



**Maryland Department of the Environment**

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# Small Electric Generating Units in the MARAMA Alpha 2011/2018 Modeling Platform

**A Methodology to Develop A Consistent  
Base Year Temporal Profile for Small Non-  
CAMD EGUs in the MANEVU+VA Region**



# Purpose

- There has been interest in how SMOKE processes small electric generating units and whether or not the model is getting peak day emissions right.
  - These small units typically operate for limited periods of time. They usually operate during high electricity demand periods (aka peak day) or when larger units are offline for maintenance. They may also operate at times where it is necessary to ensure grid reliability.
- Large units operating profiles are developed from CEMS data, so we know their profiles are reasonable but what about the smaller units – those without CEMS?
- Our goal is to develop a temporal profile for coal, oil and gas-fired electric generating units < 25 MW at EGU facilities.
  - Based on what we know about their typical operational patterns, profiles for these units should show limited annual operation, but high peak day operation.

# Overview

- Step 1: Identify the 2011/2018 temporal profiles for base and peaking EGUs >25MW.
- Step 2: Identify the 2011/2018 temporal profiles currently assigned by SMOKE to small EGUs <25MW.
- Step 3: Apply the temporal profile for large peaking EGUs (identified in step 1) to small EGUs <25MW.
  - Compare the daily NO<sub>x</sub> mass allocated by current SMOKE profiles for small EGUs vs. the MDE-developed profiles.

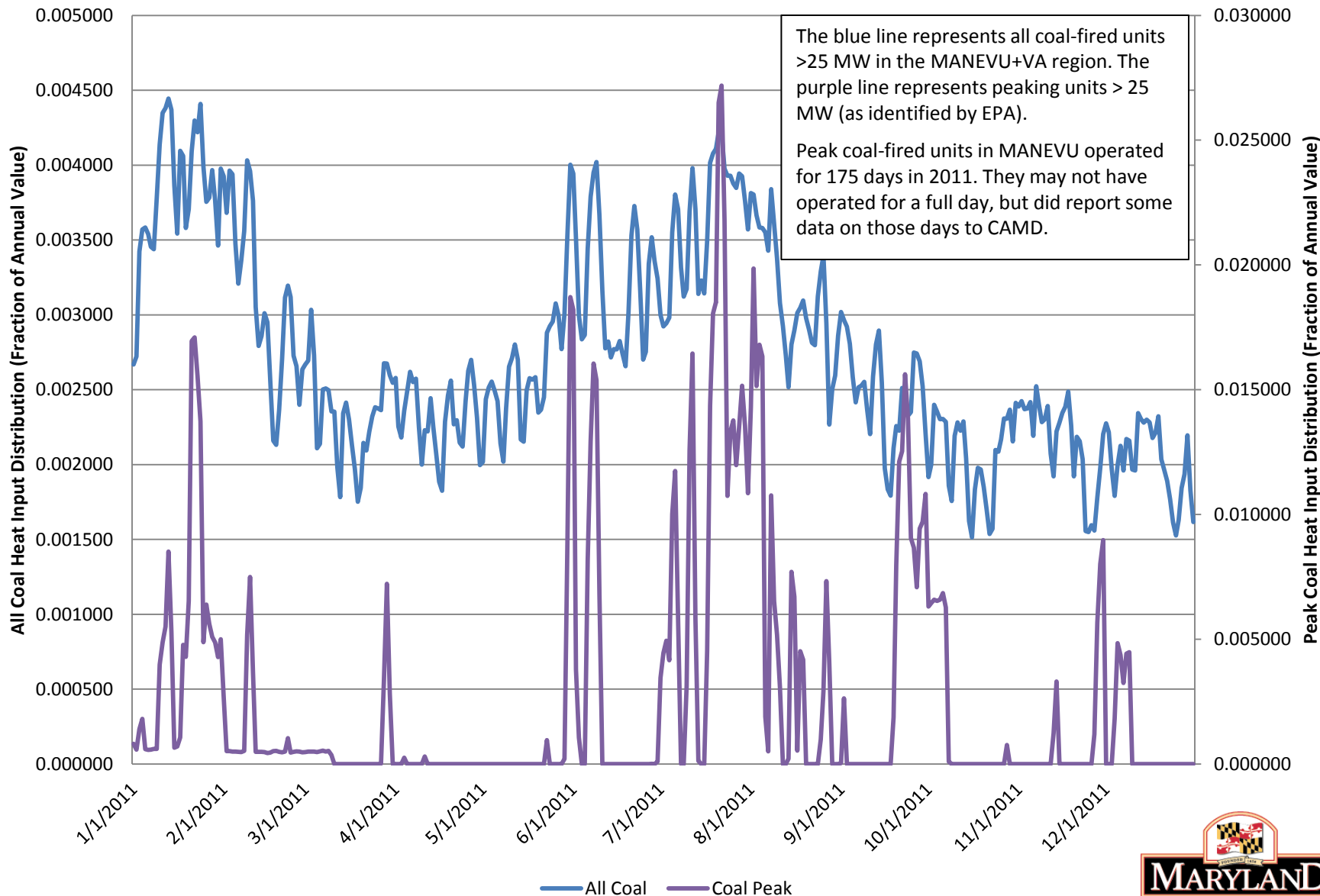


# Step 1 – Identify Base and Peaking Profiles For Units >25MW

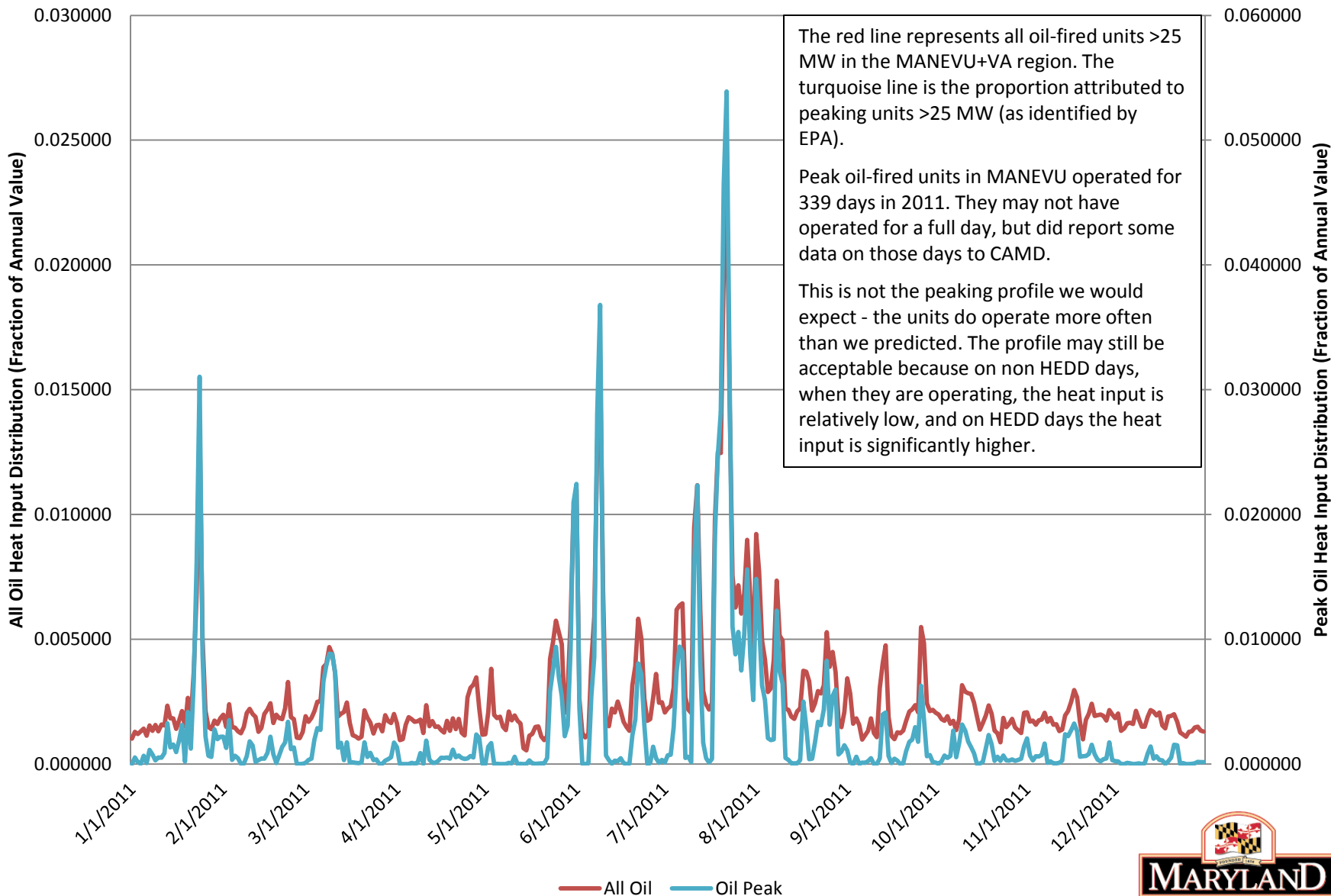
- Downloaded daily heat input data for 2011 from CAMD. Separated by fuel-type and region.
  - Coal, oil and gas
  - MANEVU, LADCO, SESARM and CENSARA
- Graphed the daily distribution of heat input (the fraction of the annual value).
- EPA has created a separate modeling file for their 2011v1 platform identifying peaking units that are > 25MW. These are units that are in both the NEI and CAMD, and were identified as peaking units because they had a capacity factor <10% over a 3 year average, and < 20% in each of 3 years (2010-2012).
- Graphed the daily distribution of heat input for the peaking units (by region and fuel-type). Overlaid the peaking profiles on the total fuel-type region profiles.
- Do the profiles match – are the peaking units running on peak days?



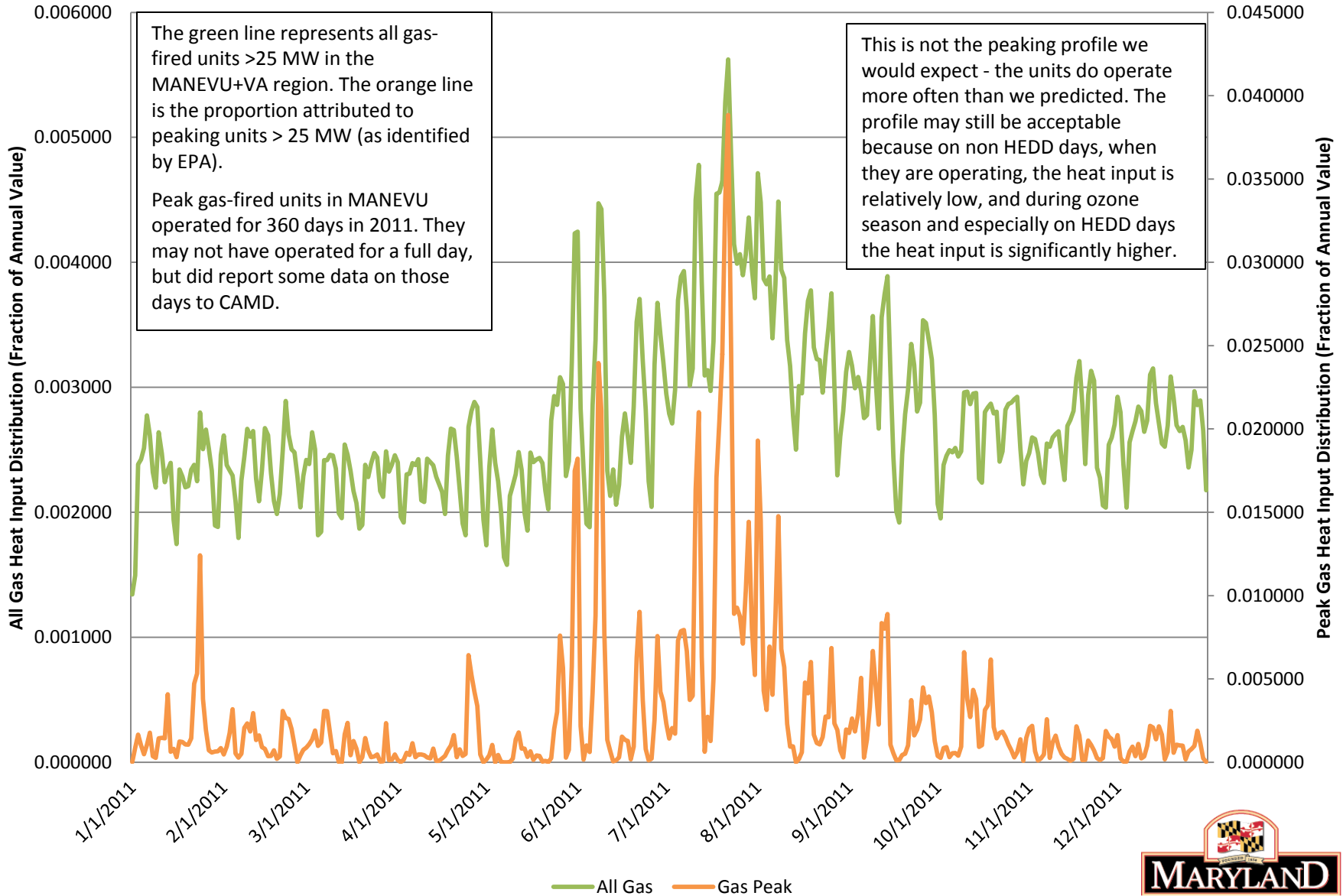
# MANEVU+VA All Coal and Peak Coal Temporal Profiles



# MANEVU+VA All Oil and Peak Oil Temporal Profiles

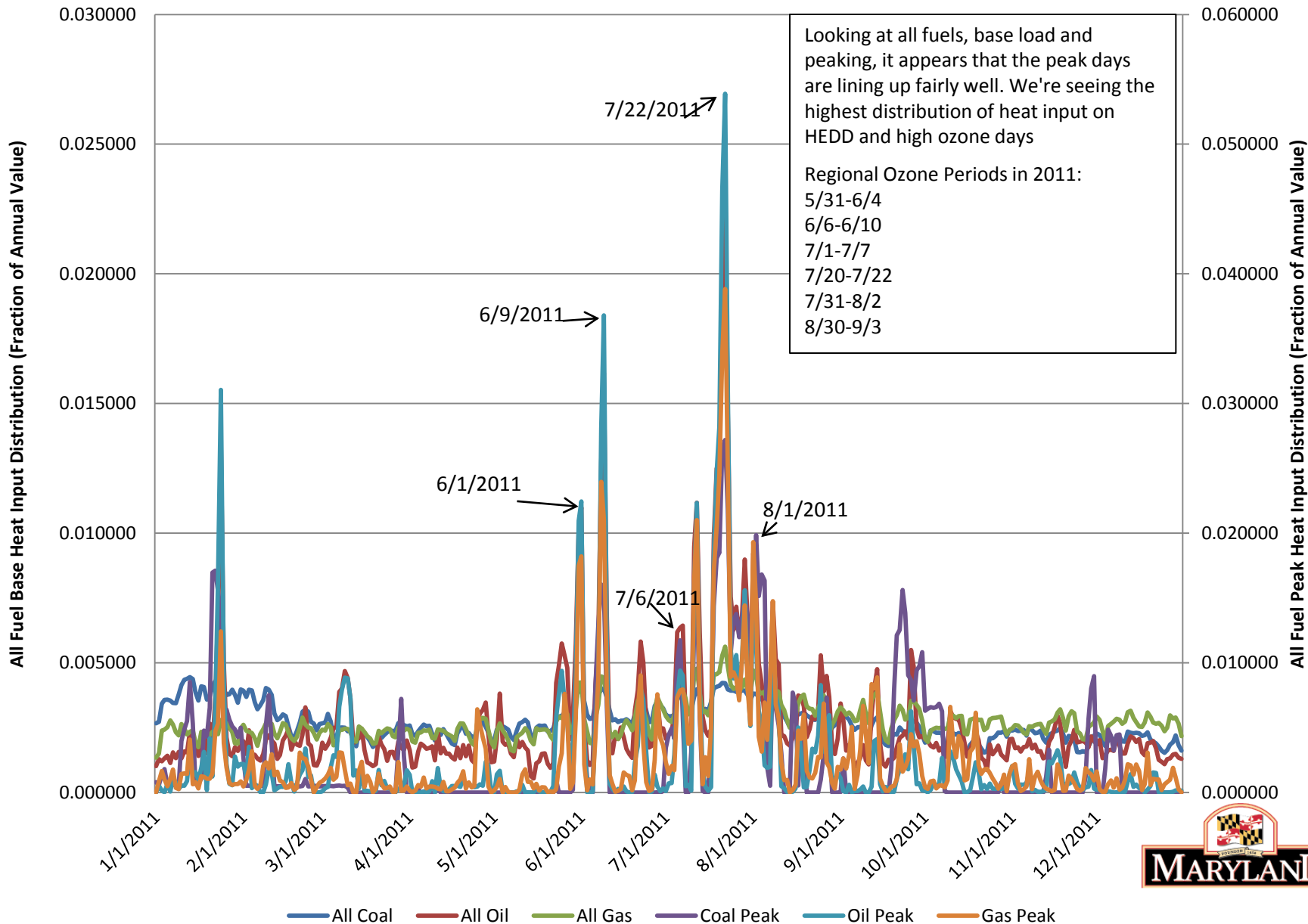


# MANEVU+VA All Gas and Peak Gas Temporal Profiles





# MANEVU+VA All Fuel Base and Peak Temporal Profiles







# What Kinds of Units? MD Examples

ORIS ID	Facility	Unit IDs	Total Size (MW)	Fuel	Plant Type	Total 2011 Emissions – MARAMA Alpha Inventory	Captured by MDE Methodology?
6565	Berlin	1A - 5A	8.55	Oil	RICE	4.36 Tons	X
1552	Crane	GT1	14	Oil	Combustion Turbine	5.41 Tons	
1571	Chalk	GT1	18	Oil	Combustion Turbine	3.08 Tons	X
1563	Crisfield	CRIS, CRS2 – 4	10	Oil	RICE	9.20 Tons	X
1572	Dickerson	GT1	13	Oil	Combustion Turbine	1.3 0 Tons	
1580	Easton	8 – 9, 11, 101 – 102	31.9	Oil	Combustion Turbine	58.88 Tons	X
1580	Easton	7, 10, 12 - 14		Oil	RICE		
4257	Easton 2	21 – 24, 201 – 202	37.64	Oil	RICE	86.58 Tons	X
4257	Easton 2	203 - 204		Oil	Combustion Turbine		
1573	Morgantown	GT1 - 2	40	Oil	Combustion Turbine	19.81 Tons	X
1555	Notch Cliff	GT1 - 8	136	Gas	Combustion Turbine	85.89 Tons	X
1557	Philadelphia	GT1 - 4	64	Oil	Combustion Turbine	24.80Tons	
1559	Riverside	CT7 - 8	22	Oil	Combustion Turbine	5.20 Tons	X
1564	Vienna	10	17	Oil	Combustion Turbine	2.22 Tons	
1554	Wagner	GT1	12.9	Oil	Combustion Turbine	2.673 Tons	X





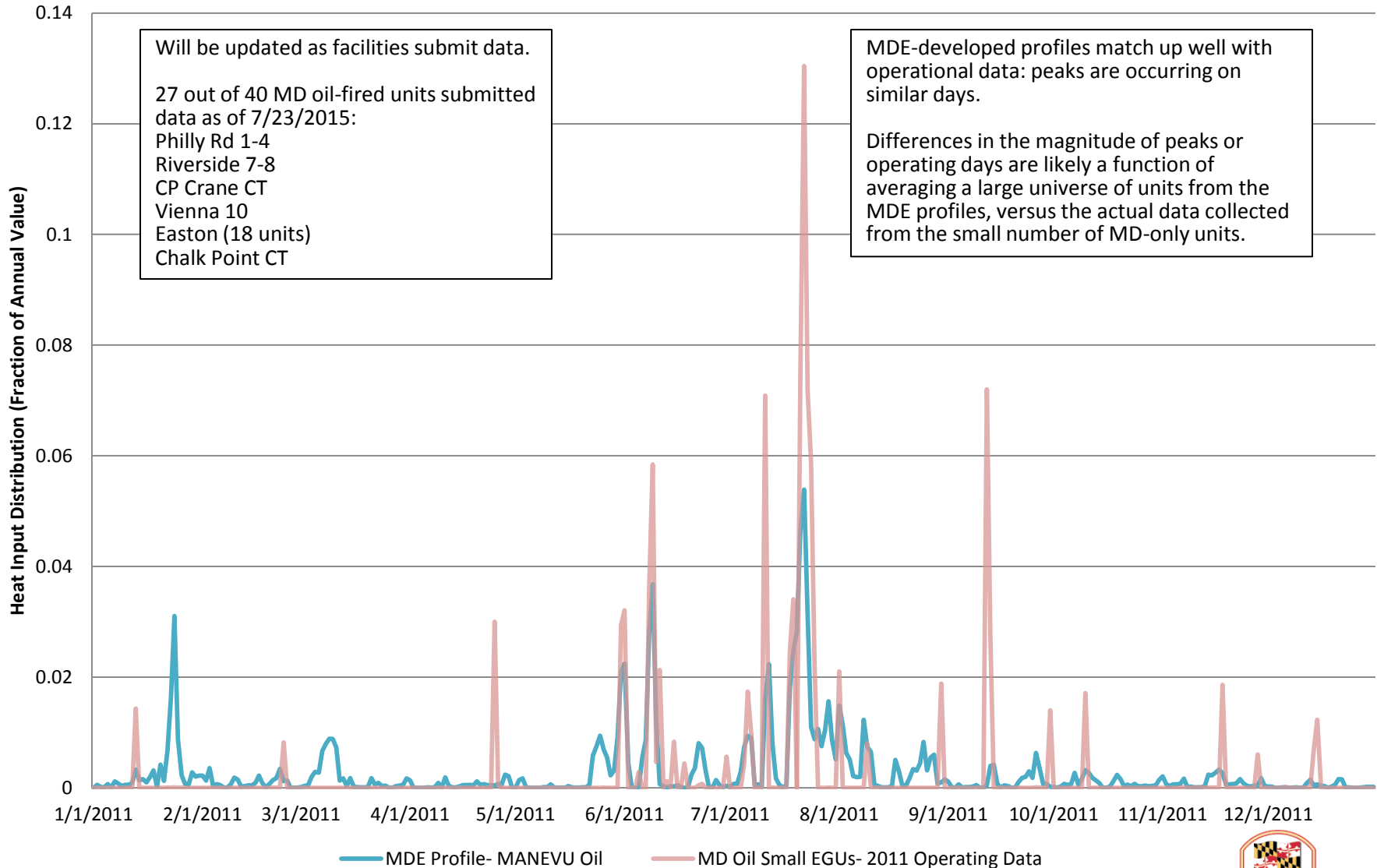
# Are the MDE-Developed Temporal Profiles Accurate?

- Collected 2011 daily heat input data for MD small EGUs from EGU facilities.
- Separated by fuel type (oil or gas).
- Graphed daily heat input distribution (fraction of annual value).
- Overlaid MDE-developed temporal profile for MANEVU gas and oil.
- Do the profiles match- are MDE temporal profiles representative of small EGU operating patterns?



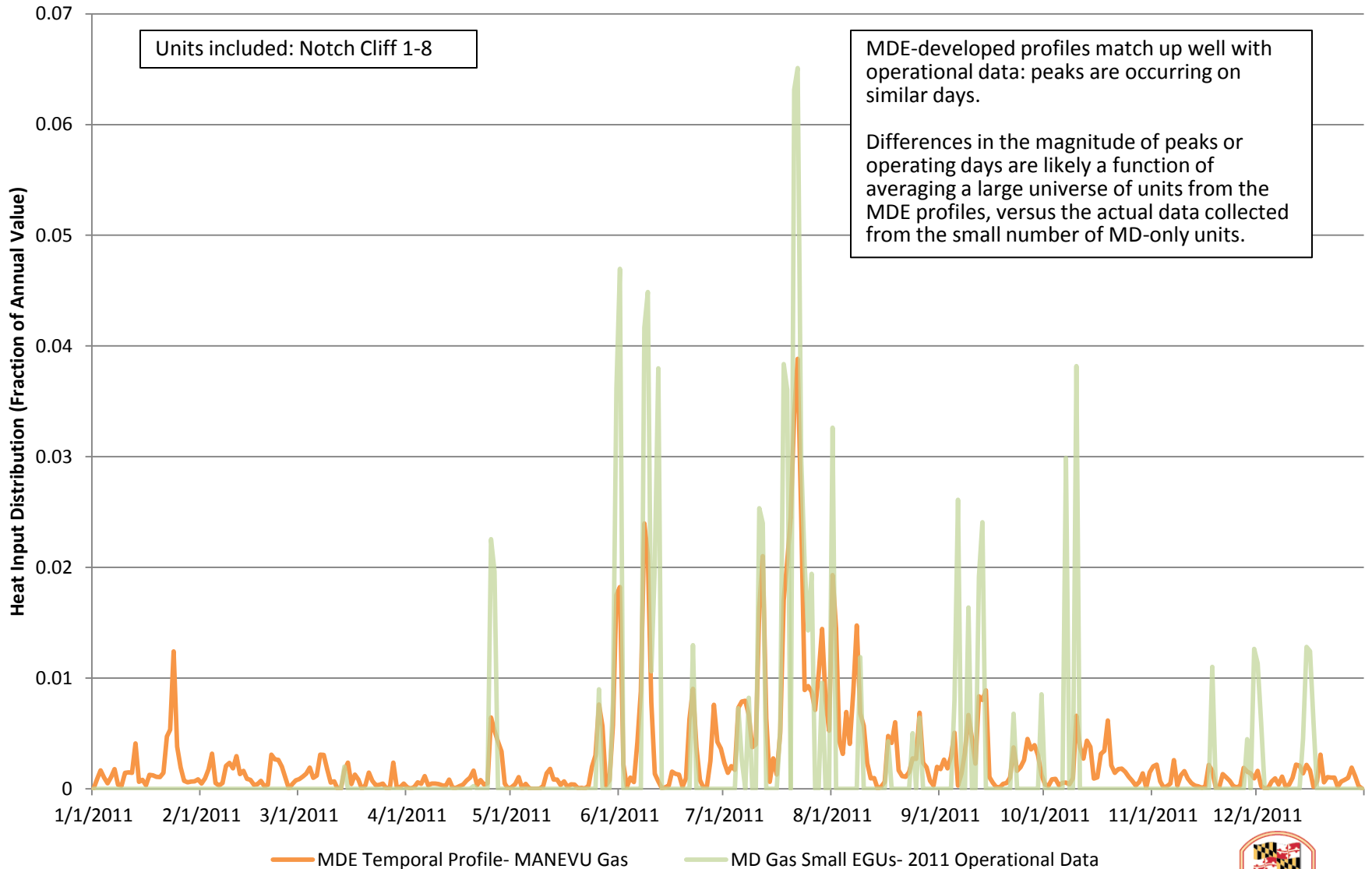


# Compare MDE-Developed Temporal Profile to 2011 Operating Data MD Oil-Fired Small EGUs





# Compare MDE-Developed Temporal Profiles to 2011 Operating Data MD Gas-Fired Small EGUs





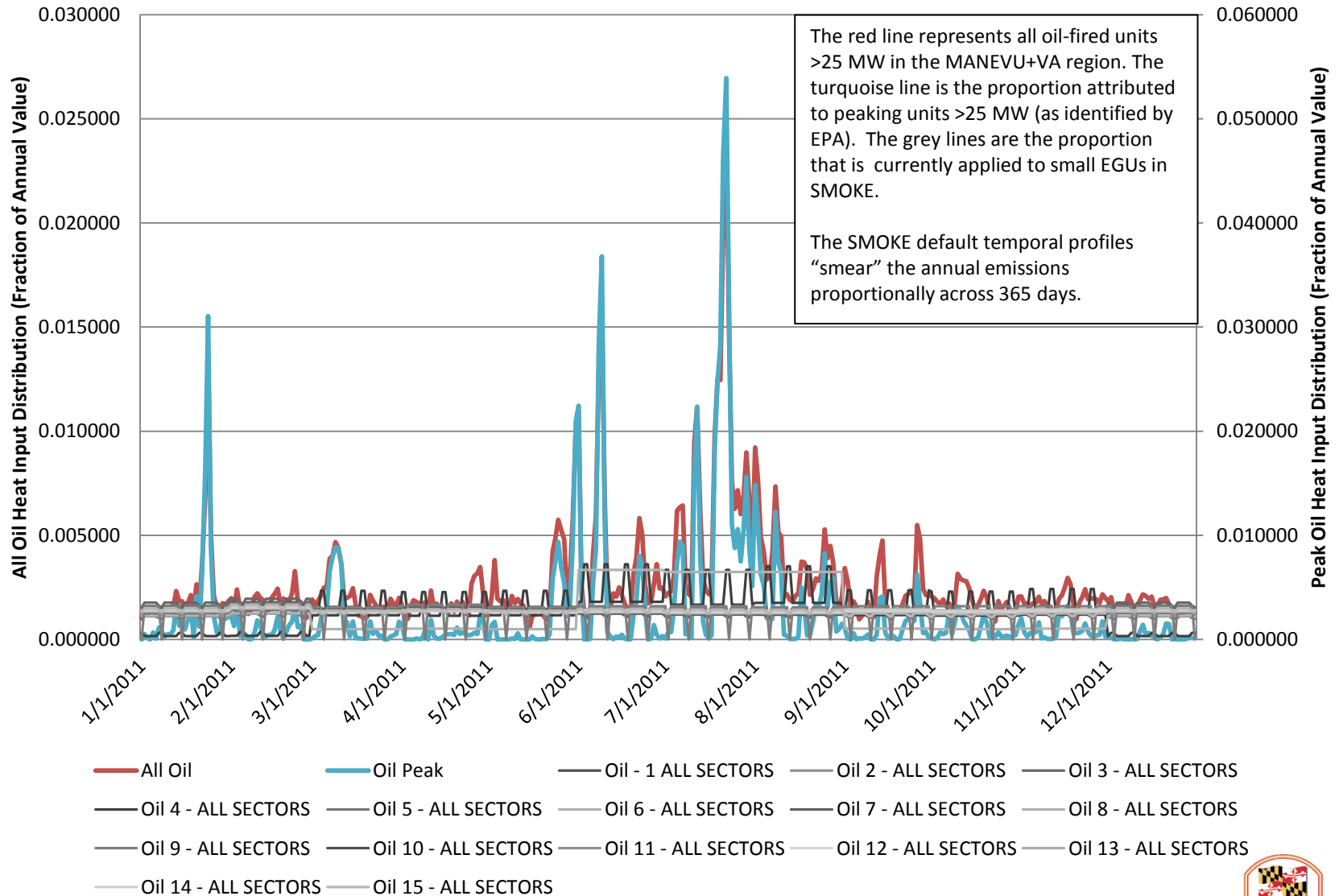
# Step 2 – Identify Profiles Assigned to Units < 25MW

- The MARAMA 2011/2018 Alpha modeling inventory took the USEPA V2 point EGU and point nonIPM inventory files, and separated them into ERTAC EGUs, small EGUs, and nonEGUs (labeled ptnonipm). The units of interest are in the small EGU and the ptnonipm files.
- Using EMF, identified facilities in the smallEGU and ptnonipm files with NAICS codes for EGUs.
- From the selected facilities, identified units with SCCs associated with coal, oil and gas-fired units.
  - Also included units with SCCs for ICI boilers, as NAICS code was used to determine if that unit is at an EGU facility
  - Included SCCs for both boilers and ICEs in the small EGU file to capture as many units as possible. Included only ICEs from the ptnonipm file to prevent capture of auxiliary boilers, industrial processes, etc.
- Placed the identified units in a new file named “nonERTAC small EGU”
  - To assess any possibility of double counting, used Access to match units in the ERTAC modeling file, based on Agency Facility ID, Unit ID, Release Point, Process and SCC to units in the nonERTAC small EGU file.
  - To prevent nonEGUs from being temporalized using the MDE profiles, used Access to match units designated as nonEGUs in the Sabo Crosswalk, based on EIS Facility ID, Unit ID, Process, Release Point and SCC to units in the nonERTAC Small EGU file.
- Because smaller electric generating units do not have hourly emissions data, a default temporal profile (supplied by EPA) is applied (by SCC and FIPS) to the annual emissions in SMOKE.
  - 209 SCC codes
    - 85 for coal; 9 distinct profiles
    - 69 for gas; 20 distinct profiles
    - 55 for oil; 15 distinct profiles
- Used the SMOKE Temporal Cross Reference file “all sectors” tab to cross reference between emissions sources and temporal profiles by SCC and FIPs to select emissions profiles in the Temporal Profile file.
- Graphed the temporal profiles assigned to small EGUs by SMOKE, by SCC groups (coal, oil and gas). Overlaid the SMOKE profiles on the peaking profiles and the base load profiles.
- Does the profile assigned to the small EGUs in SMOKE align with the “peaking” profiles developed in the previous step?



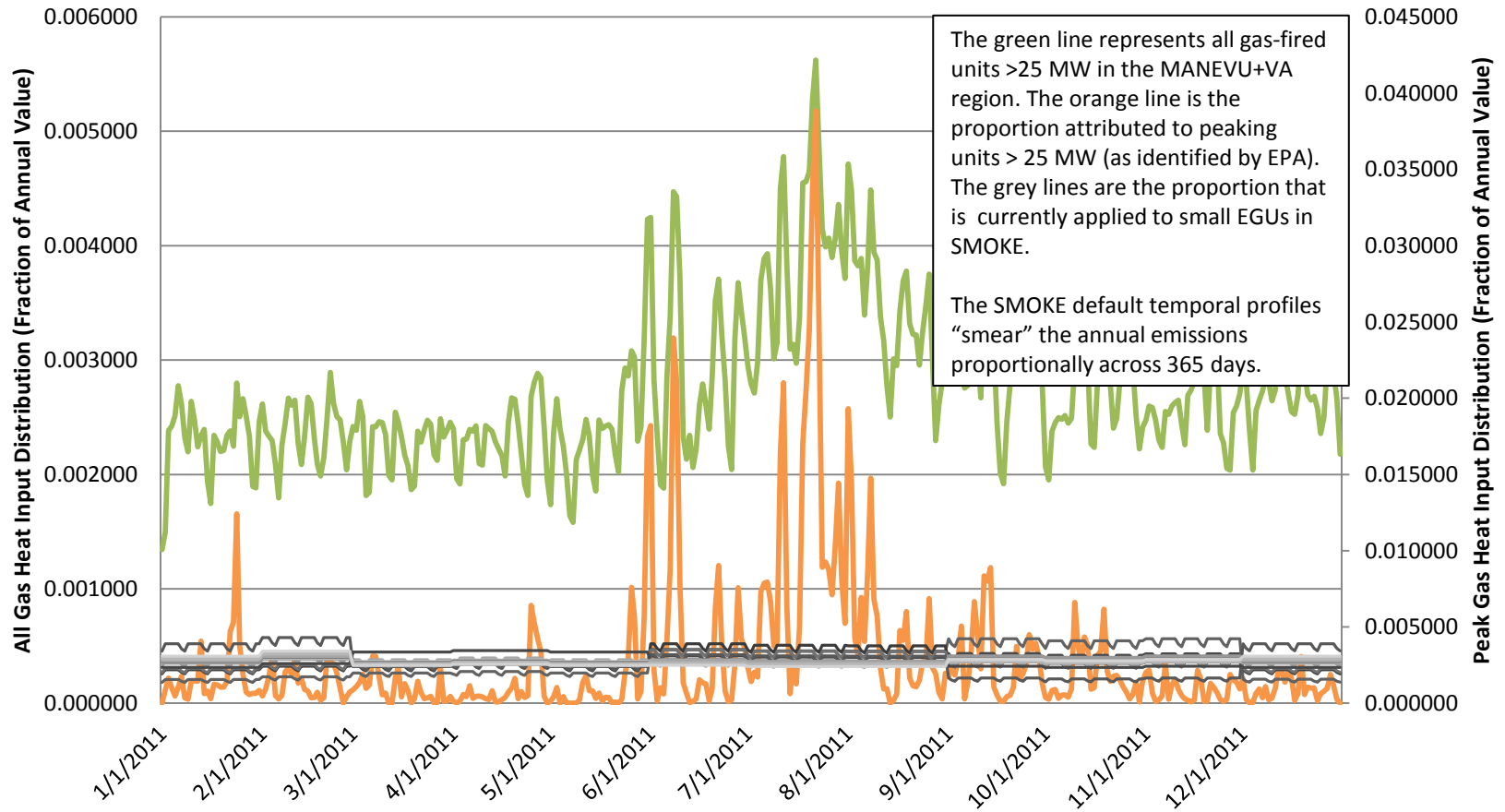


# MANEVU+VA All Oil, Peak Oil and SMOKE Temporal Profiles





# MANEVU+VA All Gas, Peak Gas and SMOKE Temporal Profiles



- All Gas
- Gas Peak
- Gas 1 - ALL SECTORS
- Gas 2 - ALL SECTORS
- Gas 3 - ALL SECTORS
- Gas 4 - ALL SECTORS
- Gas 5 - ALL SECTORS
- Gas 6 - ALL SECTORS
- Gas 7 - ALL SECTORS
- Gas 8 - ALL SECTORS
- Gas 9 - ALL SECTORS
- Gas 10 - ALL SECTORS
- Gas 11 - ALL SECTORS
- Gas 12 - ALL SECTORS
- Gas 13 - ALL SECTORS
- Gas 14 - ALL SECTORS
- Gas 15 - ALL SECTORS
- Gas 16 - ALL SECTORS
- Gas 17 - ALL SECTORS
- Gas 18 - ALL SECTORS
- Gas 19 - ALL SECTORS
- Gas 20 - ALL SECTORS





# Step 3 – Compare the Daily NO<sub>x</sub> Mass Allocations from the Default SMOKE Profiles vs. the MDE Profiles

- Graphed (by region and fuel type) the daily NO<sub>x</sub> mass for coal, oil and gas-fired EGUs >25 MW.
- Using EMF and the temporalization tool, graphed (by region and fuel-type) the daily NO<sub>x</sub> mass for coal, oil and gas-fired EGUs <25 MW identified in Step 2.
  - These are the units placed in the nonERTAC Small EGU file
- Using the daily distribution profiles developed by MDE, temporalized and graphed (by region and fuel type) the daily NO<sub>x</sub> mass for coal, oil and gas-fired EGUs <25 MW identified in Step 2.
  - These are the units placed in the nonERTAC Small EGU file
- Overlaid (by region and fuel type) the daily NO<sub>x</sub> mass for units >25 MW with the additional daily NO<sub>x</sub> mass from the nonERTAC Small EGUs when emissions are temporalized using default SMOKE profiles.
- Overlaid (by region and fuel type) the daily NO<sub>x</sub> mass for units >25 MW with the additional daily NO<sub>x</sub> mass from the nonERTAC Small EGUs when emissions are temporalized using the MDE profiles.
- Compared the daily NO<sub>x</sub> mass gain (or loss) from using the two temporalization processes (SMOKE vs. MDE).



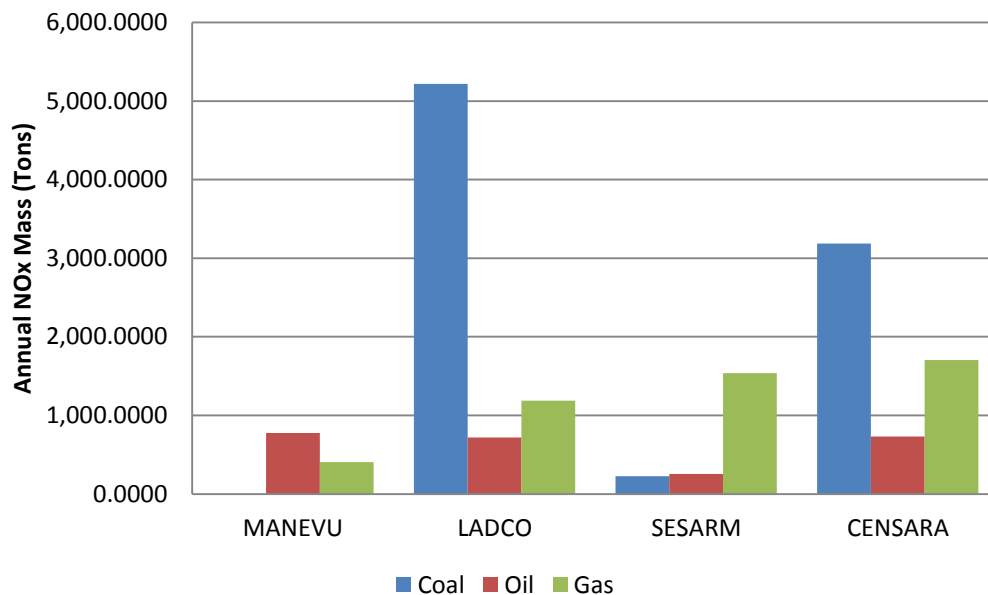




# Is It Worth It?

Region	Number of Units	Fuel	2011 Annual NOx Mass (Tons)
MANEVU+VA	544	Coal	N/A
		Oil	774.01
		Gas	404.89
MANEVU+VA Total			1,178.90
LADCO	864	Coal	5,216.69
		Oil	717.18
		Gas	1,188.75
LADCO Total			7,122.61
SESARM	359	Coal	225.00
		Oil	254.16
		Gas	1,538.66
SESARM Total			2,017.82
CENSARA	658	Coal	3,185.90
		Oil	731.39
		Gas	1,705.80
CENSARA Total			5,623.09
Total	2,425	Coal	8,627.59
		Oil	2,476.73
		Gas	4,838.10
<b>Grand Total NOx Mass</b>			<b>15,942.42</b>

**2011 Annual NOx Mass nonERTAC Small EGUs For Temporal Allocation by MDE**



The proportion of emission attributed to fuel types varies by region. For example, in SESARM, emissions from small gas-fired units have the largest impact and emissions from coal and oil-fired units are nearly equal. Conversely, in MANEVU+VA emissions from oil-fired units have the largest impact and emissions from gas-fired units have a lesser impact.

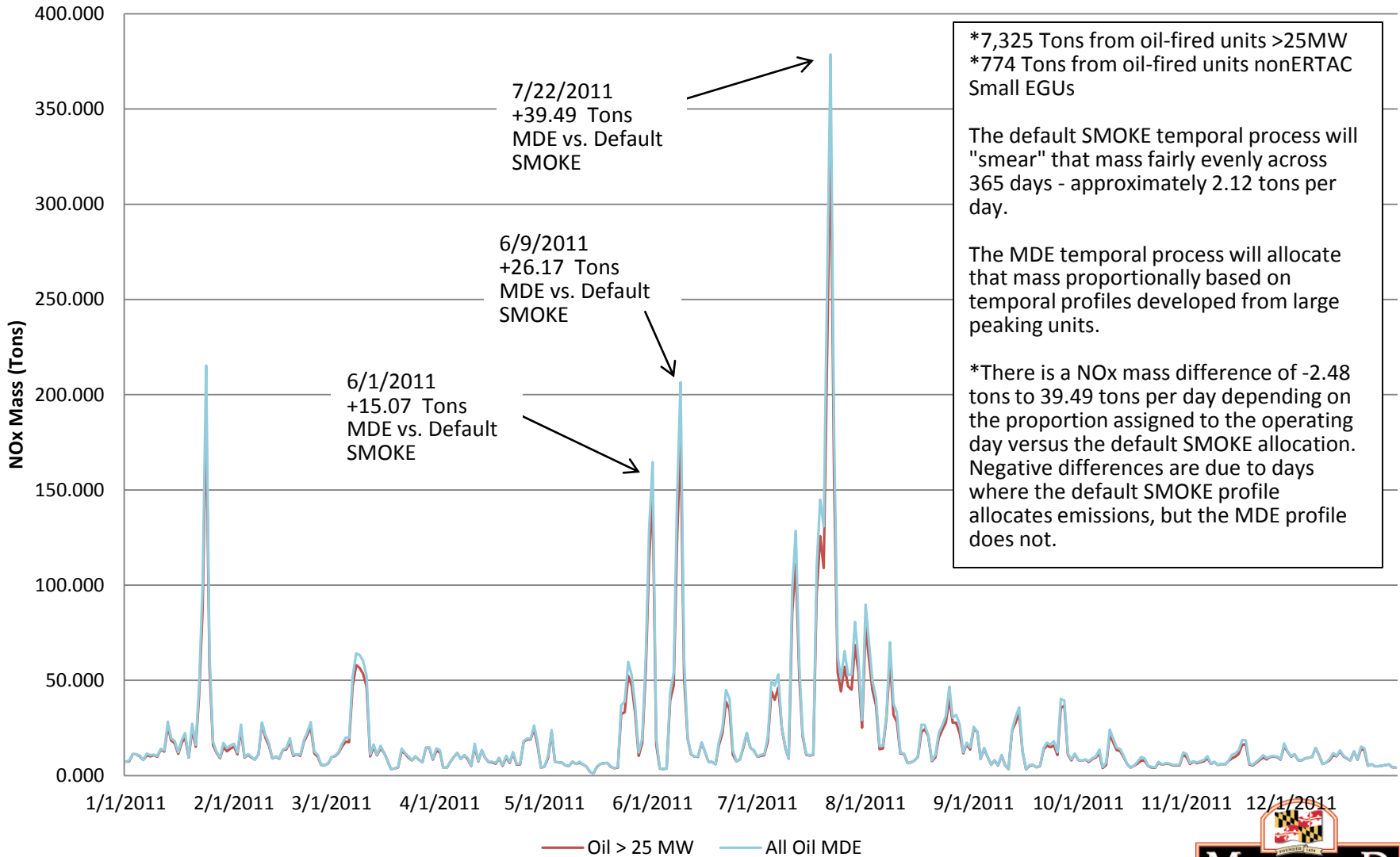
15,942 Tons of NOx is not a significant amount of mass to be concerned about. The top 3 NOx emitters in 2011 could easily emit more NOx than all of the 2,438 units identified in this analysis. But *where* that NOx mass is allocated temporally is very important.





# MANEVU+VA Oil 2011 Daily NOx Mass

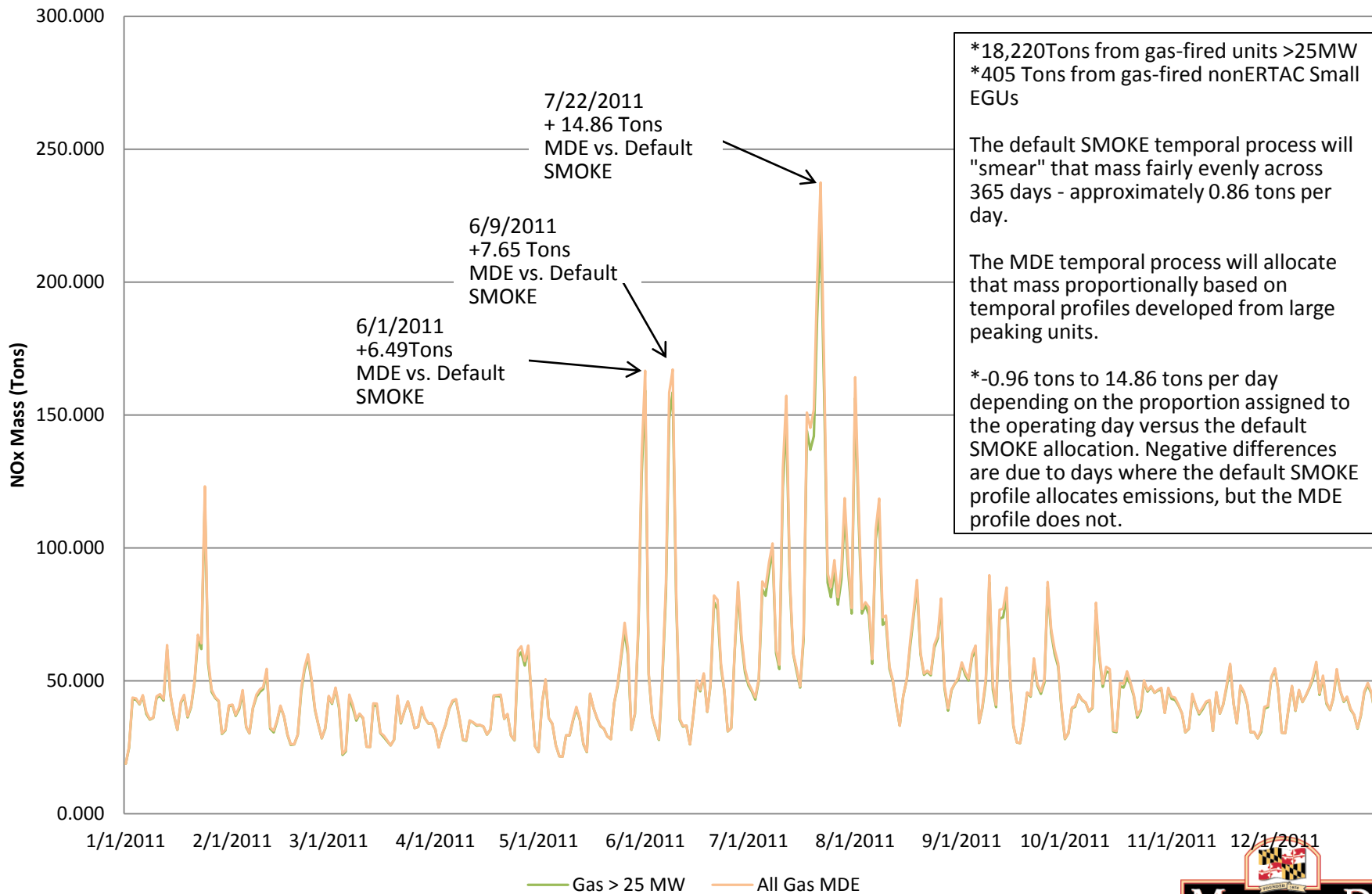
## Units > 25 MW Plus nonERTAC Small EGUs Temporarily Allocated by MDE





# MANEVU+VA Gas 2011 Daily NOx Mass

## Units > 25 MW Plus nonERTAC Small EGUs Temporally Allocated by MDE





# Peak Day Impact – 7/22/2011

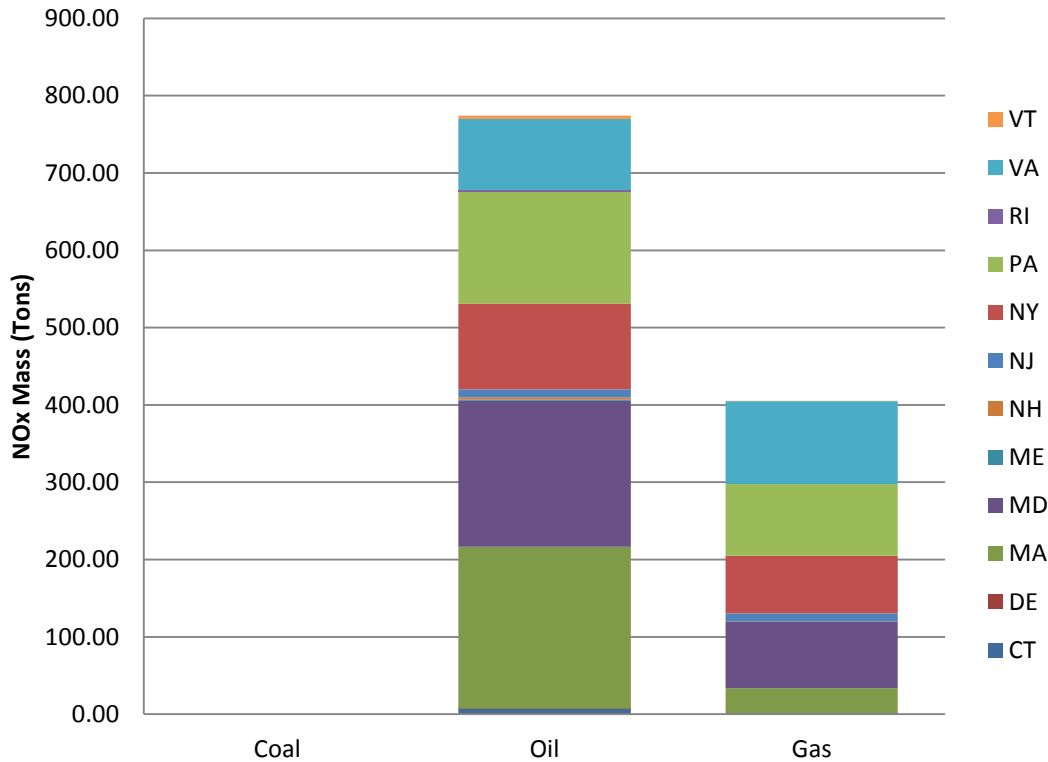
Region	Number of Units	Fuel	7/22 NOx Mass- Units > 25 MW	7/22 nonERTAC Small EGU Contribution using SMOKE Profile (Tons)	7/22 nonERTAC Small EGU Contribution using MDE Profile (Tons)	Difference SMOKE vs. MDE (Tons)	Peak Day % Increase with nonERTAC Small EGU by MDE
MANEVU+VA	544	Coal	806.35	N/A	N/A	N/A	N/A
		Oil	337.01	2.23	41.72	34.49	12.4%
		Gas	221.73	0.86	15.72	14.86	7.1%
MANEVU+VA Total			558.74	3.09	57.44	54.35	10.3%
LADCO	864	Coal	1,462.46	14.38	133.3	118.92	9.1%
		Oil	1.96	2.21	36.46	34.25	1860.2%
		Gas	87.35	3.39	36.31	32.92	41.6%
LADCO Total			1,551.77	19.98	206.07	186.09	13.3%
SESARM	359	Coal	1,545.47	0.62	2.57	1.95	0.2%
		Oil	16.5	0.67	4.7	4.03	28.5%
		Gas	131.57	4.64	18.33	13.69	13.9%
SESARM Total			1,693.54	5.93	25.6	19.67	1.5%
CENSARA	658	Coal	1,360.05	9.28	44.13	34.85	3.2%
		Oil	5.4	2.63	0	-2.63	0.0%
		Gas	384.82	5.52	14.27	8.75	3.7%
CENSARA Total			1,750.27	17.43	58.4	40.97	3.3%
Total	2,425	Coal	5,174.33	24.28	180	155.72	3.5%
		Oil	360.87	7.74	82.88	82.88	23.0%
		Gas	825.47	14.41	84.63	84.63	10.3%
<b>Grand Total NOx Mass</b>			<b>6,360.67</b>	<b>46.43</b>	<b>347.51</b>	<b>347.51</b>	<b>5.5%</b>





# MANEVU+VA 2011 Contribution by State

**MANEVU+VA 2011 NOx Mass  
nonERTAC Small EGUs For Temporal  
Allocation by MDE**



State	2011 Coal NOx Mass (Tons)	2011 Oil NOx Mass (Tons)	2011 Gas NOx Mass (Tons)
CT	0	7.13	1.55
DE	0	0.03	0
MA	0	209.36	32.20
MD	0	188.88	85.89
ME	0	1.41	0.68
NH	0	3.11	0.02
NJ	0	10.41	10.18
NY	0	110.76	74.67
PA	0	144.65	92.60
RI	0	2.37	0
VA	0	91.68	106.94
VT	0	4.22	0.17
<b>Total</b>	<b>0</b>	<b>744.01</b>	<b>404.89</b>



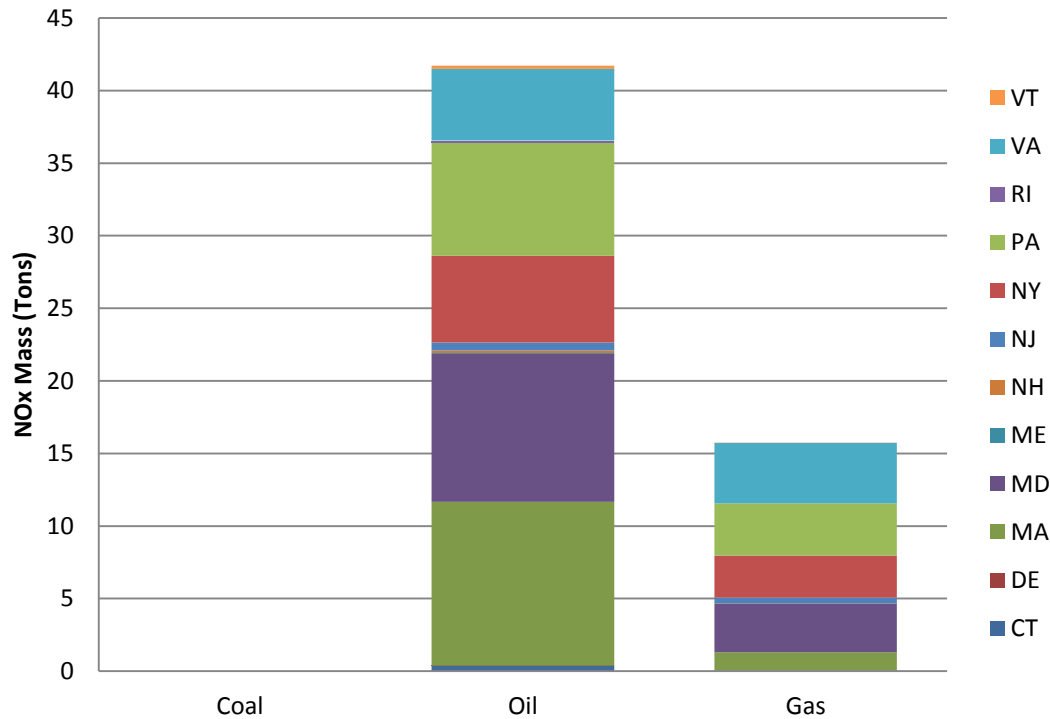
Oil – in 2011, MA, MD, and PA are the largest contributors from the nonERTAC Small EGU file  
 Gas – in 2011, MD, PA, and VA are the largest contributors from the nonERTAC Small EGU file



# MANEVU+VA Peak Day Impact – 7/22/2011 – Contribution by State

## MANEVU+VA Peak Day NOx Mass: 7/22/2011

### nonERTAC Small EGUs Temporally Allocated by MDE



State	7/22/2011 Coal NOx Mass (Tons)	7/22/2011 Oil NOx Mass (Tons)	7/22/2011 Gas NOx Mass (Tons)
CT	0	0.38	0.06
DE	0	0	0
MA	0	11.28	1.25
MD	0	10.18	3.34
ME	0	0.08	0.03
NH	0	0.17	0
NJ	0	0.56	0.40
NY	0	5.97	2.90
PA	0	7.80	3.60
RI	0	0.13	0
VA	0	4.94	4.15
VT	0	0.23	0.03
<b>Total</b>	<b>0</b>	<b>41.72</b>	<b>15.72</b>

Oil – on 7/22/2011, when nonERTAC Small EGUs are temporalized by MDE, MA, MD, and PA are the largest contributors

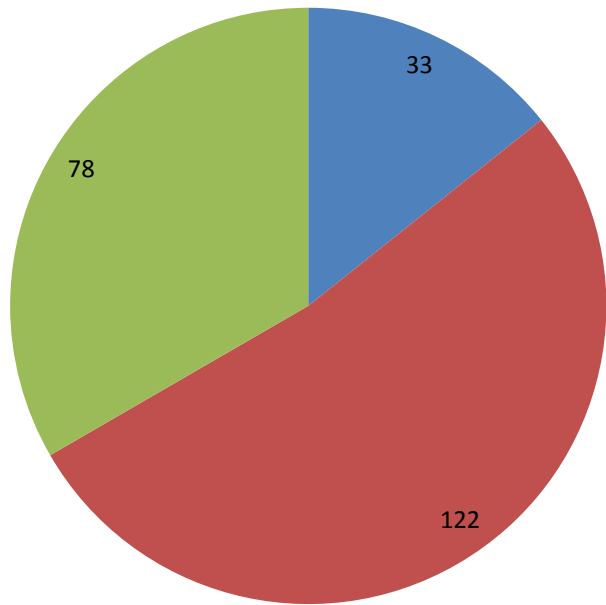
Gas – on 7/22/2011, when nonERTAC Small EGUs are temporalized by MDE, MD, PA, and VA are the largest contributors





# MANEVU+VA Oil-Fired nonERTAC Small EGUs, Contribution by State and Top Emitters

**MANEVU+VA 2011 NOx Mass Oil-Fired nonERTAC Small EGUs Top 10 Emitters**



■ NY  
■ MA  
■ VA

State	Facility	Facility ID	Unit ID	NAICS Code	SCC Code	2011 NOx Mass (Tons)
NY	* PE Bayshore	54541	Unknown	221112	20200402	33
MA	NRG Oak Bluffs	1597	UNI1	221112	20100102	31
MA	NRG Oak Bluffs	1597	UNI2	221112	20100102	30
MA	NRG Oak Bluffs	1597	UNI3	221112	20100102	30
VA	*Darbytown	7212	1	221112	20200101	21
VA	*Darbytown	7212	4	221112	20200101	21
VA	*Darbytown	7212	2	221112	20200101	18
VA	*Darbytown	7212	3	221112	20200101	18
MA	*Med Area Total Energy Plant	10883	DEG5	221112	20200401	16
MA	*Med Area Total Energy Plant	10883	Unknown	221112	20200401	15

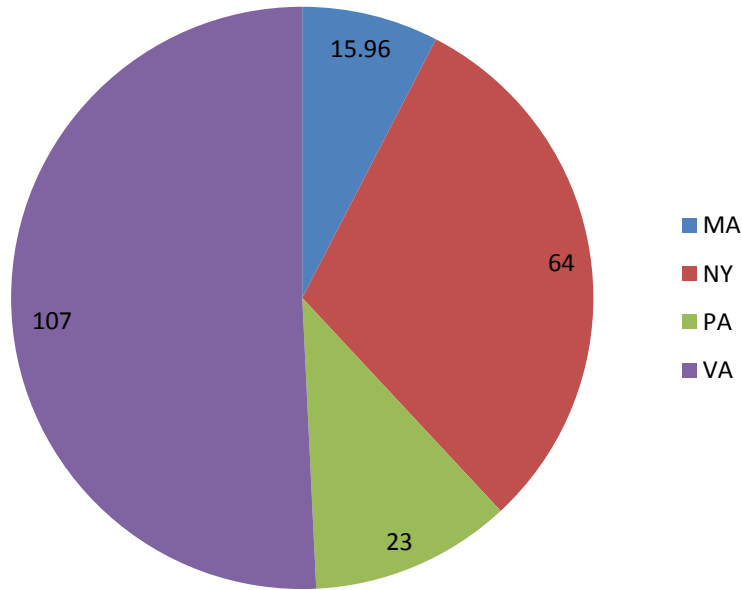
\*Units that could be considered nonEGUs or ERTAC EGUs remain in the nonERTAC small EGU file because they cannot be queried out using EIS or Agency level identifiers or crosswalk data. Quick Google searches of the rest of the nonERTAC smallEGUs indicate that we have properly identified the units we want to temporalize.





# MANEVU+VA Gas-Fired nonERTAC Small EGUs, Contribution by State and Top Emitters

**MANEVU+VA 2011 NOx Mass Gas-Fired nonERTAC Small EGUs Top 10 Emitters**



State	Facility	Facility ID	Unit ID	NAICS Code	SCC Code	2011 NOx Mass (Tons)
VA	Pow Gen Suffolk Energy Partners			221112	20100202	37
VA	* Duke Energy of Narrows	52089	7A	221112	10200601	32
NY	* Kings Plaza Total Energy Plant			221112	20200254	31
VA	Ingenco Brunswick			221112	20100201	22
NY	Sarnac Power Partners	54574	GEN3	221112	10200601	21
MA	Taunton Municipal			221112	20100201	16
VA	Ingenco Chester			221112	20100201	15
PA	Blossburg Gen Sta.	3120	1	221112	20100201	13
NY	Southampton GT	2519	1	221112	20100901	12
PA	PPL Martins Creek			221112	20100201	10

\*Units that could be considered nonEGUs or ERTAC EGUs remain in the nonERTAC small EGU file because they cannot be queried out using EIS or Agency level identifiers or crosswalk data. Quick Google searches of the rest of the nonERTAC smallEGUs indicate that we have properly identified the units we want to temporalize.





## Improvements to Temporal Profiles

- MDE profiles concentrate emissions for nonERTAC Small EGUs on peak days rather than spread over 365 days.
- Separating by region and fuel type will bring the modeling inputs for small EGUs closer to actual operating profiles.
- Profiles reflect base year EGU operations
  - Methodology can be easily replicated for other base year modeling inventories.
- As better data becomes available on small EGU emissions and operational patterns, the data can easily be fed into the database in order to refine and improve the small EGU temporal profiles.

## Limitations of MDE Temporal Profiles

- MDE profiles are limited by the data that was used to create them. These profiles do likely have small EGUs operating more often than they actually do.
  - There is no hourly emissions database for small/peaking EGUs.
- Initial screening identified 3,481 potential small EGUs. The methodology for identifying small EGUs captured 2,425 units (70% of the potential units).
  - Due to discrepancies in NAICS and SCC codes, the methodology may not capture every small EGU. This methodology may also have captured units that should not have been included.



# Next Steps...Improvements for the 2011/2017 Modeling Platform

- Distribute list of nonERTAC Small EGUs that will be temporalized using the profiles developed by MDE. Request states review list to confirm that the identified units are EGUs.
- Remove the double counted units from the Small EGU and ptnonipm files that are in the ERTAC files.
- Create a new inventory file for the nonERTAC Small EGUs that will be temporalized with the new MDE temporal profiles.
- Create 12 temporal profiles in EMF
  - 4 regions with 3 fuel types each
- Using EMF, apply the temporal profile, by SCC and FIPS to the selected units
  - The profile will allocate emissions down to the day. SMOKE will allocate the emissions to the hours.
  - Initial investigation of the hourly profiles in SMOKE indicates that SMOKE will allocate the daily emissions across 24 hours. May be able to create a diurnal profile that would allocate emissions to specific hour blocks.
- SMOKE the emissions
- Merge the inventories
- For both 2011 and 2017





# Maryland Department of the Environment

## Air Quality Planning Program

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