Maryland’s GHG Inventory
Methane

Maryland Commission on Climate Change
Mitigation Working Group
February 24, 2017
Why an Emissions Inventory

- Required by the Clean Air Act/ GGRA
  - 3 Year Increments for Full Inventories
  - Points collected annually

- Track emissions relative to the SIP (State Clean Air Plan) Reasonable Further Progress Requirements/ GGRA

- Trends - Going up? Going down?

- Advises regulations

- Most importantly ... identifies large and small source categories to provide focus for reduction opportunities
Source Categories

Criteria Pollutants

• Point (Major) Sources
  – EGUs, Cement Plants, Incinerators

• Stationary Area Sources
  – Paint, Consumer Products, Residential Fuel Combustion

• On-road Mobile Sources

• Non-road Mobile Sources
  – Lawn & Garden, Construction Equipment

• Marine-Air-Rail Sources

• Biogenic Sources
Source Categories

**GHG Emissions**

- Electricity Use (Consumption)
- Residential, Commercial, Industrial Fuel Use
- On-road Mobile Sources
- Non-road Mobile Sources
  - Lawn & Garden, Construction Equipment, Marine, Air, Rail
- Sinks
How are Criteria Emissions Estimated?

- Based upon the very best data available
- Perfect ... No
- Very Good ... Yes
- Estimation/Calculation process varies from one source to another
  - Point Sources – from MDE Registration Files
    - Continuous Monitors (CEMs), Stack Tests, Mass Balance, EF
  - Area – Activity level × an emissions factor
    - Surrogates used to estimate emissions
  - Non-road – M-A-R
    - Marine Vessels: Data from Baltimore Maritime Exchange & EPA
    - Railroads: Data directly from railways
    - Airports: Survey of Airport Data (LTOs)
  - Non-road Model – EPA’s latest version
  - On-road – Mobile model called “MOVES”
  - Biogenic – EPA model (BEIS)
How are GHG Emissions Estimated?

- Based upon the very best data available
- Perfect ... No
- Very Good ... Yes
- Estimation/Calculation process varies from one source to another
  - Electricity Consumption (direct read data, CEMS)
  - RCI – State specific fuel consumption data/Fuel specific carbon contents
  - Off Road and On Road (EPA model)
  - Waste Management (MDE collected data and EPA model)
  - Industrial (Pulp & Paper) – (direct read data, CEMS)
  - Industrial (Cement) – Facility/kiln-specific fuel consumption data; Clinker kiln dust data; Raw meal organic carbon content data
  - Most other categories (EPA Model)
Maryland’s GHG Inventory

Overview

• The Greenhouse Gas Reduction Act (GGRA) requires MDE to report on the statewide greenhouse gas inventory every three years
  – Most recent update released based on 2014 data
  – Next update will be based on 2017 data

• 2014 Inventory covers six types of GHGs, including methane

• Emissions were estimated bottom-up using generally accepted principles and guidelines
  – Maryland specific data to the extent possible

<table>
<thead>
<tr>
<th>Greenhouse Gas</th>
<th>GWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>1</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>21</td>
</tr>
<tr>
<td>Nitrous Oxide (N₂O)</td>
<td>310</td>
</tr>
</tbody>
</table>

• Equivalent CO₂ (CO₂e) was calculated using global warming potentials (GWP) from the IPCC 2nd Assessment Report
Maryland’s GHG Inventory

Data Sources

- Mobile source emissions (both on-road and non-road) are generated using a well-accepted EPA model with inputs from data sets maintained by SHA, MDE, MVA and EIA

- Emissions from the majority of point sources are directly measured

- Non-point source calculations utilize state-specific consumption data, fuel-specific carbon content coefficients and EPA established emissions factors and methodology
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Results

2014 Emissions (MMtCO$_2$e)

- CO$_2$: 91%
- N$_2$O: 2%
- CH$_4$: 3%
- HFC, PFC, SF$_6$: 4%

91%
Maryland’s GHG Inventory

High level of confidence on over 90% of the inventory

<table>
<thead>
<tr>
<th>Description</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ emissions from MD EGUs were compiled from CEMS/Emissions Certification Reports and cross-checked against two other reporting programs</td>
<td>21.5%</td>
</tr>
<tr>
<td>PJM provides both the fuel mix information and CO₂ emission rates for each fuel type to determine emissions from imported electricity</td>
<td>17.1%</td>
</tr>
<tr>
<td>EPA’s well-accepted MOVES model was used to estimate on-road mobile emissions as well as most off-road mobile emissions</td>
<td>34.6%</td>
</tr>
<tr>
<td>R/C/I Fuel Use emissions estimates were calculated using MD specific fuel consumption data and carbon content coefficients specific to each fuel</td>
<td>17.1%</td>
</tr>
</tbody>
</table>
Methane (CH$_4$)

The Basics

- Second most prevalent greenhouse gas emitted in the U.S. by human activities
  - EPA estimated 11% of national emissions in 2014
  - MDE estimated 3% of state emissions in 2014

- Shorter atmospheric lifetime than carbon dioxide (CO$_2$)
  - Approximately 12 years

- Higher global warming potential than CO$_2$
  - Approximately 28 times more effective than CO$_2$ at trapping heat in the atmosphere over 100 years
  - Approximately 84 times more effective over 20 years
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Methane Sources

• Leakage and venting of CH₄ from oil and gas fields, processing facilities, and natural gas pipelines

• Fugitive CH₄ emissions released during coal mining

  • Non-energy CH₄ from enteric fermentation, manure management, and agricultural soils

  • CH₄ emissions from solid waste management in municipal and industrial landfills (including flared, captured for energy, and from municipal solid waste incinerators)

• CH₄ emissions from wastewater management

• CH₄ released during wildfires and prescribed forest burns
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Determination of Methane Emissions

Electricity Supply
• Data: annual direct emissions from Emissions Certification Reports submitted to MDE

Residential, Commercial, and Industrial (RCI) Fuel Combustion
• Data: statewide energy consumption
• Calculations: default EPA’s SIT emission factors, based on fuel type

On-Road Mobile Energy Use
• Local Data:
  - SHA: VMT, vehicle mixes and seasonal/hourly factors
  - MVA: vehicle population and age
  - MDE: environmental and fuel data, control strategies
• Calculations: Mobile 6.2, PPSUITE and MOVES modeling

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Determination of Methane Emissions

Non-Road Mobile Energy Use

- Data:
  - Equipment population distributed by age, power, fuel type and application
  - Average load factor and available horsepower
  - Activity in hours of use per year
  - Emission factors

- Calculations: MOVES-NONROAD modeling

- Data: EIA Maryland fossil fuel consumption information (railroads, aviation, and commercial marine vessels)

- Calculations: EPA standard emission factor by fuel type

Industrial Processes

- No raw material transformation and production processes analyzed emit CH_4
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Determination of Methane Emissions

Fossil Fuel Production Industry

• Data:
  – U.S. DOT (pipeline information)
  – EIA (natural gas production information)
  – U.S. DOI (surface mining information)

• Calculations: EPA’s SIT default emission factors and methods provided in the Emission Inventory Improvement Program (EIIP)

Agriculture

• Data: USDA Maryland data on animal populations, fertilizer consumption, crop production and dry matter burned

• Calculations: EPA’s SIT with reference to methods in the EIIP
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Determination of Methane Emissions

Waste Management

• Solid Waste Data:
  – MSW Landfill-specific data and control device information from MDE programs
  – Annual waste emplacement data (including type of waste)

• Solid Waste Calculations:
  – Emissions based on landfill-specific technology efficiencies
  – EPA default surface oxidation factor
  – Industrial landfill emissions assumed to be 7% of municipal emissions

• Wastewater Data: state population

• Wastewater Calculations: default biochemical oxygen demand and emissions factors from EPA’s SIT
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Methane Results

All GHGs (2014)

- Methane: 2.6%
- Total GHGs: 97.4%

Methane Breakdown (2014)

- Waste Management: 38%
- Agriculture: 23%
- Fossil Fuel Industry: 29%
- Mobile Sources: 1.6%
- Forestry and Land Use: 1.6%
- Electricity Use: 1.2%
- RCI Fuel Use: 4.9%

Methane Results

Maryland’s GHG Inventory

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- Electricity Use: 1.2%
- RCI Fuel Use: 4.9%

Methane Breakdown (2014)
## Methane Results

### Maryland’s GHG Inventory

<table>
<thead>
<tr>
<th>Sector</th>
<th>Methane (MMt CO\textsubscript{2}e)</th>
<th>Total GHGs (MMt CO\textsubscript{2}e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Use</td>
<td>0.03</td>
<td>33.76</td>
</tr>
<tr>
<td>RCI Fuel Use</td>
<td>0.12</td>
<td>15.80</td>
</tr>
<tr>
<td>Mobile Sources</td>
<td>0.04</td>
<td>33.45</td>
</tr>
<tr>
<td>Industrial Processes</td>
<td>0.00</td>
<td>04.78</td>
</tr>
<tr>
<td>Fossil Fuel Industry</td>
<td>0.72</td>
<td>00.72</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.57</td>
<td>01.89</td>
</tr>
<tr>
<td>Waste Management</td>
<td>0.96</td>
<td>02.26</td>
</tr>
<tr>
<td>Forestry and Land Use</td>
<td>0.04</td>
<td>-11.65</td>
</tr>
<tr>
<td><strong>Total Emissions</strong></td>
<td><strong>2.47</strong></td>
<td><strong>92.67</strong></td>
</tr>
</tbody>
</table>
## Maryland’s GHG Inventory

### Methane Results

<table>
<thead>
<tr>
<th>Sector</th>
<th>CH$_4$ Emissions (MMtCO$_2$e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCI Fuel Use</td>
<td>0.1173</td>
</tr>
<tr>
<td>Wood</td>
<td>0.0875</td>
</tr>
<tr>
<td>Natural Gas &amp; LPG</td>
<td>0.0198</td>
</tr>
<tr>
<td>Petroleum</td>
<td>0.0068</td>
</tr>
<tr>
<td>Coal</td>
<td>0.0032</td>
</tr>
<tr>
<td>Mobile Sources</td>
<td>0.0315</td>
</tr>
<tr>
<td>Lawn &amp; Garden Equipment</td>
<td>0.0121</td>
</tr>
<tr>
<td>Recreational Equipment &amp; Craft</td>
<td>0.0083</td>
</tr>
<tr>
<td>Construction Equipment &amp; Fuel</td>
<td>0.0065</td>
</tr>
<tr>
<td>Commercial Equip.</td>
<td>0.0044</td>
</tr>
<tr>
<td>Industrial Equipment &amp; Fuel</td>
<td>0.0030</td>
</tr>
<tr>
<td>Highway Vehicles</td>
<td>0.0011</td>
</tr>
<tr>
<td>Other</td>
<td>0.0024</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sector</th>
<th>CH$_4$ Emissions (MMtCO$_2$e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Production (in-state)</td>
<td>0.0323</td>
</tr>
<tr>
<td>Coal</td>
<td>0.0296</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>0.0024</td>
</tr>
<tr>
<td>Oil</td>
<td>0.0003</td>
</tr>
<tr>
<td>Fossil Fuel Industry</td>
<td>0.719</td>
</tr>
<tr>
<td>Natural Gas Industry</td>
<td>0.584</td>
</tr>
<tr>
<td>Coal Mining</td>
<td>0.135</td>
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<tr>
<td>Agriculture</td>
<td>0.572</td>
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<tr>
<td>Enteric Fermentation</td>
<td>0.338</td>
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<tr>
<td>Agricultural Burning</td>
<td>0.143</td>
</tr>
<tr>
<td>Manure Management</td>
<td>0.090</td>
</tr>
<tr>
<td>Waste Management</td>
<td></td>
</tr>
<tr>
<td>Landfills</td>
<td>0.556</td>
</tr>
<tr>
<td>Wastewater Management</td>
<td>0.403</td>
</tr>
<tr>
<td>Forest Fires</td>
<td>0.040</td>
</tr>
</tbody>
</table>
Reducing Maryland’s Methane

• MDE conducted research on both current and anticipated future emissions, to prioritize three source categories for initial action:
  – Landfills
  – Compressor Stations
  – Wastewater Treatment Plants

• EPA has a number of voluntary programs and regulatory initiatives to reduce methane emissions, including the Landfill Methane Outreach Program
  – Maryland already has 12 operational LFG energy projects
Reducing Maryland’s Methane

**Updated regulations for hydraulic fracturing**

- In 2015, Maryland established a 2 year moratorium on fracking which remains in effect until October 2017
- MDE held three public meetings in June last year to solicit comments on draft regulations for oil and gas exploration and production
- Final regulations were proposed in October 2016

Methane leakage-related fracturing requirements:
- Top-Down Best Available Control Technology (BACT) required for all emitting equipment and leaks
  - Includes comprehensive LDAR programs
- Methane offset requirement
- State sponsored air monitoring
- Compliance with State air toxics requirements
Early last year, Pennsylvania’s governor Tom Wolf announced a strategy to reduce methane emissions from the oil and natural gas industries, calling it “one of the essential steps needed to reduce global greenhouse gas emissions and reduce the impacts of climate change”.

The plan includes four main strategies:

1. Revise the general permit for new pads to include BAT for equipment and processes, better record keeping, and quarterly inspections
2. Revise the general permit to update BAT requirements and apply more stringent LDAR for new compressor stations and processing facilities
3. Develop requirements for existing oil and NG facilities for the consideration of the Environmental Quality Board
4. Establish BMP for pipelines that include leak detection and repair programs

In November, the governor entered into a partnership with EDF, Google, and Carnegie Mellon University to map methane leaks in Pittsburgh.
Questions ?