Oil and Gas Methane Emissions Mitigation – Opportunities and Costs in North America

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Overview

- What are the Key Questions around Methane Emissions?
- Marginal Abatement Cost (MAC) Curve Concept
- MAC Curve Development Methodology
- Major Opportunities by Country
- Some Caveats to the MAC Curve
- Key Takeaways
What are the Key Questions?

- What is the potential for methane emissions reduction at a country level?
- What control technologies are available?
- How well do they work, i.e. control efficiency?
- What percentage of equipment is already controlled?
- What do these technologies and practices cost?
MAC Curve Concept

- Amount Reduced
- Area shows total cost
- Cost per Mcf
- Savings per Mcf
MAC Curve Development Methodology

- Developed a baseline emissions inventory by emissions source and segment
  - Source level emissions inventory allows for allocation of specific mitigation measures; over 100 sources analyzed across 9 segments
  - Used activity data specific to each country, such as well count, compressor count, etc.
  - Used latest country specific emissions factors where available

- Projected base year emissions to 2018 to evaluate emissions mitigation potential

- Identified a list of methane emissions mitigation measures and assigned them to relevant emission sources
  - List includes over 20 mitigation measures
  - Estimated level of control currently in place
  - Determined the applicability of new controls to uncontrolled sources

- Developed estimates of capital, maintenance, and operational costs for each mitigation measure
  - Local cost factors included when analyzing different regions

- Determined annualized cost of implementing mitigation measures per unit reduction of emissions ($ annualized cost per Mcf methane emissions reduced)
2018 U.S. Onshore Methane Emissions by Source

Top 22 sources ~ 80% of emissions

- Reciprocating Compressor Fugitives: 13.3%
- High Blood Pneumatic Devices: 7.1%
- LDC Meters and Regulators: 7.1%
- Centrifugal Compressors (wet seals): 5.9%
- Gas Engine Exhaust: 5.5%
- Well Fugitives: 5.1%
- Reciprocating Compressor Rod Packing: 4.3%
- Liquid Unloading - Wells w/ Plunger Lifts: 3.3%
- Intermittent Bleed Pneumatic Devices: 3.2%
- Intermediate Blow Pneumatic Devices - Dump Valves: 1.9%
- Stranded Gas Venting from Oil Wells: 2.1%
- Flares: 2.2%
- Oil Tanks: 2.8%
- Killray Pumps: 2.9%
- Oil Well Completions - with Fracturing: 1.7%
- Intermittent Bleed Pneumatic Devices - Dry Seals: 1.6%
- Mains - Cast Iron: 1.6%
- Mains - Plastic: 1.6%
- Transmission Station Venting: 1.5%
- Chemical Injection Pumps: 1.5%

Other 105 Sources: 17.7%

Total = 404 Bcf Methane

Economic Analysis of Methane Emission Reduction Opportunities in the On-Shore Oil and Natural Gas Industries - 2014
U.S. Sector-wide Abatement Cost Curve

Recovered Gas at $4/Mcf

Source: Reduction Measure

LDC Meters and Regulators--LDAR
Reciprocating Compressor Rod Packing--Rod Packing
Well Fugitives--LDAR
Compressor Stations (Transmission)--LDAR
Oil Well Completions--with Fracturing--Flares
Intermittent Bleed Pneumatic Devices--Low Bleed
Gathering and Boosting Stations--LDAR
Transmission Station Venting--Gas Capture
Liquids Unloading--Uncontrolled--Plunger Lift
Chemical Injection Pumps--Solar Pumps
Pipeline Venting--Pump-Down
Oil Tanks--VRU

Stranded Gas Venting from Oil Wells--Flares
Reciprocating Compressor Fugitives--LDAR
High Bleed Pneumatic Devices--Low Bleed

Total 163 Bcf methane reduced
40% of onshore emissions
Net cost $108 M/year
$0.66/Mcf of methane reduced
Less than $0.01/Mcf of natural gas produced
Mexico Sector-wide Abatement Cost Curve

Recovered Gas at $61.6 MXN/Mcf

Total 12.2 Bcf methane reduced
54% of total emissions
Net cost $MXN 0.34M/year
$MXN 0.89/Mcf of methane reduced
Less than $MXN 0.01/Mcf of natural gas produced
Canada Sector-wide Abatement Cost Curve
Major Reduction Opportunities by Segment

- United States
- Canada
- Mexico

- Oil Production - Offshore
- Gas Distribution
- Gas Transmission
- Gas Production
- Oil Production
- Gathering and Boosting
- LNG
- Gas Storage
- Gas Processing
Some Caveats to the MAC Curve

- The MAC curves provide average economics of mitigation measures
  - Site specific economics will vary depending on equipment sizing, emissions reduction potential, type of control option, price of gas, etc.

- New data has been published that can improve the baseline inventory

- U.S. MAC was analyzed with base year 2011; companies have implemented control measures since that may not be reflected in the MAC curve

- Projections in year 2018 were made using certain assumptions on crude oil and gas prices
Key Takeaways

- **MAC curves indicate significant potential for methane emissions reductions**
  - 232 Bcf in North America (or 111.7 million metric tonnes CO$_2$e)

- **MAC curve can be developed in multiple layers and levels - country, state, basin, company, segment, source, etc.**

- **Better characterization of certain emission sources will better inform level of reductions achievable**
  - E.g. Pneumatic device bleed and actuation emissions characterization and rod packing emissions profile over time

- **Not all emission sources have cost-effective mitigation options**
  - Cast-iron replacement
  - Intermittent pneumatic devices

- **Power grid access or renewable energy can mitigate emissions through electrification**
Key Takeaways

- Ultimately, the best solutions are site-specific

Example: Replace Wellhead Pneumatics

- Tank Emissions
- MicroTurbine
- Solar (and Battery Pack)
- Air Compressor
- Power
- Pneumatic Devices
- Capture Tank Vapors
- Instrument Air
- Solenoid OR Servo Motor
ICF MAC Curve Report Links

- **United States**
  - [https://www.edf.org/sites/default/files/methane_cost_curve_report.pdf](https://www.edf.org/sites/default/files/methane_cost_curve_report.pdf)

- **Canada**
  - [https://www.edf.org/sites/default/files/content/canada_methane_cost_curve_report.pdf](https://www.edf.org/sites/default/files/content/canada_methane_cost_curve_report.pdf)

- **Mexico**
  - [https://www.edf.org/sites/default/files/mexico_methane_cost_curve_report.pdf](https://www.edf.org/sites/default/files/mexico_methane_cost_curve_report.pdf)
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