Potential NOx Emission Control Measures – "What Can We Do" Analysis

Measure	NOx Reduction (tpd)	Cost	Implementing Agency
Electric Generating Units (EGU) – Point Source			
2008/2015 O3 NAAQS RACT Adoption	Large	Variable depending on technology used	State – Check status with states
EGU – External Combustion Boilers	Large	$1370-$4868/ton, varies depending on fuel and control technology used[1]	State
EGU – Utility Boilers	Large	Varies depending on fuel used and control technology used[1]	State
Performance Standards for HEDD Combined Turbines	Large (2,500 tons per ozone season in OTR) – based on 2007 data[3]	Water injection - $4,400/ton Turbine retrofit - $1,100-$9,000/ton[3]	State - DC & MD – Under review VA – None
Oil and Gas Boilers Serving Electric Generating Units	Large (~40 tpd) VA & MD emission assumed same[5]	Variable depending on fuel and control technology used ($5,460-$21,800 /ton)[5]	State - MD – Under review VA – None
Non-Electric Generating Units (Non-EGU) – Point Source			
2008/2015 O3 NAAQS RACT Adoption	Small-Medium	Varies depending on control technology used	States– Check status with states
Waste Incineration Facility NOx Control	Medium (VA-Covanta=4.63 tpd + MD-Mont County Res. Rec. facility = 1.31 tpd; Total=5.94 tpd, CE=45%; total reduction=2.67 tpd in Wash. Region) Data from 2008 O3 MP EI (NEGU emissions)	1,814/ton (Using Selective Non-Catalytic Reduction)[1]	State

OTC Nat Gas Ultra Low NOx Burners - New Natural Gas-Fired Boilers, Steam Generators, Process Heaters, and Water Heaters; 75,000 BTUs/hr to 5,000,000 BTUs/hr	Small[3]	Units (75,000 Btu/hr to 2.0 million Btu/hr) - $1,108-5,385/ton[3] Units (2.0 million Btu/hr to 5.0 million Btu/hr) - $12,000-$23,000/ton[3]	State – DC & MD - Under consideration, check status VA – None
Non-Point Source			
Demand Response/Distributed Generator emissions controls	Large[4]		State - DC – Developing; Check status VA – Exists MD – Check with MDE for any control rule
Stationary Generators	Small-Medium (43 tons per hour in OTR)[3]	Varies depending on power ($39,700-$79,700/ton for 1-2 MW, $145,000-$165,00/ton for 1750 kW-2500 kW)[3]	State DC & MD – Under review VA – Check
District Energy Systems and Microgrids	Small-Medium		Local – Can encourage high efficiency district energy and microgrid systems in public and commercial facilities
Urban Heat Island Mitigation	Small-Medium		Local – Can incentivize or encourage cool/green roofs, cool pavements, urban tree cover
High Performance Building	Small-Medium		Local – 64% COG juris green bldg. policy, Arlington – Model program for commercial bldg. energy performance, DC – New construction to be net zero energy use by 2032.

			Can adopt more rigorous energy codes, voluntary programs to improve bldg. efficiency and on-site RE generation
Green Power purchasing	Depends on amount of purchase	Varies depending on source and amount	Local – DC- 100% RE electric, Montgomery – 100% RE electric by 2016 (check this), 50% COG juris EPA green power communities, Rest– potential candidates?
Energy Efficiency & Renewable energy programs	Small-Medium		State – Existing Local – Check
Ultra-low sulfur fuel oil (Home and water heating fuel oil)	Small		State – DC - Proposed MD – Under consideration, check status from both VA – None
On-Road Source			
Travel Efficiency Measures (EPA Smartway Partnership, commuter strategies, system operations (e.g., eco-driving, ramp metering), pricing (e.g., parking taxes, congestion pricing, intercity tolls), speed limit restrictions, and multimodal freight strategies	Large (2-5% control) (2.75 – 7.0 tpd)[1]		EPA Smartway Partnership: State – DC Exists MD – Planning to adopt, check status VA – Check
Diesel I/M programs	Medium		State – DC – Under consideration MD – Diesel opacity test VA – Tests LD diesel vehicle, expand in 2015; check status

OTC aftermarket catalyst initiative	Small-Medium (20-28 tpd in OTR)[3]	$4,000-7,000/ton[3]	State – DC – Under consideration, check status MD – In dev, check status VA – None
On-road fleet replacement, retrofits and repowers (Class 6 and above truck)	Small-Medium	$4,284-$12,157/ton[1]	State – DC & MD – Check for any ongoing program VA – Ongoing programs for trucks, school and transit buses
On-road heavy-duty vehicle long-duration idling reduction	Small (10-33% control)[1]	Class 8: from a cost of $46,506 to savings of $16,001/ton Class 6&7: from a cost of $68,323 to savings of $15,501/ton[1]	State
Purchase of CNG transit buses	Large (0.46 tpy/0.001 tpd) per bus (Table A) Total benefit = 6,111[6] x 0.001 = 6.1 tpd	$130,435/ton if replacing a diesel transit bus (Table A)	State & Local
Purchase of CNG refuse trucks	Small (0.47 tpy/0.001 tpd) per truck (Table A) Total benefit = 557[6] x 0.001 = 0.6 tpd	$191,490/ton if replacing a diesel refuse truck (Table A)	State – DC – Proposed[2] MD & VA – AFV and fueling infra- programs available Local – Can be expanded
Purchase of electric refuse trucks	Small (0.47 tpy/0.001 tpd) per truck (Table A) Total benefit = 557[6] x 0.001 = 0.6 tpd	$510,638/ton if replacing a diesel refuse truck (Table A)	State – DC – Proposed[2] MD & VA – AFV and fueling infra- programs available Local – Can be expanded
Purchase of electric transit buses	Large (0.46 tpy/0.001 tpd) per bus (Table A) Total benefit = 6,111[6] x 0.001 = 6.1 tpd	$1,021,740/ton if replacing a diesel transit bus (Table A)	State – DC – Proposed[2] MD & VA – AFV and fueling infra- programs available, Local – Can be expanded

Idling reduction rebate	Small (2.5-5.5 tpy/0.007-0.015 tpd) (Table 3)[2]	$3,800-1,727/ton (Table 3)[2]	State – DC – Proposed rebates to public and private fleet owners to retrofit older diesel shuttle buses, transit buses, and Class 5-8 medium and heavy-duty trucks with idling reduction technologies MD & VA – Check
CAL LEV	Small	None	State – MD – Exists Need to implement in DC and VA since Tier 3 benefits are similar?
Bicycle & Pedestrian programs	Small	Variable	Local
Nonroad Source			
Nonroad Diesel Equipment Anti-Idling	Large - $194,831 ton/year (534 tpd) in OTR (2009 estimate) (Table 3-15)[3]	None	DC – Exists MD – Exists, Discussion of enhanced enforcement with MDOT & MD State Police currently underway VA – None
Nonroad Diesel Engine Retrofit & Rebuilds	Large (0-37% control)[1] Upto 18 tpd	$4,500/ton for most, $3,245-$5,164/ton for some construction equipment[1]	State & Local
Tougher Locomotive Engine Standards	Large	Varies depending on technology	Advocacy to EPA for rule implementation
Tougher Marine Diesel Engine Standards	Large	Varies depending on technology	Advocacy to EPA for rule implementation
Tougher Aircraft Engine Standards	Large	Varies depending on technology	Advocacy to EPA for rule implementation

Commercial Marine - Ocean Going Vessels – Shore Based Electrical Power - Cold Ironing	Medium (~3.5 tpd)	$6,500-$18,000[1]	State
Idling Restrictions for Lawn & Garden Equipment	Small-Medium	None	Local
Effective implementation of Idle reduction initiative	Small (~1 tpd)		State – Nonroad idling rule in place in all three jurisdictions MD – Considering enhanced enforcement with MDOT & State Police
Switcher Engine Replacement	Small (12.9 tpy/0.035 tpd) per engine[2]	$104, 284/ton[2] $6,500-$18,000/ton for Diesel-electric hybrid[1]	State – DC – Proposed (Draft DC VW Funding Plan) VA – Ongoing programs for locomotives MD – Potential
Reduce locomotive idling	Small		State – There may be a jurisdictional issue here. APUs, shore power, and automatic shut-offs available to stop idling
Boat engine replacement	Small		State – DC – Ongoing program (check with DOEE for details)
Aircraft GSE Alternative Fuels (LPG/CNG)	Small	Gas: $0 (savings) Diesel: $1,110-$3,325/ton VOC/CO/NOx combined[1]	MWAA
Aircraft GSE Alternative Fuel (Electric)	Small	$6,500-$18,000/ton[1]	MWAA

Emission Reduction Potential: Large: >5 tpd, Medium: 1-5 tpd, Small: <1 tpd

[1] EPA Menu of Controls

[2] Draft DOEE Spending Plan for Volkswagen Settlement Funds

[3] OTC Model Rules, August 2016

[4] http://www.mwcog.org/uploads/committee-documents/ZV1aVl1Y20131209141112.pdf

[5] Status of Adoption of OTC Model Rules (2009-2014)

[6] TPB Staff Email/Memo- Dated March 8, 2018

Table A: Comparison of Emission Benefits & Costs - Refuse Truck and Transit Bus Replacements

(Based on Info- provided in DOEE's Draft Spending Plan for Volkswagen Settlement Funds)

Vehicle Type	Vehicle Purchase Cost39	NOx Emissions (total tons emitted per year)	Reduction in NOx Emissions (total tons reduced per year/day)	Additional Cost to Replace a Diesel Truck (per ton)	PM 2.5 Emissions (total tons emitted per year)	GHG Emissions (total tons emitted per year)
Electric Refuse Truck	$450,000	0	0.47 tpy/ 0.001 tpd	$450,000-$210,000/0.47 = $510,638	0	139
CNG Refuse Truck	$300,000	0.001	0.47 tpy/ 0.001 tpd	$300,000-$210,000/0.47 = $191,490	0.001	156
New Diesel Refuse Truck	$210,000	0.029			0.001	196
Electric Transit Bus	$770,000	0	0.46 tpy/ 0.001 tpd	$770,000-$300,000/0.46 = $1,021,740	0	64
CNG Transit Bus	$360,000	0.0013	0.46 tpy/ 0.001 tpd (Assumed same as CNG Transit Bus)	$360,000-$300,000/0.46 = $130,435	0.001	72
New Diesel Transit Bus	$300,000	0.027			0.001	88