



*Emissions Projection Methods for Nonroad
Mobile and Non-Electricity Generating Unit
Stationary Source Emissions Categories*

August 17, 2017

Department of Environmental Quality



Emissions Projection Methods for Nonroad Mobile and Non-Electricity Generating Unit Stationary Source Emissions Categories

- Nonroad Mobile Sources
- Non-Electricity Generating Unit (EGU) Stationary Sources
 - ★ Point Source Industrial Fuel Combustion



NONROAD Model Growth Factor Refinements

- Default NONROAD Model Growth Data
 - Growth Indices (1996 = 1000) by FIPS, Indicator Code (sector/fuel type), and Year
 - Model Values Generally Reflect Growth Rates Calculated from Estimated National Engine Populations by Sector/Fuel Type in 1989 and 1996
 - Limitations
 - Growth rates from early 1990s continue for all post-1996 years
 - National growth rates apply to all geographic areas
- North Carolina Division of Air Quality (NC DAQ) Prioritization
 - Construction and Agriculture Sector Diesel Equipment
 - Greater than half of total NONROAD Model 2011 NO_x emissions in NC

NONROAD Model Growth Factor Refinements

- NONROAD Default Growth Indices
 - Model Interpolates Values for Missing Years

Year	Construction Sector Diesel	Agriculture Sector Diesel
1996	1000	1000
1998	1063	1063
2000	1125	1126
2005	1286	1271
2010	1446	1414
2015	1607	1558
2025	1927	1845
2045	2569	2420

NONROAD Model Growth Factor Refinements

- U.S. Energy Information Administration (EIA) No. 2 Diesel Sales/Deliveries for North Carolina (1000 gallons)

Year	Off-Highway Construction ¹	Farm Consumers ²
1996	56,304	30,029
2000	45,600	36,850
2005	39,846	29,776
2010	43,175	38,594
2015	41,130	44,834

¹ U.S. EIA, "North Carolina No 2 Diesel Off-Highway Construction," accessed from <http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=K2DVCNSNC1&f=A>

² U.S. EIA, "North Carolina No 2 Diesel Sales/Deliveries to Farm Consumers," accessed from <http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=K2DVFMSNC1&f=A>

NONROAD Model Growth Factor Refinements



- Replace National Default Growth Rates
 - Incorporate NC-specific records (apply default NONROAD growth rates for post-2015 years)

Year	Construction Sector Diesel		Agriculture Sector Diesel	
	NONROAD Default (FIPS 00000)	North Carolina (FIPS 37000)	NONROAD Default (FIPS 00000)	North Carolina (FIPS 37000)
1996	1000	1000	1000	1000
2000	1125	810	1126	1227
2005	1286	708	1271	992
2010	1446	767	1414	1285
2015	1607	730	1558	1493
2025	1927	876	1845	1765
2045	2569	1168	2420	2319

NONROAD Model Growth Factor Refinements



- Growth Rate Comparisons
 - NONROAD National Defaults versus EIA Fuel Sales-Based Values

Years	Agriculture Sector Diesel		Construction Sector Diesel	
	Default	NC DAQ	Default	NC DAQ
1996-2015	+56%	+49%	+61%	-27%
1996-2025	+85%	+77%	+93%	-12%
1996-2045	+142%	+132%	+157%	+17%

- Method Currently Being Incorporated in Version 2 of the 2014 NEI
- Plans for EPA/OTAQ to Incorporate Similar Refinements on National Scale

Non-Electricity Generating Unit Stationary Source Emissions Categories



- Non-Electricity Generating Unit Stationary Source Emissions Categories
 - Industrial Point Source Sector – Link Growth Factors to Base Year Industrial Fuel Combustion Sector Records based on Source Classification Code (SCC)/North American Industrial Classification System (NAICS) Code Combinations
 - Annual Energy Outlook (AEO) Projections
 - Sample Energy Consumption Calculations
 - Sample Emission Projection Comparisons

Energy Intensity-Based Industrial Fuel Consumption Projections



- Industrial Sector (link data to Industrial Fuel Combustion SCCs and NAICS)
 - Agriculture, Construction, and Mining
 - Manufacturing
 - Aluminum
 - Chemicals
 - Computer
 - Electrical Equipment
 - Fabricated Metal Products
 - Food
 - Glass
 - Iron and Steel
 - Machinery
 - Paper
 - Plastics
 - Refining
 - Transportation Equipment
 - Wood Products
 - Balance of Manufacturing

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Energy Intensity-Based Industrial Fuel Consumption Projections



- AEO – National Energy Consumption Projections by Sector: Tables 25-35

	Report	Annual Energy Outlook 2015				
	Scenario	ref2015			Reference case	
	Release Date		April 2015			
27. Paper Industry Energy Consumption						
	2012	2013	2014	2015	2016	2017
Value of Shipments (billion 2009 dollars)	152	152	149	153	154	154
Energy Consumption (trillion Btu) 1/						
Residual Fuel Oil	19.1	19.1	19.0	20.0	19.5	19.5
Distillate Fuel Oil	5.2	5.2	5.2	5.8	5.5	5.5
Propane	3.4	3.4	3.4	3.7	3.5	3.5
Petroleum Coke	8.1	8.2	8.3	9.1	8.7	8.7
Other Petroleum 2/	4.0	4.1	4.1	4.6	4.3	4.4
Petroleum and Other Liquids Subtotal	39.7	40.0	39.9	43.1	41.6	41.6
Natural Gas	397.0	396.7	398.3	405.9	410.2	408.6
Steam Coal	149.7	148.6	142.2	139.0	138.6	138.2
Renewables	1,180.4	1,181.2	1,164.1	1,187.8	1,198.8	1,198.1
Purchased Electricity	193.8	186.7	176.7	175.3	172.2	168.2
Total	1,960.6	1,953.2	1,921.1	1,951.1	1,961.5	1,954.7

Energy Intensity-Based Industrial Fuel Consumption Projections

- AEO – Constant Dollar Output by Sector, National and Regional (EIA request)

Census Division - South Atlantic	2011	2012	2013	2014	2015	2016	2017
REVIND1 Food Products (Billions of Fixed 2009 Dollars)	81.88026	84.97709	85.6177	87.3296	88.98308	91.44936	93.45758
REVIND2 Grain and Oil Seed Milling (Billions of Fixed 2009 Dollars)	6.48013	6.64725	6.51251	6.66654	6.87267	7.01986	7.15836
REVIND3 Dairy Products (Billions of Fixed 2009 Dollars)	6.09224	6.23841	6.21255	6.28298	6.34446	6.52869	6.69132
REVIND4 Animal Slaughter and Seafood Products (Billions of Fixed 2009 Dollars)	28.07773	28.29563	28.59869	29.14896	29.59206	30.39478	31.04599
REVIND5 Other Food Products, (Billions of Fixed 2009 Dollars)	40.67929	43.37468	44.11914	45.09395	46.0604	47.41146	48.47131
REVIND6 Beverage and Tobacco Products (Billions of Fixed 2009 Dollars)	77.93689	80.86095	82.32971	84.67361	86.82182	88.17221	89.24111
REVIND7 Textiles, Apparel and Leather (Billions of Fixed 2009 Dollars)	30.83061	31.21685	31.30396	31.42626	31.27757	30.62398	29.32838
REVIND8 Wood Products (Billions of Fixed 2009 Dollars)	14.83061	15.4667	16.83773	17.72833	19.86531	20.32405	20.50029
REVIND9 Furniture and Related Products (Billions of Fixed 2009 Dollars)	11.01932	11.65939	12.1428	12.68735	13.206	13.67605	13.85403
REVIND10 Paper Products (Billions of Fixed 2009 Dollars)	30.32281	29.68297	29.7073	29.24101	29.90211	30.20245	30.1658
REVIND11 Printing (Billions of Fixed 2009 Dollars)	12.69148	12.51055	12.43851	12.71636	12.44628	12.26067	12.13449
REVIND12 Basic Inorganic Chemicals (Billions of Fixed 2009 Dollars)	5.81586	6.21424	6.0314	6.14931	6.4131	6.65117	6.83537
REVIND13 Basic Organic Chemicals (Billions of Fixed 2009 Dollars)	9.10168	9.17336	9.47948	9.87214	10.36631	10.57037	11.48379
REVIND14 Resins and Synthetics (Billions of Fixed 2009 Dollars)	20.69143	20.80373	20.74225	20.82429	21.425	21.38428	22.7419
REVIND15 Agricultural Chemicals (Billions of Fixed 2009 Dollars)	9.98056	9.29508	9.93901	10.28638	10.65031	11.44648	12.95954
REVIND16 Other Chemical Products Subtotal (Billions of Fixed 2009 Dollars)	61.32143	61.64834	62.43742	64.2392	65.58409	66.76417	67.93669
REVIND17 Pharma Products (Billions of Fixed 2009 Dollars)	27.36399	26.36021	25.91396	26.92143	27.22363	27.72181	28.22206
REVIND18 Paint Products (Billions of Fixed 2009 Dollars)	5.02555	5.30031	5.76223	5.91983	6.20275	6.29453	6.3509
REVIND19 Soaps and Cleaning Products (Billions of Fixed 2009 Dollars)	21.90351	23.11275	23.93461	24.33783	24.79208	25.12389	25.23545
REVIND20 Other Chemical Products (Billions of Fixed 2009 Dollars)	7.95634	8.04826	8.12583	8.33783	8.63202	8.8778	9.29062
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REVIND36 Crop Production (Billions of Fixed 2009 Dollars)	21.56155	22.22846	22.15956	20.83679	22.91653	23.16919	23.31947
REVIND37 Animal Production (Billions of Fixed 2009 Dollars)	22.00465	21.68753	21.63342	21.63056	22.09278	22.1832	22.31066
REVIND38 Other Agriculture (Billions of Fixed 2009 Dollars)	7.80626	7.81381	8.01987	8.56258	9.04072	9.18026	9.21494
REVIND39 Coal Mining (Billions of Fixed 2009 Dollars)	10.49479	9.80466	9.62944	9.35495	9.24251	9.15544	9.29909
REVIND40 Oil & Gas Extraction & Support Activities (Billions of Fixed 2009 Dollars)	4.90667	5.13443	5.29506	5.6127	6.10772	6.32893	6.76099
REVIND41 Other Mining & Quarrying (Billions of Fixed 2009 Dollars)	10.6213	10.66213	10.7483	11.06444	11.32345	11.63786	12.0535
REVIND42 Construction (Billions of Fixed 2009 Dollars)	198.3904	213.8304	222.618	230.1197	244.5018	258.6378	272.3563



Energy Intensity-Based Industrial Fuel Consumption Projections

- Sample Energy Consumption Calculations

- Steam Coal Consumption in Paper Industry

- National coal consumption per dollar of output = coal consumption in Paper industry / Paper industry output, e.g., 2011 = $184.6/155.0 = 1.191$.

Variable	2011	2017	2030
National Steam Coal Consumption in Paper Industry (trillion btu)	184.6	138.2	131.6
National Paper Industry Output (billions of 2009\$)	155.0	154.2	149.0
Steam Coal Consumption Per Dollar of Output (1000 btu/2009\$)	1.191	0.896	0.883

- South Atlantic Energy Consumption = National Steam Coal Energy Consumption Per Dollar of Output in Paper Industry * South Atlantic Paper Industry Output, e.g., 2011 = $1.191 * 30.323 = 36.103$ trillion btu.

Variable	2011	2017	2030
South Atlantic Region Paper Industry Output (billions of 2009\$)	30.323	30.166	29.124
South Atlantic Region Steam Coal Consumption in Paper Industry (trillion btu)	36.103	27.031	25.730

Energy Intensity-Based Industrial Fuel Consumption Projections



- Sample NOx Emission Projection Comparisons
 - Steam Coal

Sector/Fuel	Post-2011 Growth Factors			2011 NOx (tpy)	2017 (tpy)		2030 (tpy)	
	2017	2025	2030		Total	Industry	Total	Industry
Total Industrial/Other Industrial Coal	1.07	1.16	1.17					
Bulk Chemical/Steam Coal/Heat & Power	0.89	0.87	0.84	1,053	1,131	937	1,237	882
Food/Steam Coal	0.97	0.99	0.99	142	152	138	166	141
Balance of Manufacturing/Steam Coal	0.91	0.90	0.90	603	647	546	708	540
Paper/Steam Coal	0.75	0.73	0.71	1,439	1,545	1,078	1,691	1,026
			TOTAL	3,237	3,475	2,699	3,802	2,588

- Industry-specific growth factors result in projected NOx emission estimates that are:
 - 22 percent lower in 2017 relative to total industrial projections
 - 32 percent lower in 2030 relative to total industrial projections

Energy Intensity-Based Industrial Fuel Consumption Projections



- Sample NOx Emission Projection Comparisons
 - Natural Gas

Sector/Fuel	Post-2011 Growth Factors			2011 NOx (tpy)	2017 (tpy)		2030 (tpy)	
	2017	2025	2030		Total	Industry	Total	Industry
Total Industrial/Natural Gas	1.17	1.21	1.23					
Aluminum/Natural Gas	1.22	1.42	1.39	18	21	22	22	25
Bulk Chemical/Natural Gas/Heat & Power	1.05	1.08	1.07	438	512	459	541	468
Food/Natural Gas	1.12	1.25	1.35	398	465	447	491	536
Glass/Natural Gas	1.01	1.03	1.04	792	925	797	976	823
Iron and Steel/Natural Gas	1.09	1.10	1.01	20	24	22	25	21
Fabricated Metal/Natural Gas	1.12	1.10	1.09	45	53	51	56	49
Machinery/Natural Gas	1.16	1.15	1.18	18	21	21	22	22
Computers/Natural Gas	1.06	1.09	1.17	21	24	22	26	24
Transportation Equipment/Natural Gas	1.25	1.24	1.31	22	25	27	27	28
Electrical Equipment/Natural Gas	1.11	1.07	1.15	7	8	7	8	8
Mining/Natural Gas	0.98	1.05	1.08	0	0	0	0	0
Wood Products/Natural Gas	1.27	1.35	1.48	9	10	11	11	13
Plastics/Natural Gas	1.06	1.07	1.09	314	367	334	388	343
Balance of Manufacturing/Natural Gas	0.97	0.92	0.94	556	649	539	685	520
Paper/Natural Gas	1.15	1.15	1.16	293	342	337	361	341
			TOTAL	2,950	3,449	3,096	3,637	3,219

- Industry-specific growth factors result in projected NOx emission estimates that are:
 - 10 percent lower in 2017 relative to total industrial projections
 - 11 percent lower in 2030 relative to total industrial projections

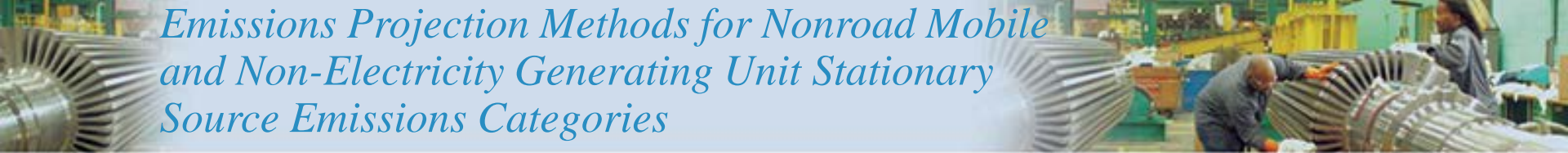
Energy Intensity-Based Industrial Fuel Consumption Projections



- Growth Factors Reflecting This Approach Incorporated into EPA and MARAMA Modeling Platform Projections for North Carolina

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*Emissions Projection Methods for Nonroad Mobile
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Source Emissions Categories*

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