0	72.3	92.4	662.8	0.0	
34	New Jersey	209	209,000	4,180.0	8,322.7	9,823.0	41,631.2	62.7	70.8	574.8	2,200.7	
48	Texas	176	176,000	3,520.0	1,998.0	8,272.0	10,316.3	52.8	84.0	484.0	547.2	
18	Indiana	152	152,000	3,040.0	6,942.8	7,144.0	2,954.4	45.6	18.9	418.0	406.3	
55	Wisconsin	128	128,000	2,560.0	2,585.7	6,016.0	6,076.8	38.4	47.4	352.0	355.3	
27	Minnesota	119	119,000	2,380.0	1,457.3	5,593.0	7,290.2	35.7	43.7	327.3	0.0	
08	Colorado	112	112,000	2,240.0	1,201.7	5,264.0	6,008.4	33.6	38.3	308.0	0.0	
29	Missouri	112	112,000	2,240.0	2,259.3	5,264.0	5,310.2	33.6	50.5	308.0	310.2	
25	Massachusetts	106	106,000	2,120.0	1,467.0	4,982.0	5,841.2	31.8	43.1	291.5	309.6	
13	Georgia	99	99,000	1,980.0	2,753.4	4,653.0	6,470.3	29.7	52.9	272.3	453.8	
24	Maryland	75	75,000	1,500.0	1,842.7	3,525.0	4,330.7	22.5	23.7	206.3	334.3	
53	Washington	72	72,000	1,440.0	1,195.0	3,384.0	3,427.9	21.6	21.4	198.0	126.8	
19	Iowa	71	71,000	1,420.0	1,038.8	3,337.0	5,190.6	21.3	32.9	195.3	0.0	
51	Virginia	69	69,000	1,380.0	1,277.5	3,243.0	3,002.0	20.7	19.3	189.8	231.9	
20	Kansas	68	68,000	1,360.0	968.4	3,196.0	4,816.8	20.4	30.9	187.0	0.0	
40	Oklahoma	62	62,000	1,240.0	1,264.9	2,914.0	2,972.2	18.6	18.8	170.5	0.0	
21	Kentucky	59	59,000	1,180.0	200.6	2,773.0	1,014.3	17.7	24.7	162.3	14.8	
47	Tennessee	59	59,000	1,180.0	4,536.9	2,773.0	22,683.6	17.7	23.9	162.3	1,202.0	
49	Utah	55	55,000	1,100.0	1,414.9	2,585.0	3,325.2	16.5	21.1	151.3	256.7	
37	North Carolina	53	53,000	1,060.0	4,593.9	2,491.0	10,878.3	15.9	30.0	145.8	1,299.0	
22	Louisiana	45	45,000	900.0	458.1	2,115.0	2,506.0	13.5	26.7	123.8	12.1	
01	Alabama	43	43,000	860.0	6,128.1	2,021.0	14,401.3	12.9	18.1	118.3	842.6	
31	Nebraska	41	41,000	820.0	540.8	1,927.0	2,659.4	12.3	16.6	112.8	0.0	
41	Oregon	39	39,000	780.0	34.6	1,833.0	139.7	11.7	10.6	107.3	2.8	
09	Connecticut	38	38,000	760.0	771.3	1,786.0	1,812.5	11.4	11.6	104.5	212.1	
05	Arkansas	36	36,000	720.0	626.1	1,692.0	3,127.3	10.8	17.6	99.0	0.0	
35	New Mexico	36	36,000	720.0	516.7	1,692.0	2,583.8	10.8	15.1	99.0	0.0	
04	Arizona	33	33,000	660.0	296.2	1,551.0	1,479.2	9.9	9.4	90.8	0.0	
54	West Virginia	31	31,000	620.0	1,612.6	1,457.0	8,045.7	9.3	10.6	85.3	363.5	
32	Nevada	29	29,000	580.0	311.2	1,363.0	1,555.4	8.7	10.9	79.8	0.0	
45	South Carolina	26	26,000	520.0	506.2	1,222.0	1,189.8	7.8	12.4	71.5	69.6	

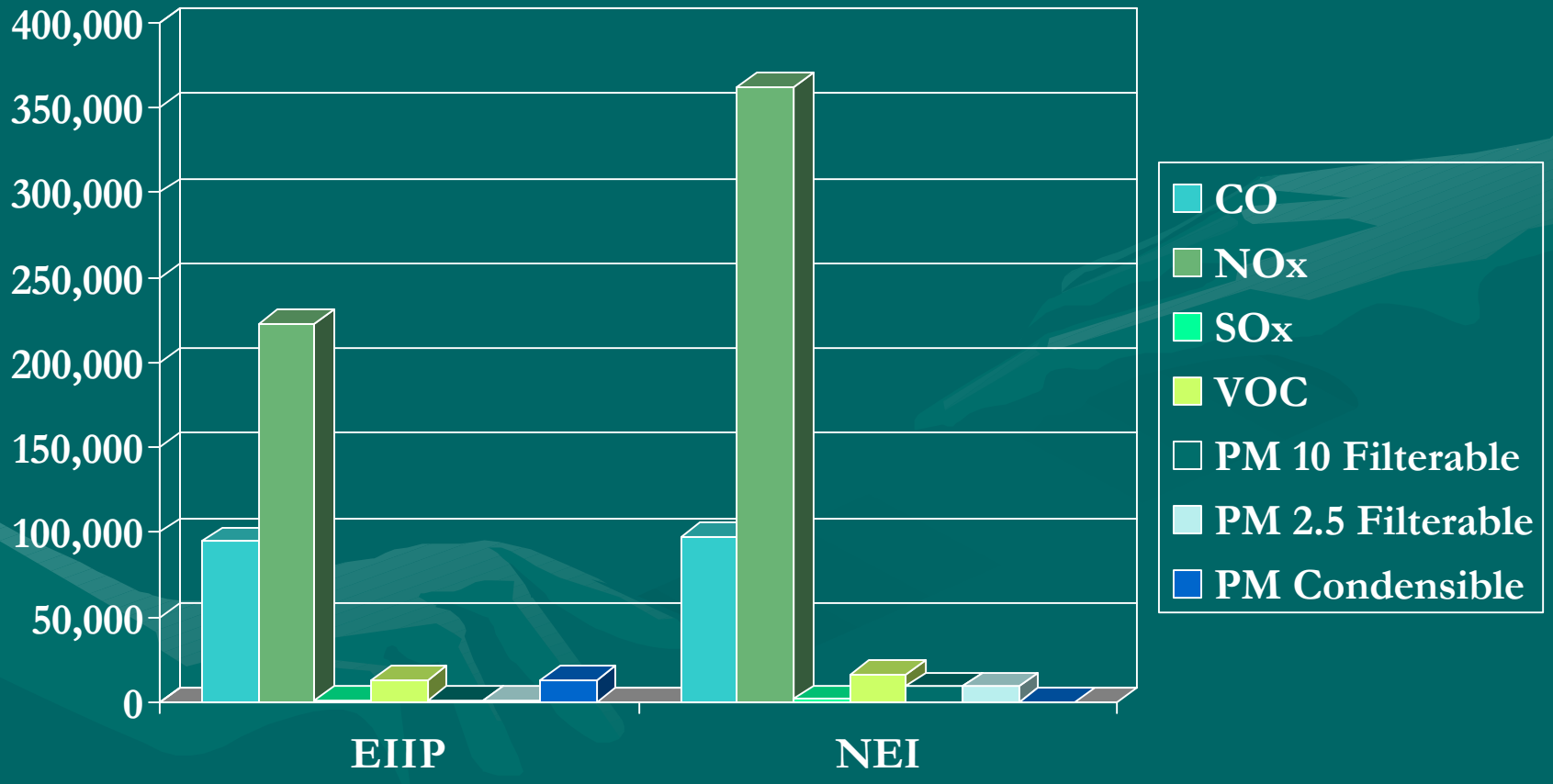
State NG | State LPG | State No. 2 | State Kerosene | State Ant Coal | State Bit Coal | Cty NG | Cty LPG | Cty No. 2 | Cty Kerosene | Cty

Ready NUM

Results

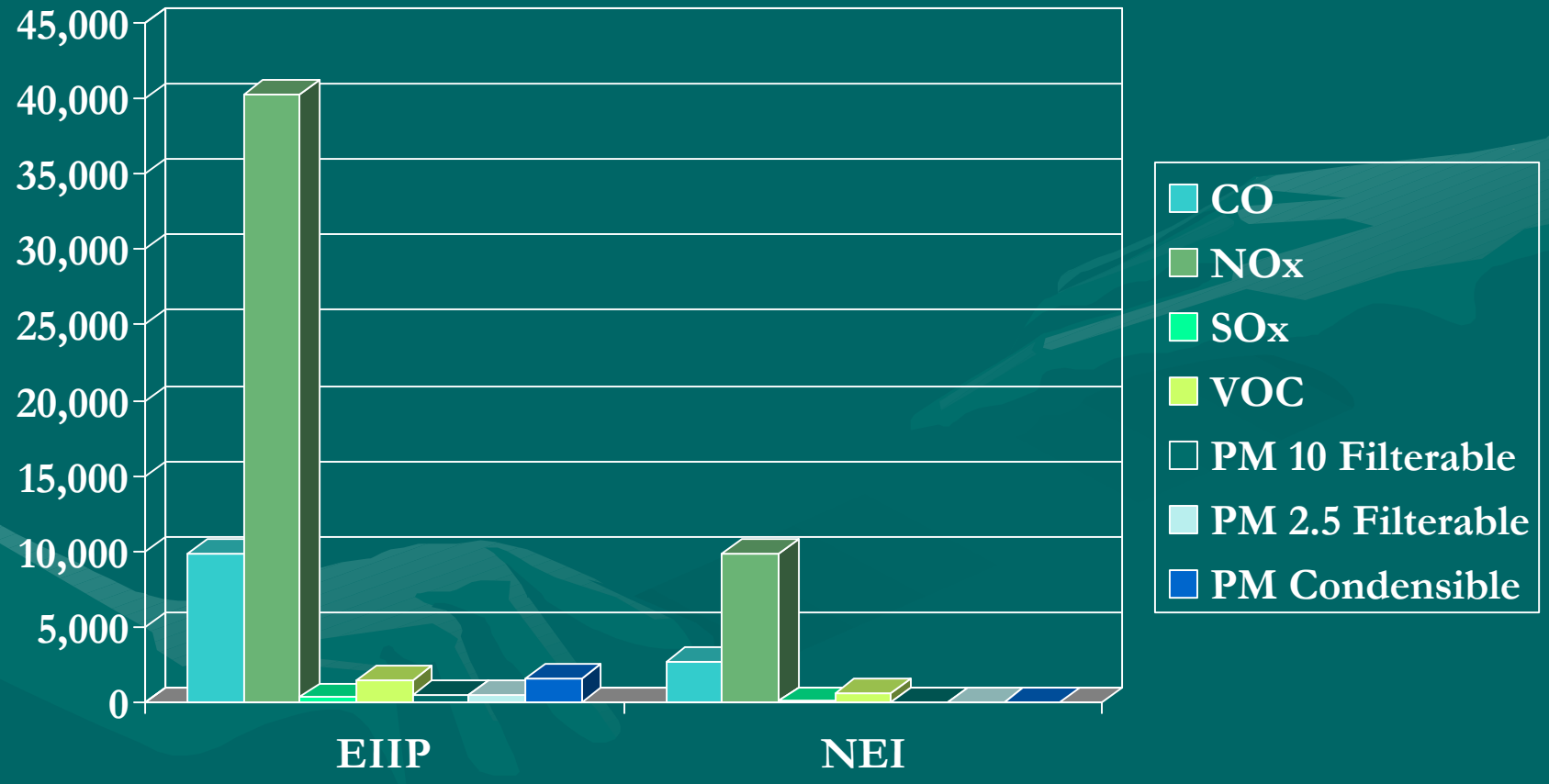
- NEI Analysis
  - NEI was analyzed for RFC emissions data
  - NEI data was compared to emission estimates developed in this project
- The following figures provide data comparisons by fuel type

Comparing NEI to Project Data
Natural Gas-Sum of States



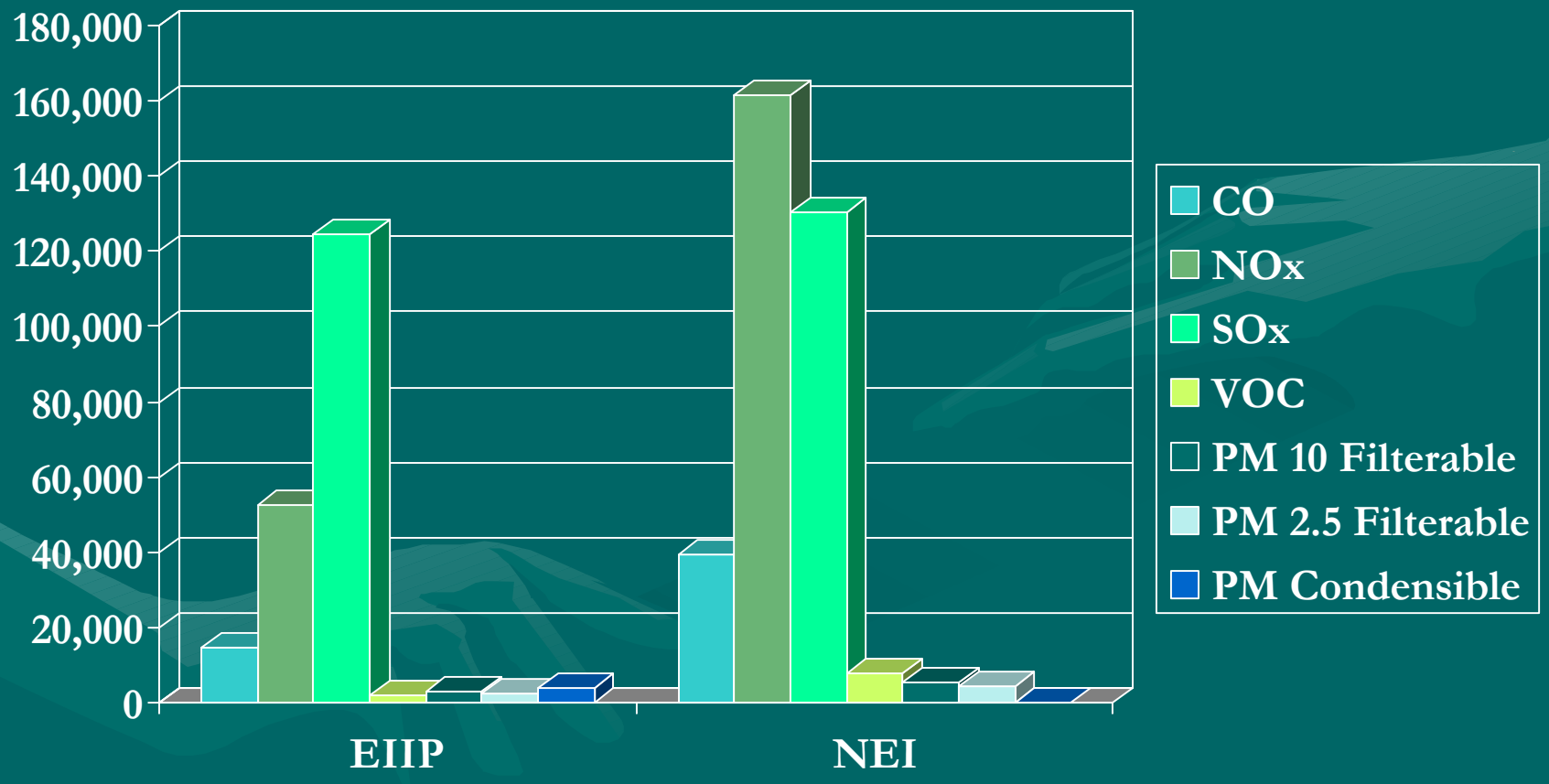
Units are tons per year

Comparing NEI to Project Data
LPG-Sum of States



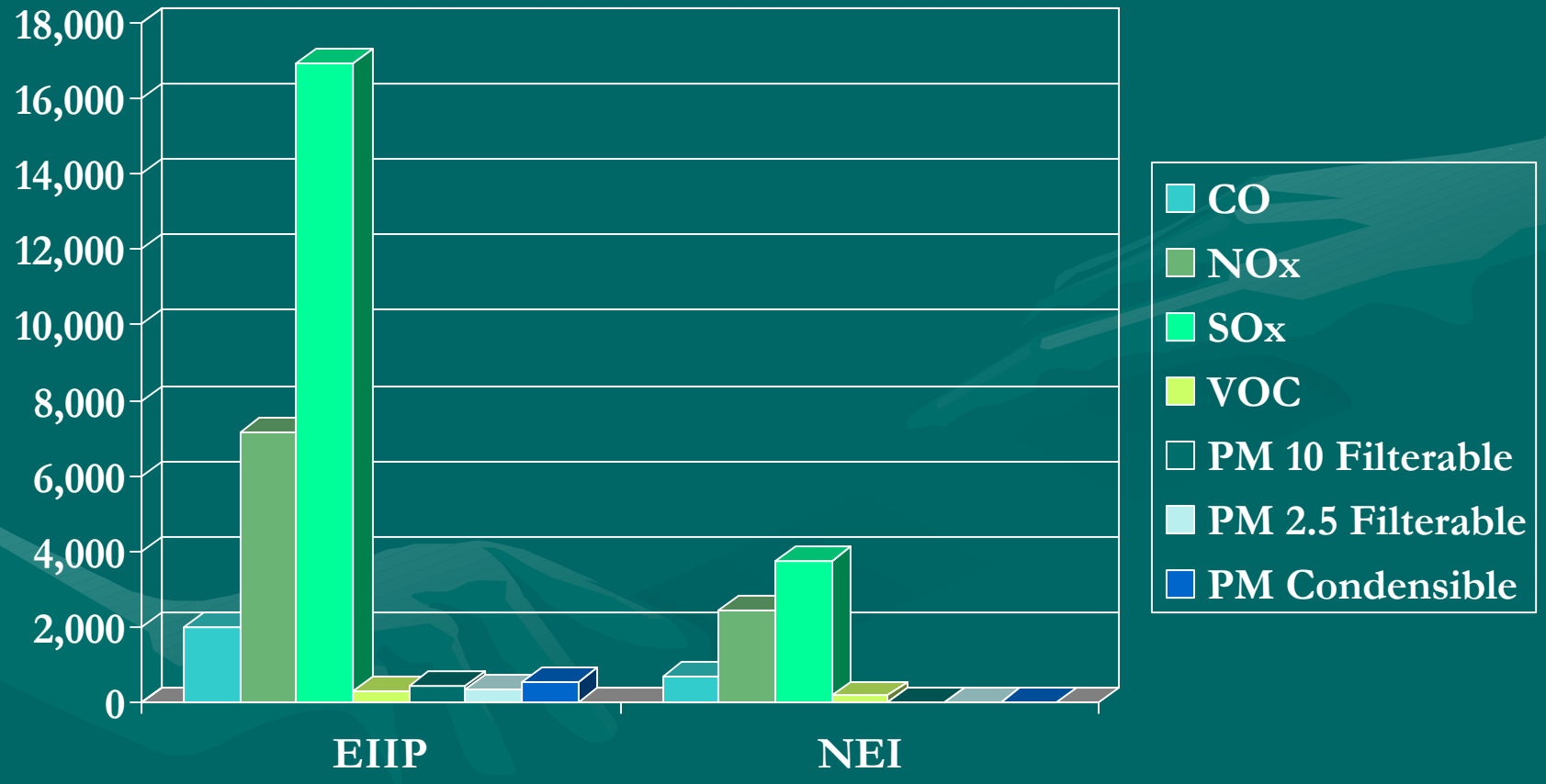
Units are tons per year

Comparing NEI to Project Data Distillate Oil-Sum of States



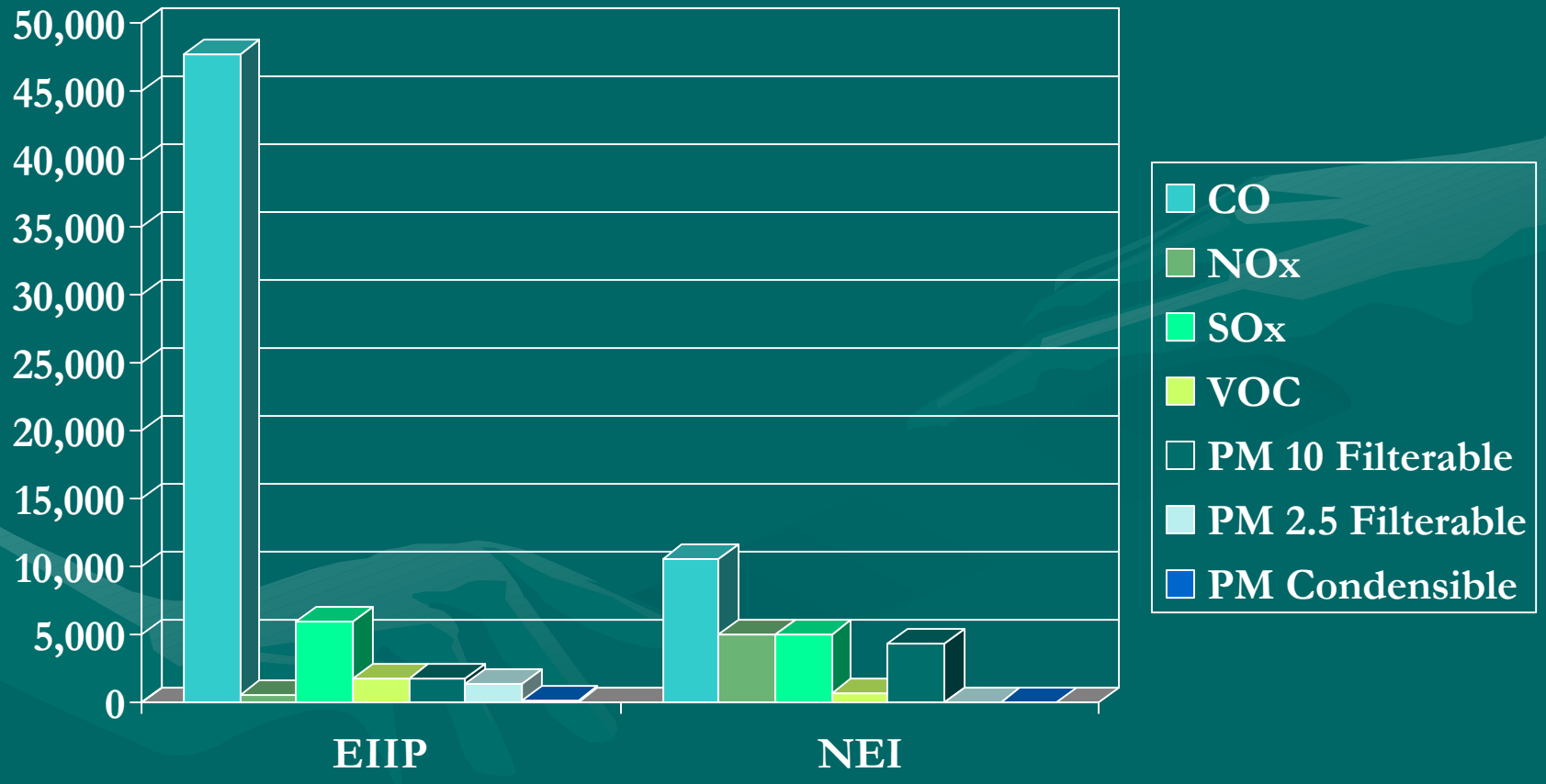
Units are tons per year

Comparing NEI to Project Data Kerosene-Sum of States



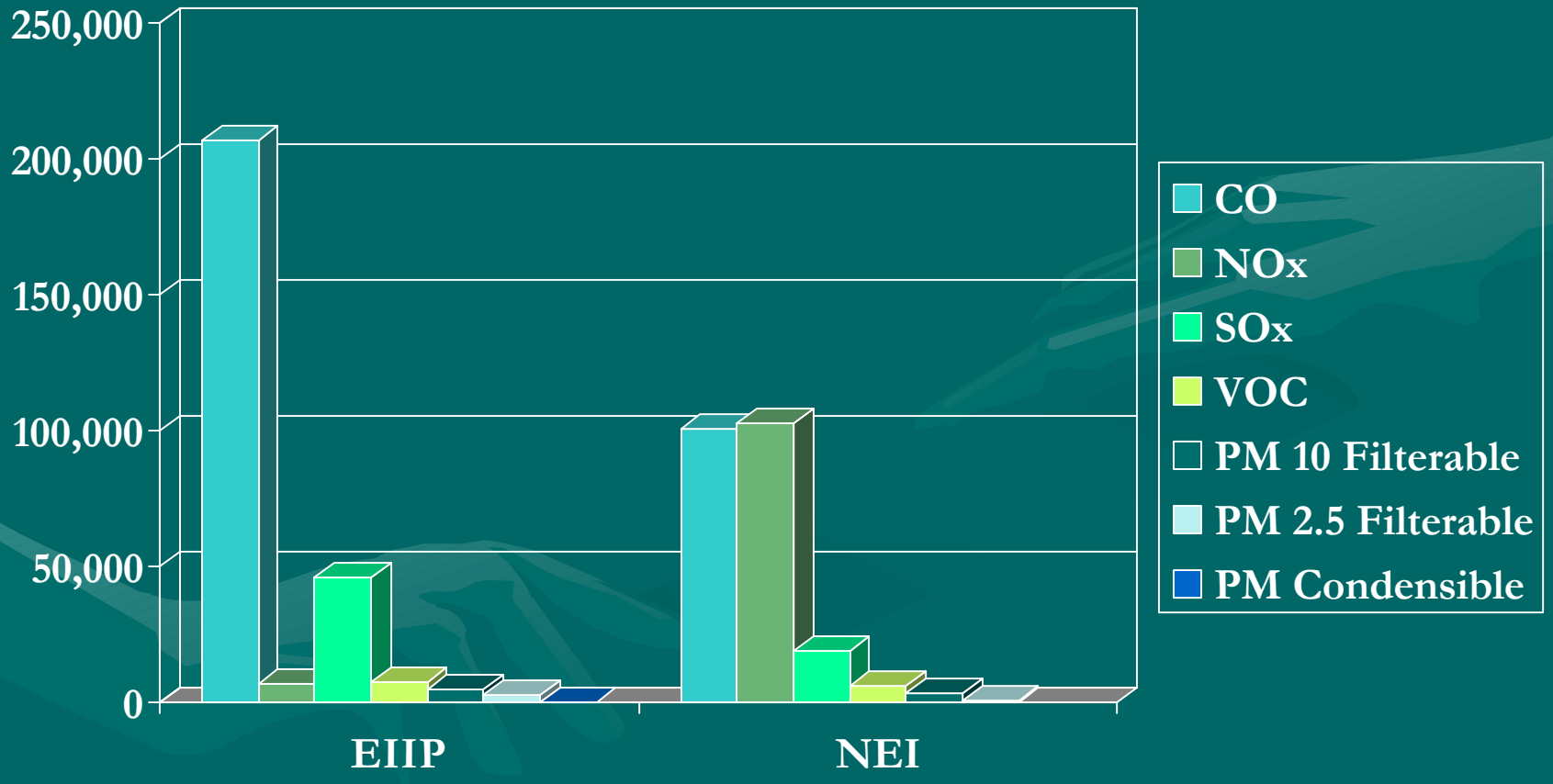
Units are tons per year

Comparing NEI to Project Data Anthracite Coal-Sum of States



Units are tons per year

Comparing NEI to Project Data Bituminous Coal-Sum of States



Units are tons per year

Conclusions

- Emissions data for RFC in the NEI v. 2 are inconsistent
- Methodology developed for this project ensures that consistent emissions estimates are prepared for RFC
  - Publicly available data sources ensures replicability
- Methodology and Excel spreadsheets ensure that updates are easy to perform
  - Census data can be easily updated
  - DOE data can be easily updated
  - Emission factors can be easily updated

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- US EPA Lead
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