Emissions Inventory Overview

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MARAMA

MARAMA WORKSHOP
Baltimore, MD
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Outline

- Inventory Status and Schedule
- Inventory Highlights
- What is next
- Over the Horizon
2007* Annual Emissions by Inventory Sector

*Onroad Mobile Estimates are interpolated 2007 emissions using MOBILE6.2

**NOx**
- Onroad Mobile*, 1,089,461 (44%)
- Point - CAMD, 431,331 (17%)
- Point - Non-CAMD, 205,546 (8%)
- Nonroad (NMIM), 304,531 (12%)
- Area, 242,035 (10%)
- Nonroad (MAR), 231,039 (9%)

**Total**
2,503,943 tpy

**VOC**
- Onroad Mobile*, 607,886 (35%)
- Area, 969,345 (55%)
- Point - CAMD, 5,983 (0%)
- Point - Non-CAMD, 102,003 (6%)
- Nonroad (NMIM), 54,503 (3%)
- Nonroad (MAR), 21,083 (1%)

**Total**
1,760,803 tpy
2007* Annual Emissions by Inventory Sector

*Onroad Mobile Estimates are interpolated 2007 emissions using MOBILE6.2 and MOVES Adjustment Factors

### NOx

- **Onroad Mobile**, 1,750,857 (55%)
- **Point - CAMD**, 431,331 (14%)
- **Point - Non-CAMD**, 205,546 (6%)
- **Nonroad (NMIM)**, 304,531 (10%)
- **Nonroad (MAR)**, 231,039 (7%)
- **Area**, 242,035 (8%)

**Total**

3,165,340 tpy

### VOC

- **Point - CAMD**, 5,983 (0%)
- **Point - Non-CAMD**, 102,003 (6%)
- **Nonroad (NMIM)**, 54,503 (3%)
- **Nonroad (MAR)**, 21,083 (1%)
- **Onroad Mobile**, 626,915 (35%)
- **Area**, 969,345 (54%)

**Total**

1,779,832 tpy
2007* Annual Emissions by Inventory Sector

*Onroad Mobile Estimates are interpolated 2007 emissions using MOBILE6.2 and MOVES Adjustment Factors

**PM2.5 – Modelled (estimated)**

- **Onroad Mobile***, 12,302
- **Point - CAMD**, 51,808
- **Area**, 69,962
- **Point - Non-CAMD**, 39,078
- **Nonroad (MAR)**, 9,772
- **Nonroad (NMIM)**, 29,208

**Total** 212,131 tpy

**SO2**

- **Onroad Mobile***, 18,265
- **Nonroad (MAR)**, 33,401
- **Nonroad (NMIM)**, 13,437
- **Point - Non-CAMD**, 152,513
- **Area**, 284,604
- **Point - CAMD**, 1,796,673

**Total** 2,298,892 tpy
Point
14% of 2007 NO\textsubscript{x}
80% of 2007 SO\textsubscript{2}
25% of 2007 PM2.5

Most Familiar
Top 100 Points
\( \text{NO}_x \) ‘02, ‘07, ‘09
Nonroad
10% of 2007 NO$_X$
4% of 2007 VOC
AREA
8% of 2007 NO$_x$
54% of 2007 VOC
Residential Wood Combustion

NO$_X$

VOC

2002 Version 3
2007
2009 Version 3_2
MAR
7% of 2007 NO$_X$
1% of 2007 VOC

NO$_X$

SO$_2$
# Inventory Status and Schedule

<table>
<thead>
<tr>
<th>Sector</th>
<th>2007</th>
<th>2013, 2017, 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGU</td>
<td>Done</td>
<td>Mid-2011*</td>
</tr>
<tr>
<td>Non-EGU Point</td>
<td>Done</td>
<td>Oct-Nov</td>
</tr>
<tr>
<td>Area Sources</td>
<td>Done</td>
<td>Oct-Nov</td>
</tr>
<tr>
<td>Nonroad - NMIM</td>
<td>Done</td>
<td>Oct-Nov</td>
</tr>
<tr>
<td>MAR</td>
<td>Oct-Nov</td>
<td>Oct-Nov</td>
</tr>
<tr>
<td>Onroad</td>
<td>Early 2011</td>
<td>2012 *</td>
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</tbody>
</table>

* EGU future and Onroad base and future estimates are highly uncertain
Where to Find the Inventories

- MARAMA’s website:
  www.marama.org/technical-center/emissions-inventory/projects-overview

- For more information contact
  - Patrick Davis (pdavis@marama.org) and
  - Julie McDill (jmcddill@marama.org)
Questions?
Where to from here?

- EGU Projections
- Mobile Sources
- Future years – the rest of the inventory
- Convert other Inventories as Necessary
- OTC Emission control strategies – BOTW inventory
- Area source MACTs effect on criteria pollutants
- Marcellus Shale
Marcellus Shale
Where is it?

Marcellus
516 TCF
Current production rate = 0.4 BCF

Barnett Shale
360 TCF
Current production rate = 923 BCF
Marcellus Shale

How does it work?

Hydraulic Fracturing

Hydraulic fracturing, or “fracing,” involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.

The shale is fractured by the pressure inside the well.

Graphic by Al Granberg
Marcellus Shale
What does it look like?
Marcellus Shale
What does it look like?
Marcellus Shale

What are the environmental issues?

- Drinking Water Quality
- Accidents
- Erosion Control
- Nuisance
- Noise
- Air Quality
Marcellus Shale

How might emissions look in the future?

From: EIA 2010
# Marcellus Shale Ballpark Emissions Estimate

<table>
<thead>
<tr>
<th></th>
<th>Production (BCF)</th>
<th>NOX</th>
<th>VOC</th>
<th>HAP</th>
<th>CH4</th>
<th>CO2 (eq)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Marcellus</strong></td>
<td>NE USA **</td>
<td><strong>Marcellus</strong></td>
<td>NE USA **</td>
<td><strong>Marcellus</strong></td>
<td>NE USA **</td>
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<tr>
<td>2010</td>
<td>1.2</td>
<td>400</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2020</td>
<td>1.2</td>
<td>800</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Compressor Engine Exhausts</td>
<td>24</td>
<td>8,067</td>
<td>7</td>
<td>2,373</td>
<td>1</td>
<td>427</td>
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<tr>
<td>Condensate and Oil Tanks</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>3,005</td>
<td>0</td>
<td>62</td>
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<tr>
<td>Production Fugitives</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>2,689</td>
<td>0</td>
<td>63</td>
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<tr>
<td>Well Drilling and Completions</td>
<td>3</td>
<td>870</td>
<td>10</td>
<td>3,322</td>
<td>0</td>
<td>78</td>
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<tr>
<td>Gas Processing</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>1,582</td>
<td>0</td>
<td>38</td>
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<tr>
<td>Transmission fugitives</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>2,847</td>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>Total Emissions (TPY) 2010</td>
<td>27</td>
<td>8,937</td>
<td>47</td>
<td>15,818</td>
<td>2</td>
<td>736</td>
</tr>
<tr>
<td>Total Emissions (TPY) 2020</td>
<td>17,874</td>
<td>31,636</td>
<td>1,471</td>
<td>212,752</td>
<td>7,078,548</td>
<td></td>
</tr>
<tr>
<td>Average Annual Emissions ***</td>
<td>1700</td>
<td>37,238</td>
<td>65,908</td>
<td>3,065</td>
<td>443,233</td>
<td>14,746,975</td>
</tr>
</tbody>
</table>

Calculations based on data from:

* PA Oil and Gas Production Webpage (2010)
** EIA reports that 2008 total Shale gas produced in NE USA. In addition to Marcellus there are plays in Michigan, called Antrim. This field is declining.
*Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements by A. Armendariz(2009)
*** Based on: 30 Years 50,000 BCF recoverable gas (From: EIA, Geology.com, and Marcellus shale wiki)
Marcellus Shale
How might emissions look in 2020?

- NOX  18,000-37,000 TPY
- VOC  31,500-66,000 TPY
- HAP  1500-3000 TPY
- CH4  213,000-450,000 TPY
- CO2 (eq)  7-15 Million TPY

Note:
Hi: Average annual emissions
Low: EIA Shale Gas growth estimate
for NE USA

Total 1,779,832 tpy
Marcellus Shale

How might emissions look in the future?

From: Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements by A. Armendariz (2009)
Marcellus Shale Regulatory Framework

- Compressor stations may require a Title V permit in nonattainment areas.
- Hourly N2O standard may be violated if modeled.
- Long-range transport and chemistry important for
  - PM2.5
  - Ozone
Marcellus Shale

Possible controls

- Engines – SNCR
  - Catalytic converters similar to the ones on cars.
  - May increase N2O emissions
- Condensate tanks - Vapor Recovery of VOC
- Piping, pumps and fixtures
  - Sniffer devices coupled with maintenance
- Green completions – capture methane during installation operations
- Electric motors to drive compressors
Marcellus Shale
Further Information

- Overview of Marcellus Shale for the Indiana PA League of Women Voters:

- A report done in Texas relevant to Marcellus region

- WRAP area source oil&gas inventory
Marcellus Shale
What does it look like?
Depends on your perspective....
OVER THE HORIZON - Options

- Ammonia emissions analysis
- Efficiency programs – How will these affect the inventory?
- 2025 future year inventory development
- Develop a link based mobile inventory for one or two urban areas
Ammonia emissions analysis

Ammonia is an important precursor to fine particulate formation.

Significant ammonia emissions from agricultural sources in MARAMA states.

Timely opportunity to link to Chesapeake Bay Diet

USEPA has released a study of ammonia emissions
  - They will be working on this topic. We can work cooperatively for a better end product

Follow up on USDA contacts made at MARAMA Ammonia meeting 2009.
Efficiency programs are being proposed for many sectors.

Inventory analysis could look at the effect on NOX of reductions to particular sectors.
OVER THE HORIZON

2025 Inventory

- Demonstrate compliance with Ozone standards
- Redesignation of areas
- More options for development without offset requirements
OVER THE HORIZON

Link based inventory

- Achieving Ozone goals is an increasing challenge.
- A new 1 hour NO$_2$ standard is in place – 100 ppb
- The largest source of NO$_2$ & NO$_X$ are mobile sources
- Better localized mobile inventories may be necessary
- Other regions have developed link based inventories – providing a template we can follow
NO2 Air Quality, 1980 - 2008
(Based on Annual Arithmetic Average)
National Trend based on 75 Sites

1980 to 2008: 46% decrease in National Average

From USEPA
Expected Near-Road NO2

- Past studies – Concentration compared to community monitor
- In-vehicle concentrations 2-3 times higher
- Near-road (within about 50 meters) 1.3-2 times higher
- 2003-2005 - Avg hourly NO2 nationwide = 30 ppb
Existing NO$_2$ Community-wide Monitors

Existing NO$_2$ monitoring sites in 2008
Many of these sites would satisfy the proposed community-wide monitoring requirements.

Areas with > 1 million population require 1 community-wide monitor

From USEPA
Near-Road NO$_2$ Monitoring Requirements in Urban Areas

Areas >500,000 population require one near road monitor

Areas >2.5 million population or with road segments with annual average daily traffic counts >250,000 vehicles require two near-road monitors

All new NO2 monitors to be operational by January 1, 2013

Redesignation of areas in 2016 or 2017

From USEPA
OTR High Ozone Day TRENDS (2010 preliminary data [up to September 6])
Questions?
Extra Slides
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PM2.5 - Calculated

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- Nonroad MA, 29

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