

# Emission and Air Quality Trends Review

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## Connecticut

May 2013

# Project Objective

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- ❑ To develop and present publicly available information on trends in emissions and ambient air quality in the U.S. since 1999 in easy to understand visual and tabular formats

# Emission Trends

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- Study Team collected and processed U.S. EPA emission inventories for years within the study period of interest (1999-2011)
  
- By pollutant and source category
  - electric generation fuel combustion
  - mobile sources
  - industrial fuel combustion & industrial processes
  - all other

# Emissions Data Summary

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- Data Obtained from EPA National Emission Inventory (NEI) and Trends Websites
  - EPA's Trends reports and emission comparisons include interpolations of all categories between key years (1999, 2002, 2005, 2008, 2011) at county-pollutant level
  - Represented Pollutants: VOC, NO<sub>x</sub>, SO<sub>2</sub>, and PM<sub>2.5</sub>
- Project Improvement
  - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

# Emission Changes

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- The following slides also include the tonnage-based emissions change from 1999 to 2011 for each pollutant
- Negative values indicate decrease in emissions, positive values indicate an increase

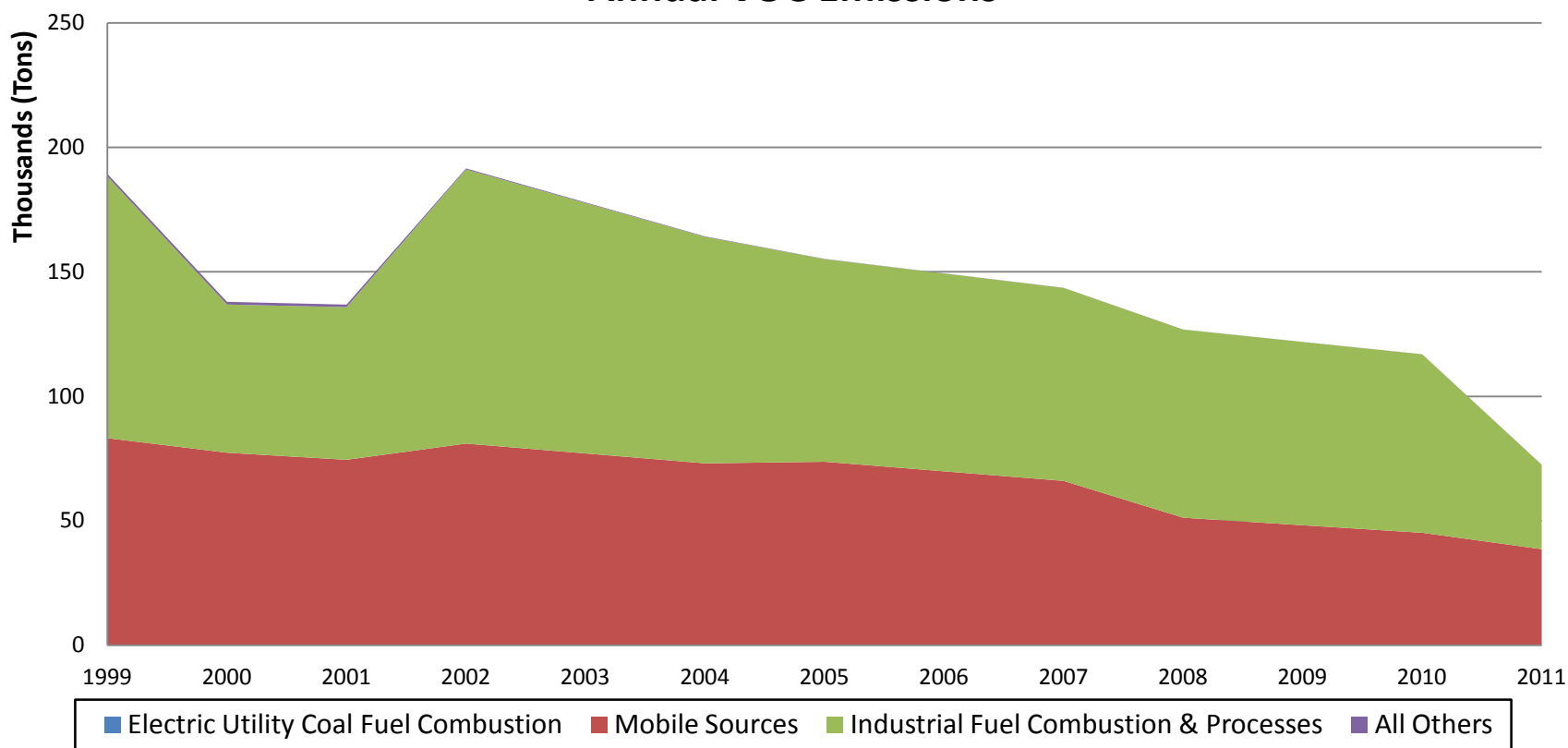
# Connecticut Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	51	54	93	41	43	36	56	29	31	11
Mobile Sources	83,136	74,444	76,954	73,668	69,827	65,986	51,184	48,170	45,157	38,583
Industrial Fuel Combustion & Processes	105,066	61,325	100,568	81,412	79,467	77,522	75,576	73,631	71,686	33,891
All Others	1,055	1,017	282	93	61	52	41	32	40	71
<b>Total</b>	<b>189,308</b>	<b>136,841</b>	<b>177,897</b>	<b>155,215</b>	<b>149,398</b>	<b>143,596</b>	<b>126,857</b>	<b>121,863</b>	<b>116,914</b>	<b>72,556</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	7%	83%	-19%	-16%	-30%	10%	-44%	-38%	-78%
Mobile Sources	0%	-10%	-7%	-11%	-16%	-21%	-38%	-42%	-46%	-54%
Industrial Fuel Combustion & Processes	0%	-42%	-4%	-23%	-24%	-26%	-28%	-30%	-32%	-68%
All Others	0%	-4%	-73%	-91%	-94%	-95%	-96%	-97%	-96%	-93%
<b>Total</b>	<b>0%</b>	<b>-28%</b>	<b>-6%</b>	<b>-18%</b>	<b>-21%</b>	<b>-24%</b>	<b>-33%</b>	<b>-36%</b>	<b>-38%</b>	<b>-62%</b>

# Connecticut Emission Trends (VOC)

**Major Source Category Summary  
Annual VOC Emissions**



# Connecticut Emission Trends (NO<sub>x</sub>)

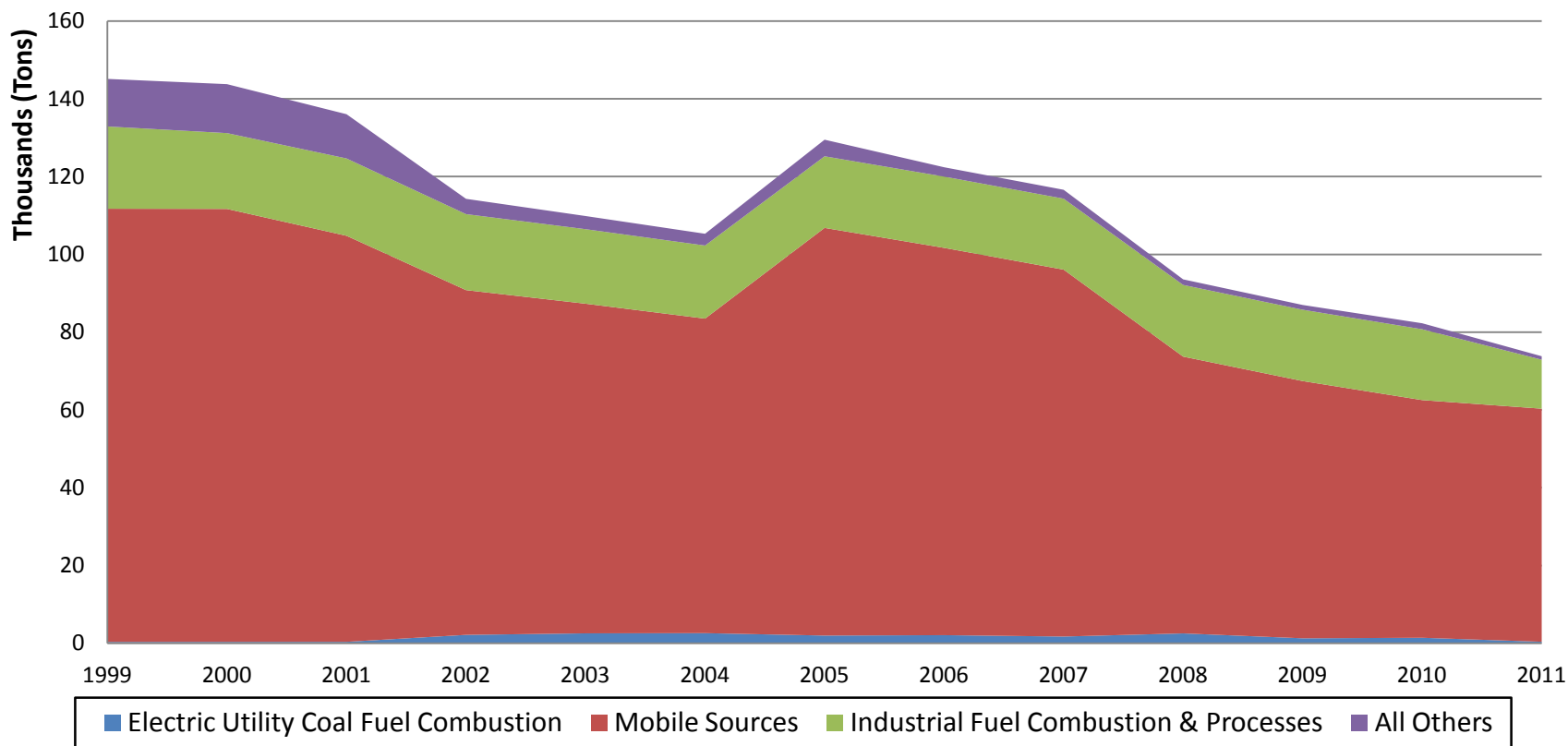
Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	346	369	2,551	1,981	2,085	1,732	2,534	1,279	1,414	388
Mobile Sources	111,392	104,417	84,771	104,834	99,594	94,353	71,180	66,150	61,119	59,936
Industrial Fuel Combustion & Processes	21,157	19,889	19,164	18,416	18,333	18,249	18,431	18,341	18,217	12,597
All Others	12,229	11,374	3,380	4,263	2,397	2,283	1,432	1,225	1,539	890
<b>Total</b>	<b>145,125</b>	<b>136,048</b>	<b>109,865</b>	<b>129,494</b>	<b>122,408</b>	<b>116,617</b>	<b>93,577</b>	<b>86,994</b>	<b>82,290</b>	<b>73,809</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	7%	636%	472%	502%	400%	632%	269%	308%	12%
Mobile Sources	0%	-6%	-24%	-6%	-11%	-15%	-36%	-41%	-45%	-46%
Industrial Fuel Combustion & Processes	0%	-6%	-9%	-13%	-13%	-14%	-13%	-13%	-14%	-40%
All Others	0%	-7%	-72%	-65%	-80%	-81%	-88%	-90%	-87%	-93%
<b>Total</b>	<b>0%</b>	<b>-6%</b>	<b>-24%</b>	<b>-11%</b>	<b>-16%</b>	<b>-20%</b>	<b>-36%</b>	<b>-40%</b>	<b>-43%</b>	<b>-49%</b>



# Connecticut Emission Trends (NO<sub>x</sub>)

**Major Source Category Summary  
Annual NO<sub>x</sub> Emissions**



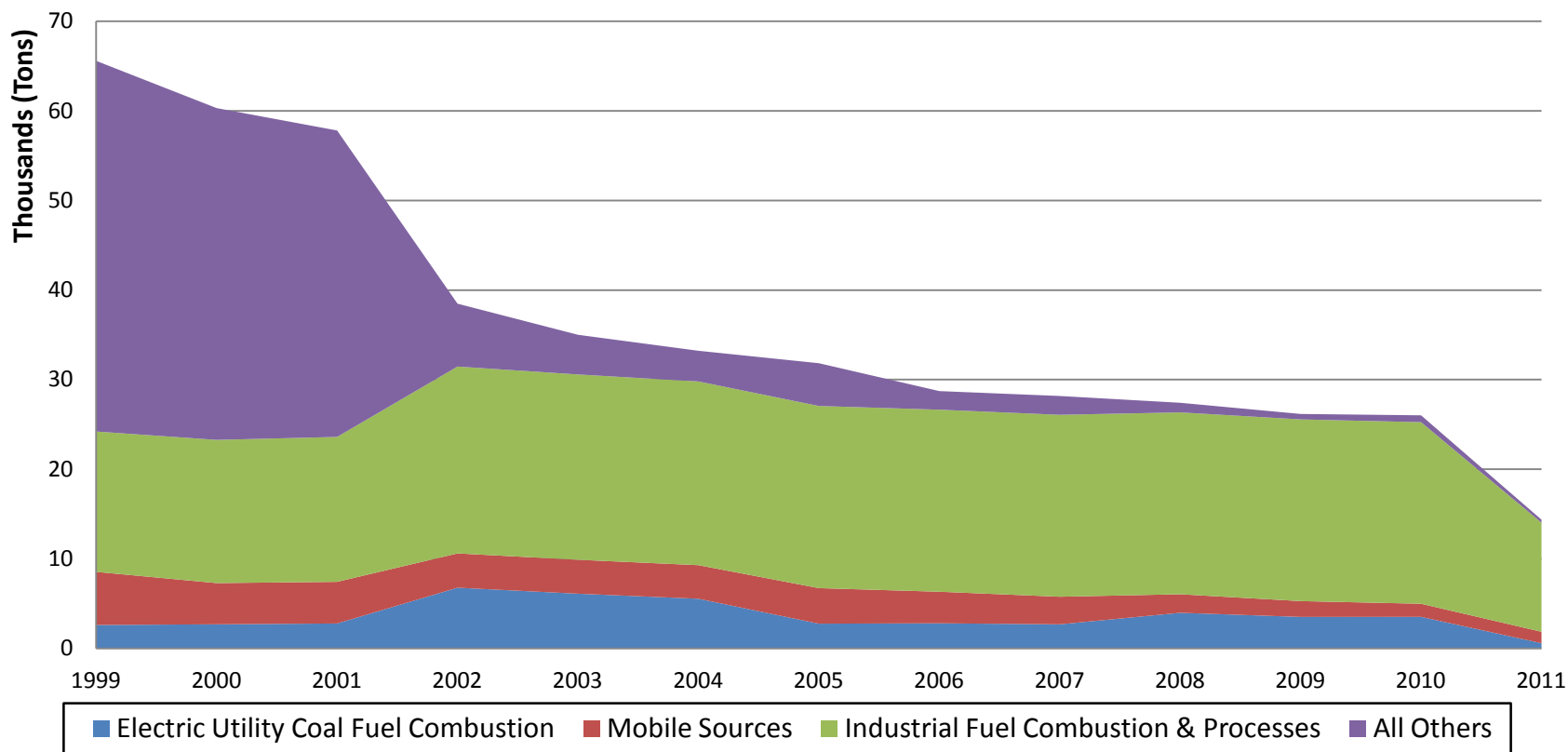
# Connecticut Emission Trends (SO<sub>2</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	2,618	2,788	6,111	2,765	2,808	2,692	3,978	3,517	3,524	585
Mobile Sources	5,928	4,645	3,788	3,967	3,523	3,078	2,070	1,767	1,464	1,276
Industrial Fuel Combustion & Processes	15,667	16,174	20,680	20,330	20,317	20,304	20,297	20,279	20,266	12,173
All Others	41,363	34,202	4,426	4,772	2,075	2,100	1,073	606	763	336
<b>Total</b>	<b>65,575</b>	<b>57,809</b>	<b>35,005</b>	<b>31,834</b>	<b>28,722</b>	<b>28,174</b>	<b>27,418</b>	<b>26,169</b>	<b>26,017</b>	<b>14,370</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	7%	133%	6%	7%	3%	52%	34%	35%	-78%
Mobile Sources	0%	-22%	-36%	-33%	-41%	-48%	-65%	-70%	-75%	-78%
Industrial Fuel Combustion & Processes	0%	3%	32%	30%	30%	30%	30%	29%	29%	-22%
All Others	0%	-17%	-89%	-88%	-95%	-95%	-97%	-99%	-98%	-99%
<b>Total</b>	<b>0%</b>	<b>-12%</b>	<b>-47%</b>	<b>-51%</b>	<b>-56%</b>	<b>-57%</b>	<b>-58%</b>	<b>-60%</b>	<b>-60%</b>	<b>-78%</b>

# Connecticut Emission Trends (SO<sub>2</sub>)

**Major Source Category Summary  
Annual SO<sub>2</sub> Emissions**



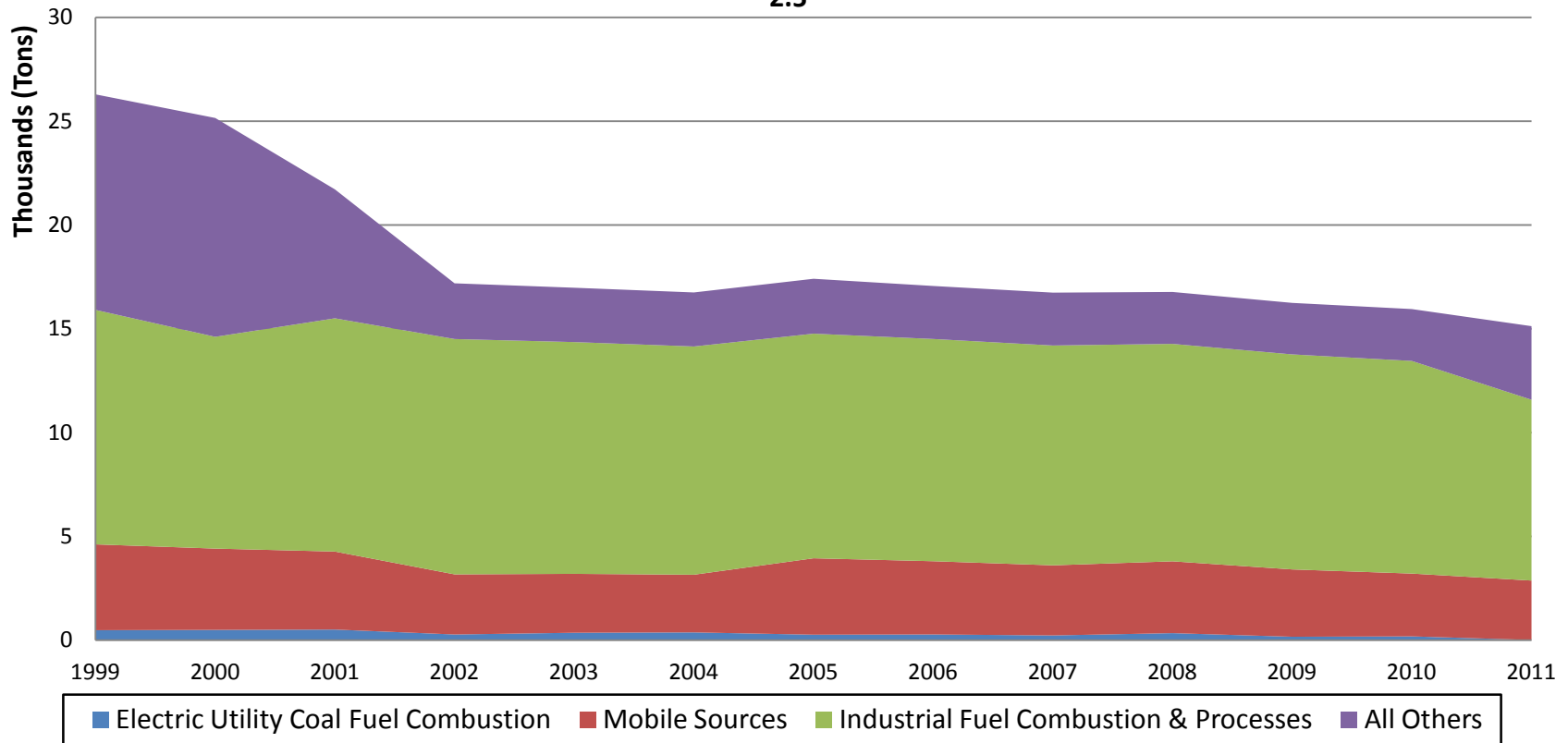
# Connecticut Emission Trends (PM<sub>2.5</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	480	511	357	264	275	228	339	165	183	11
Mobile Sources	4,135	3,758	2,837	3,680	3,528	3,377	3,460	3,243	3,026	2,861
Industrial Fuel Combustion & Processes	11,294	11,235	11,165	10,821	10,705	10,589	10,474	10,358	10,242	8,711
All Others	10,382	6,211	2,617	2,644	2,553	2,547	2,501	2,481	2,498	3,544
<b>Total</b>	<b>26,291</b>	<b>21,715</b>	<b>16,977</b>	<b>17,409</b>	<b>17,062</b>	<b>16,741</b>	<b>16,774</b>	<b>16,247</b>	<b>15,949</b>	<b>15,126</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	6%	-26%	-45%	-43%	-52%	-29%	-66%	-62%	-98%
Mobile Sources	0%	-9%	-31%	-11%	-15%	-18%	-16%	-22%	-27%	-31%
Industrial Fuel Combustion & Processes	0%	-1%	-1%	-4%	-5%	-6%	-7%	-8%	-9%	-23%
All Others	0%	-40%	-75%	-75%	-75%	-75%	-76%	-76%	-76%	-66%
<b>Total</b>	<b>0%</b>	<b>-17%</b>	<b>-35%</b>	<b>-34%</b>	<b>-35%</b>	<b>-36%</b>	<b>-36%</b>	<b>-38%</b>	<b>-39%</b>	<b>-42%</b>

# Connecticut Emission Trends (PM<sub>2.5</sub>)

**Major Source Category Summary  
Annual PM<sub>2.5</sub> Emissions**



# Emission Trends Summary

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- All pollutants have decreased since 1999 in aggregate across the Connecticut
- NO<sub>x</sub> and SO<sub>2</sub> from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NO<sub>x</sub> Budget Trading Program and CAIR control implementation
- Onroad emission step increase seen between 2004 and 2005 is the result of EPA's method change and MOVES model integration for estimating onroad mobile source emissions

# Air Quality Design Values

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## □ Ozone

- Annual 4<sup>th</sup> highest daily maximum 8-hour average averaged over three consecutive years
- Current standard = 0.075 ppm

## □ PM<sub>2.5</sub> Annual

- Annual arithmetic mean of quarterly means averaged over three consecutive years
- Current standard = 12 ug/m<sup>3</sup>

## □ PM<sub>2.5</sub> 24-Hour

- Annual 98<sup>th</sup> percentile of daily averages averaged over three consecutive years
- Current standard = 35 ug/m<sup>3</sup>

# State-Wide Design Value (DV) Trends

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- Trends in state-wide maximum DV and average DV
  - Max DV: Maximum DVs over all valid trend monitoring sites in the state in each overlapping three year period
  - Average DV: Average of DVs over all valid trend monitoring sites in the state in each overlapping three year period
- Compute linear trend via least-squares regression



# Data Handling Procedures

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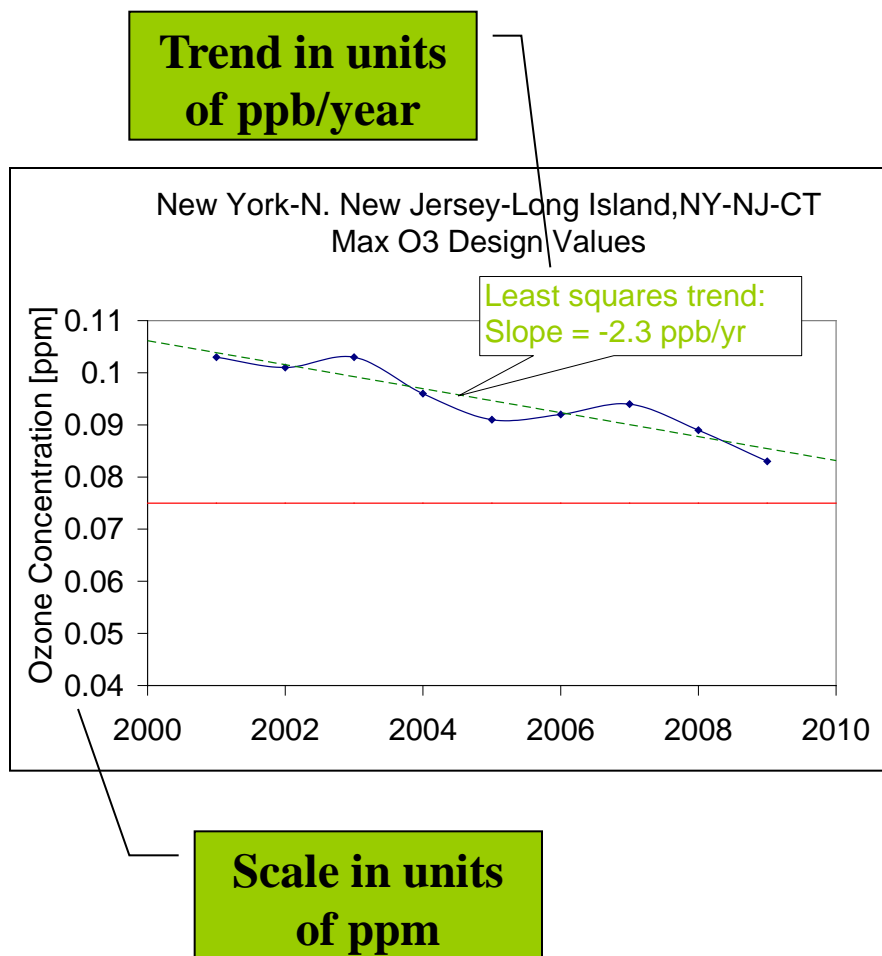
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional events that have received EPA concurrence are omitted
  - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011
  - Identification of nonattainment areas is with respect to the 2008 8-hour standard only

# Data Handling Procedures

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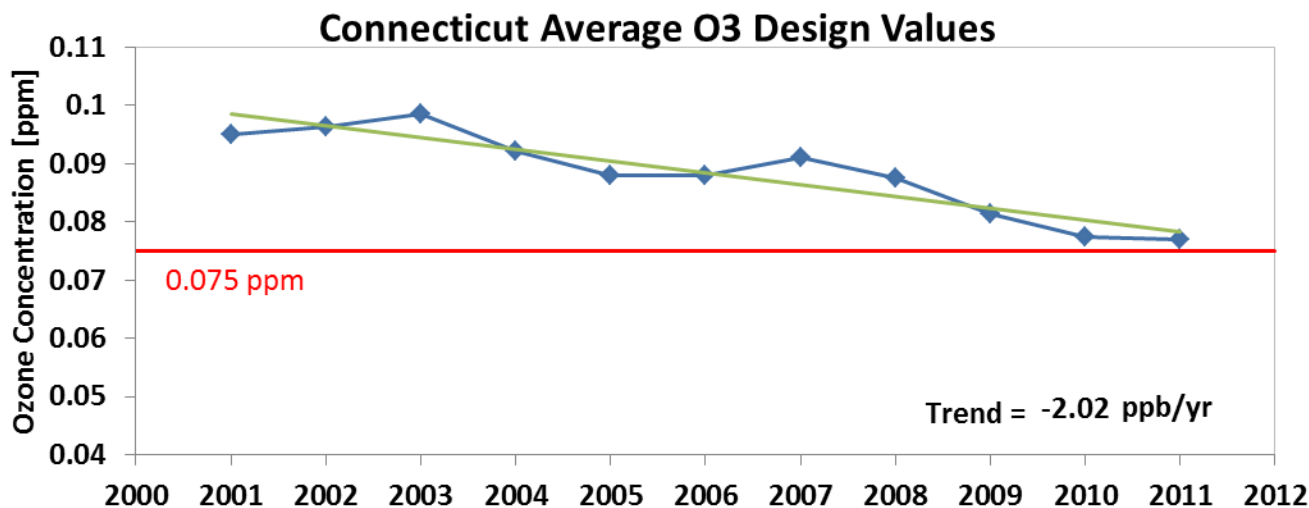
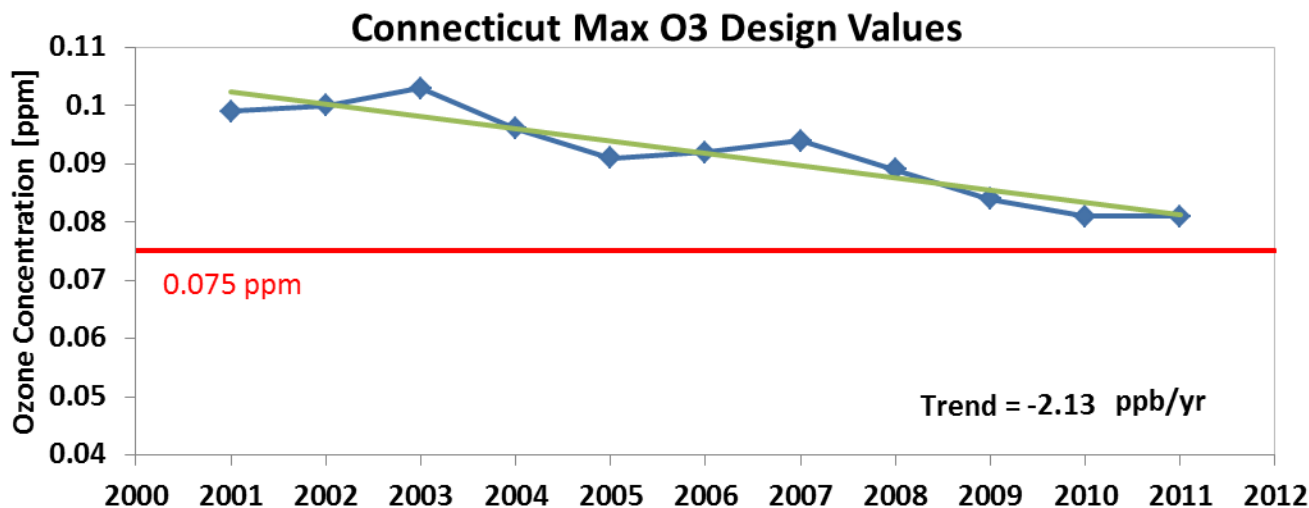
- Annual  $PM_{2.5}$  DV and 24-hr  $PM_{2.5}$  DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011

# Trend Calculation



- Trends based on linear least squares fit to rolling three year design values (DVs)
- Negative trend indicates improving air quality
- DVs based on each 3-year period: 1999-2001, 2000-2002, ... 2009-2011
- Notes
  - On plots, DVs are for three year period ending in year shown (i.e., 2009-2011 DV plotted as 2011 value)
  - Ozone trend values expressed as ppb/year (1,000 ppb = 1 ppm); DVs are plotted as ppm

# Max/Ave O<sub>3</sub> DVs and Trend



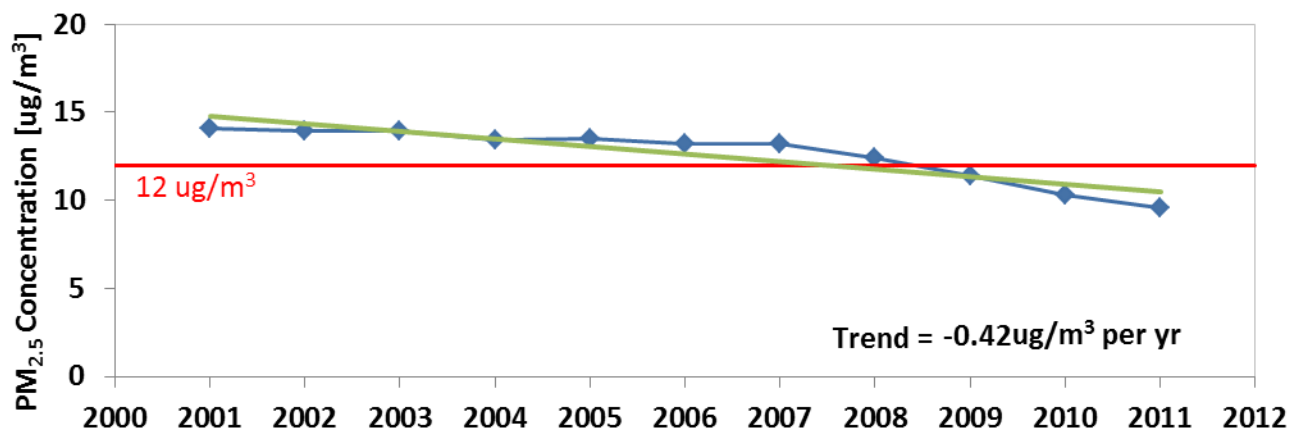
# Ozone Trends by Site in Connecticut

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0900100174420101	Fairfield, CT	0.076	-2.10
0900111234420101	Fairfield, CT	0.08	-1.78
0900130074420101	Fairfield, CT	0.079	-2.25
0900190034420101	Fairfield, CT	0.079	-2.08
0900310034420101	Hartford, CT	0.071	-1.45
0900700074420101	Middlesex, CT	0.077	-2.47
0900930024420101	New Haven, CT	0.081	-2.28
0901310014420101	Tolland, CT	0.073	-1.73

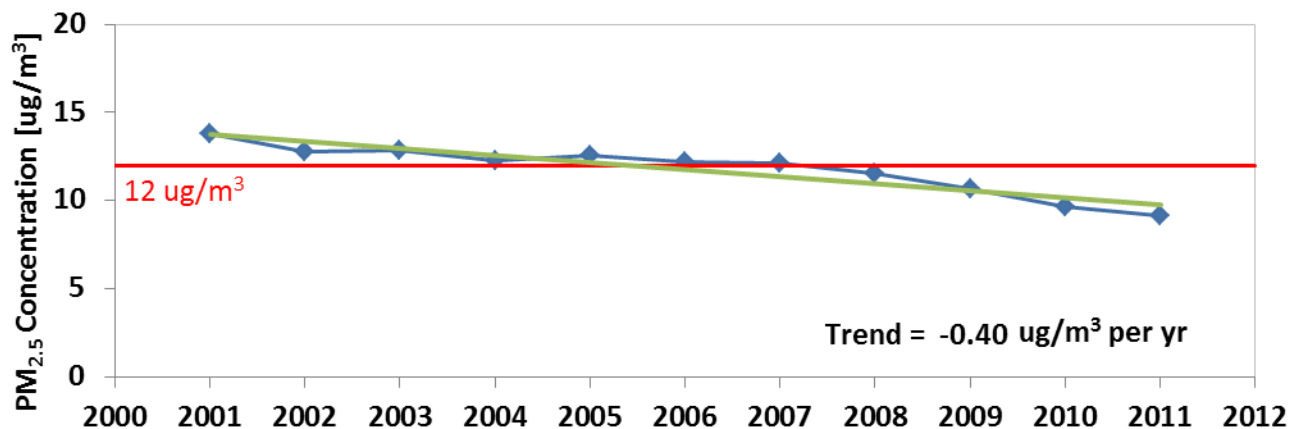
Note: Only monitoring sites meeting data completeness criteria listed

# Max/Ave PM<sub>2.5</sub> Annual DVs and Trend

## Connecticut Max PM<sub>2.5</sub> Annual Design Values

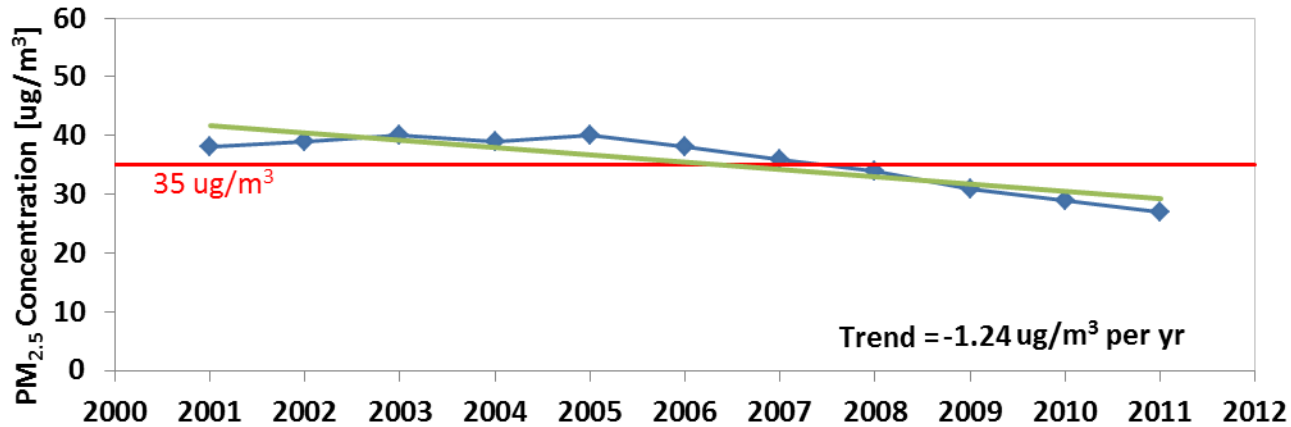


## Connecticut Average PM<sub>2.5</sub> Annual Design Values

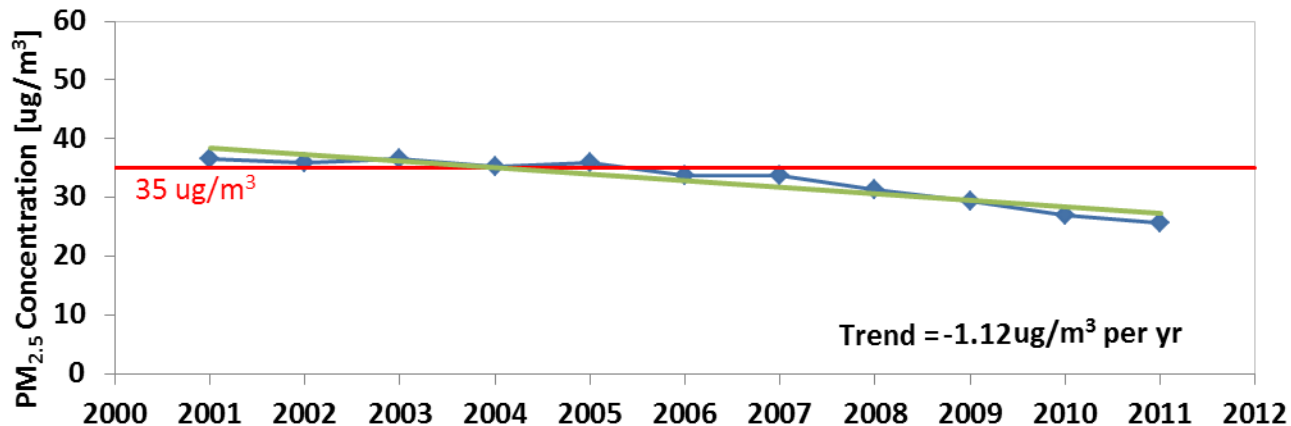


# Max/Ave PM<sub>2.5</sub> 24-Hour DVs and Trend

Connecticut Max PM<sub>2.5</sub> 24-Hour Design Values



Connecticut Average PM<sub>2.5</sub> 24-Hour Design Values



# PM<sub>2.5</sub> Trends by Site in Connecticut

Monitoring Site	County	2009-2011 DV [ug/m <sup>3</sup> ]		Trend [ug/m <sup>3</sup> per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
090010010	Fairfield	9.4	25	-0.37	-1.25
090011123	Fairfield	9.3	26	-0.37	-0.93
090013005	Fairfield	9.4	N/A	-0.43	N/A
090019003	Fairfield	N/A	26	N/A	-1.48
090031003	Hartford	8.2	24	-0.41	-1.52
090091123	New Haven	9.6	27	-0.43	-1.07
090092123	New Haven	9.5	26	-0.39	-0.88
090113002	New London	8.4	N/A	-0.37	N/A

Note: Only monitoring sites meeting data completeness criteria listed



# Air Quality Trends Summary

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- Average O<sub>3</sub> and PM<sub>2.5</sub> design values have decreased since 1999 in Connecticut
- O<sub>3</sub> and PM<sub>2.5</sub> design values have decreased since 1999 in all currently designated O<sub>3</sub> and PM<sub>2.5</sub> non-attainment areas