NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Improving Heavy Oil Production through Solvent Conservation and Emission Mitigation

Heavy Oil Working Group

September 22nd, 2015

Bogotá, Colombia

Emissions mitigation and solvent recovery present an opportunity in heavy oil operations…

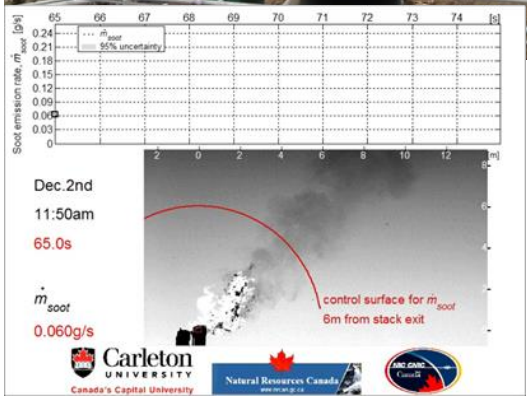
- Flaring, venting and fugitive emissions are a growing global concern
  - Several countries committing to more stringent methane and VOC regulations – incl. Canada
  - Flaring is being targeted for reduction internationally

- Technology and practices can reduce these emissions and provide benefits
  - Recovery of methane and hydrocarbon solvent commodities
  - Cost saving energy management options

…CanmetENERGY-Devon and partners develop technologies and practices…

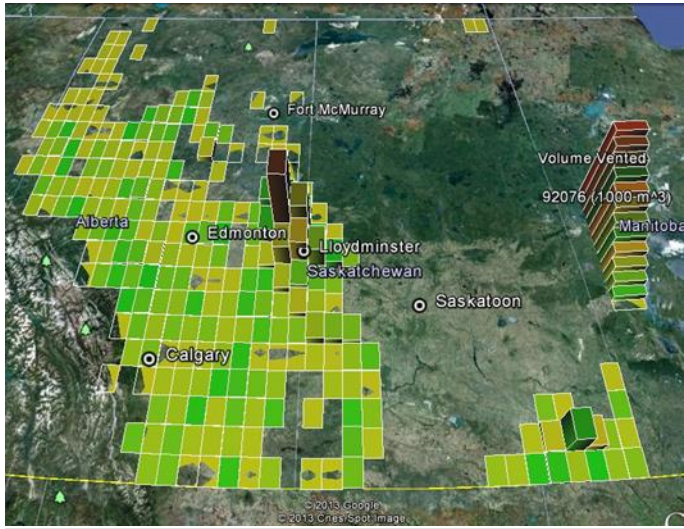
- Canadian partnerships **demonstrate technologies** to economically improve hydrocarbon recovery, emissions reduction, and energy management
  - **Optical technologies** for methane and solvent commodity quantification from vent and flare streams
  - **Gas and liquids recovery** technologies and practices that increase energy and solvent availability
  - **Energy and process management** systems to optimize energy integration and reduce emissions

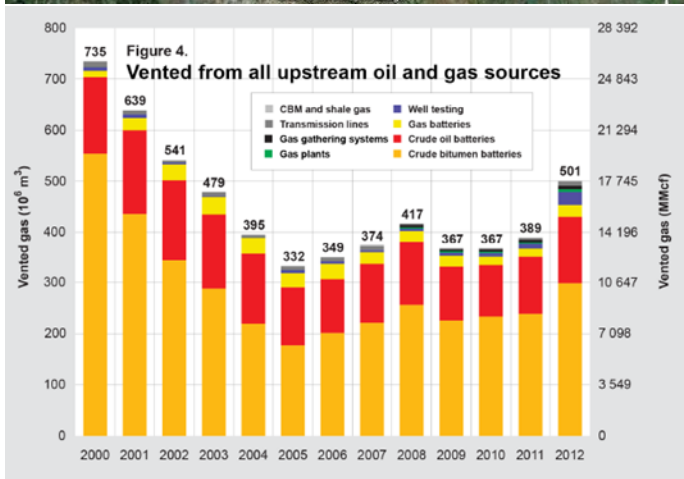
- **Plume monitoring technology** to quantify black carbon PM2.5 emissions from flaring rich gases



…and identify opportunities and best practices for oil and gas operations domestically…

- Developed a comprehensive techno-economic analysis process based on:
  - Thorough evaluation of **current technology, practices, and cost** of technically achievable opportunities to reduce emissions
  - Assessment for **available "cost effective" options** that facilities or jurisdictions can prioritize for immediate emission reductions
  - Ongoing research to **enlarge the suite** of available "cost effective" technology and practice options for industry and government – in partnership with regulators, academia and industry





…and internationally with PEMEX in Mexico…

- **Partners**: PEMEX Refinacion and PEMEX Exploración y Producción (PEP)
- **Refinery Assessment - 2012-13 NAMA projects:**
  - Flaring Reductions: 1.3 Mt/yr GHG reduction and US $237 M/yr avoidable commodity losses
  - Fugitive Steam Losses: 22 Kt/yr GHG emissions reductions and $18.9 M/yr avoidable energy use
  - Switching flare assist (steam to compressed air): 15.7 Kt/yr GHG emission reduction and $1.3 M/yr avoidable energy use
- **PEP - Summer 2015 CCAC projects:**
  - Projects: Significant CAPEX currently being allocated for methane and solvent recovery from gas streams
  - Opportunity: US $84 million annual commodity recovery and 8.2 Mt GHG reduction over life of control technologies

…and heavy oil producers in Colombia.

- **Partner**: EcoPetrol
- **Heavy Oil Battery - 2012-13 NAMA projects:**
  - Flaring & Venting: 211 Kt/yr GHG reduction and US $50 M/yr avoidable commodity losses
  - Cost & Payback period: Capital costs of assessed opportunity is US $24.6 million and the payback period is 6 months

- **Partners:** Pacific E&P and Mansarovar
- **Summer 2015 CCAC projects:**
  - June 2015 technology workshop with government and industry
  - August 2015 energy and emissions measurement & prefeasibility study

Continuing research to develop new practices and technologies

- Partnership with academia to **further developing key measurement and sensor technology** to better assess:
  - Storage tank venting (optical methane and VOC measurement technology)
  - Flares and PM2.5 / black carbon emission rates (optical camera)
  - Continuous detection and source location of fugitive methane and VOC emissions (sensor development)

- Collaborating with industry researchers to **develop management practices and technologies** to address:
  - Energy inefficiencies and hydrocarbon products losses (process controls)
  - Turn waste gas into condensable hydrocarbon solvent (recovery system)
  - Improve economic, energy, & emission evaluation (management systems)

Opportunities for Collaboration

- Collaboration under **international climate or clean energy partnerships** to advance technology and practice development and deployment
  - UNEP Climate and Clean Air Coalition (CCAC)
  - Global Methane Initiative (GMI)
  - Intergovernmental Panel for Climate Change (IPCC)

- Collaboration between **national environmental** and **energy laboratories and petroleum research institutes** to advance technology and method development

Thank You!

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