Techno-Economics of Methane Mitigation at Oil Sites in Alberta

Implications for Achieving Reductions

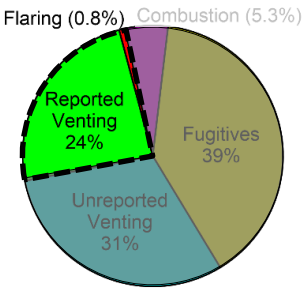
Carleton UNIVERSITY
Canada's Capital University

eerl ENERGY AND EMISSIONS RESEARCH LABORATORY

David Tyner, Ph.D.
Prof. Matthew Johnson, Ph.D., P.Eng.
EERL Methane Symposium
November 21, 2017

2015 Methane Emissions

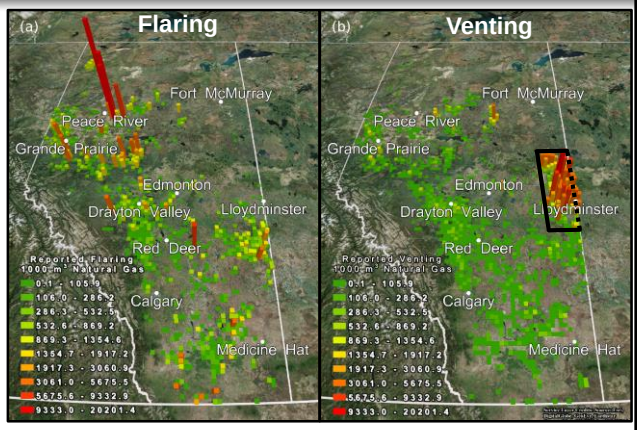
- ECCC 2015 Alberta total ≈ 1.06 $MtCH_4$ (26.4 $MtCO_2e$)
- Methane from **reported flaring and venting** in Alberta totalled 254 $ktCH_4$ in 2015
- 90% of reported CH_4 emissions from conventional oil sites



2

2015 Reported Flaring and Venting at Oil Sites

- 9422 oil sites
  - 1/3 heavy oil
- Reported flaring
  - 401 million m^3
  - 53% of AB total
- Reported venting
  - 353 million m^3
  - 91% of AB total
  - 2/3 of AB total in 97 km × 233 km box
- Distinct flaring and venting regions



3

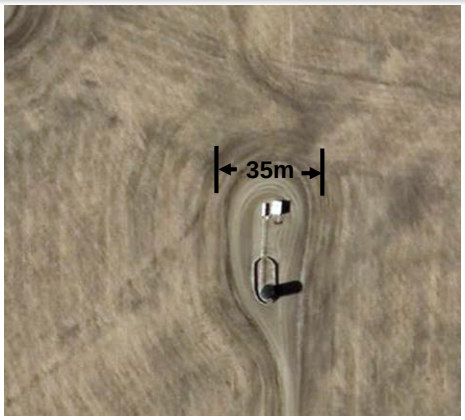
Techno-Economic Objectives

Consider **reporting** flaring and venting at "conventional" oil sites

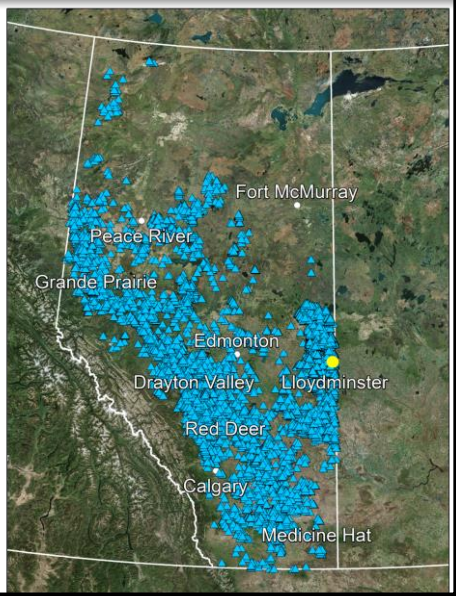
- Assess feasibility of reducing methane
  - Cost?
    - Site-by-site economics (NPV) over a range of available technologies
  - Effectiveness?
    - Cost on $/t$CO_2$e basis
  - Uncertainty?
    - Monte Carlo simulations
  - Sensitivity to inventory estimates?

4

Conventional Oil includes Small Sites

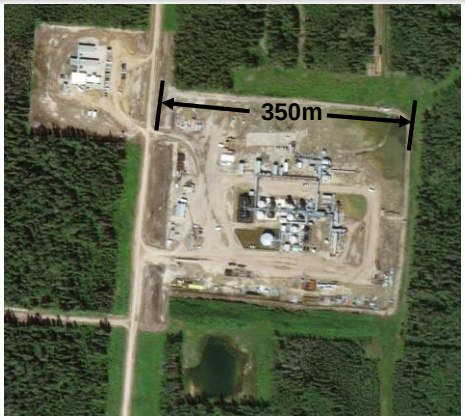


- CHOPS well site near Lloydminster

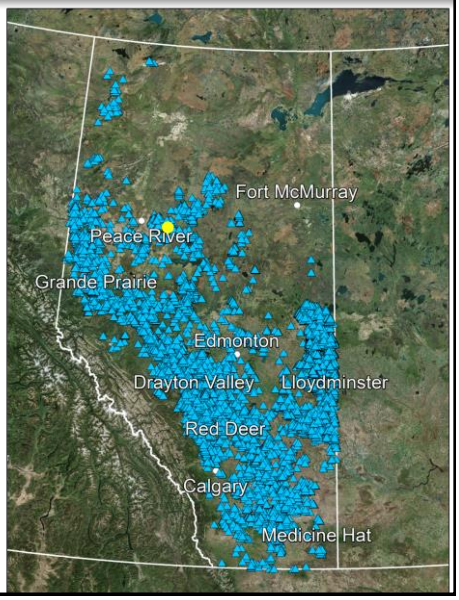


5

Conventional Oil includes Big Sites



- Crude Bitumen Multi-well Proration Battery near Peace River (Seal Lake)



6

Reported CH_4 Emissions at Big and Small Sites

Crude Bitumen Multi-well Proration BT

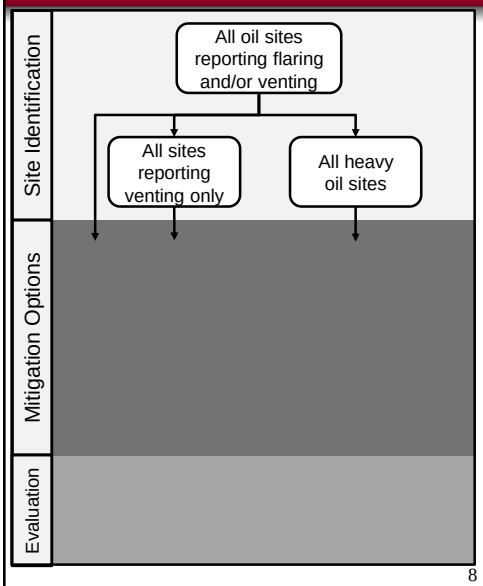
- 166 wells, pipelines on-site
  - ~143,400 m^3 Oil Produced
  - ~7.6 million m^3 gas **flared**
  - ~$820,000
- Reported ~16 kg CH_4/hr
- CO_2e basis: 3700 – 5800 cars

CHOPS well

- 1 well, nearest pipeline ~1 km
  - ~234 m^3 Oil Produced
  - ~0.57 million m^3 gas **vented**
  - ~$63,000
- Reported ~43 kg CH_4/hr
- CO_2e basis: 2000 – 7600 cars

7

Techno-Economic Methodology

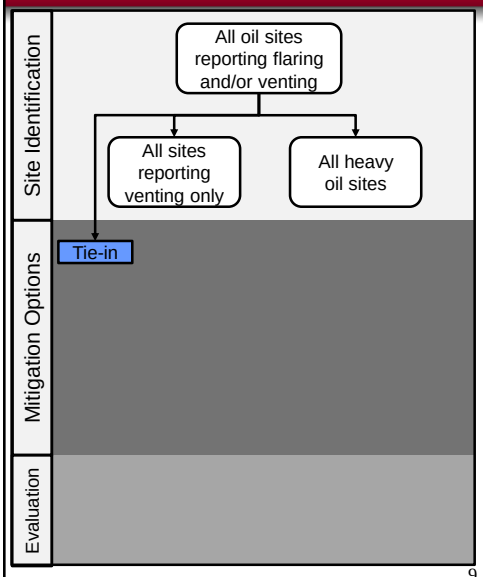


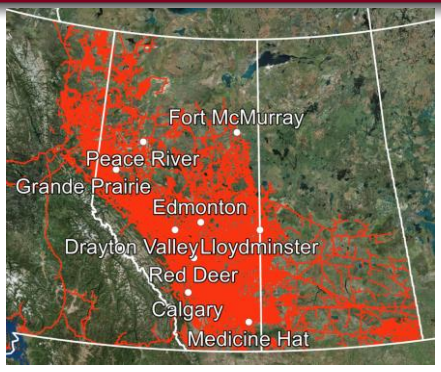
Base input parameters

- Economic
  - Inflation, StatCan 1.3%
  - Discount rate, ATB + 3%,
  - Project life, 10 years
  - Gas and propane pricing
    - GLJ Petroleum Consultants
  - Equipment capital costs
    - Clearstone Engineering Ltd.
    - Operating Costs, 7%-10%
    - Salvage value $0
- Site
  - Site specific composition
  - Light/Heavy decline rates
  - Flare, vent and fuel volumes

8

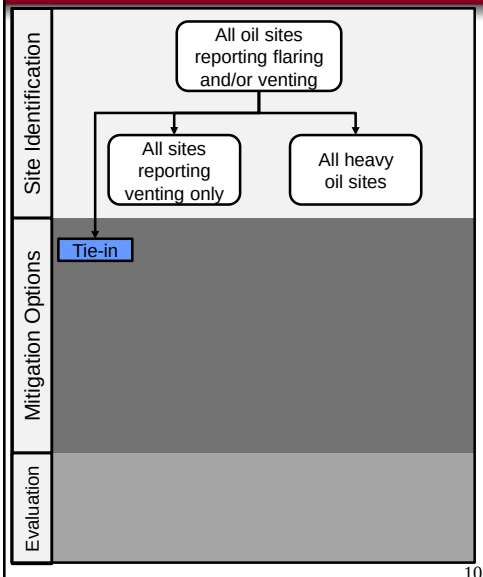
Techno-Economic Methodology





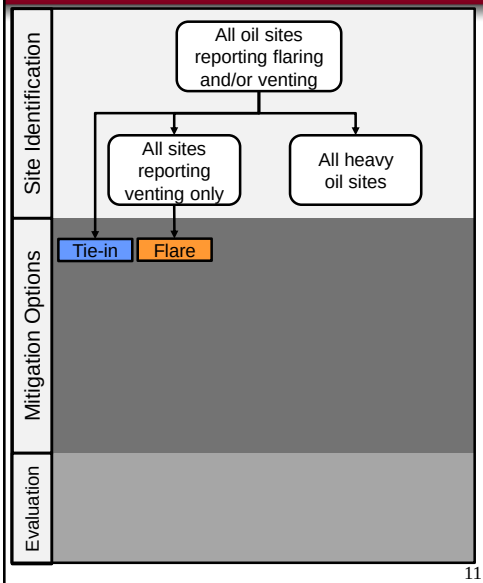
9

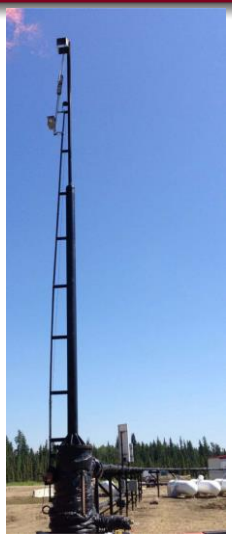
Techno-Economic Methodology



10

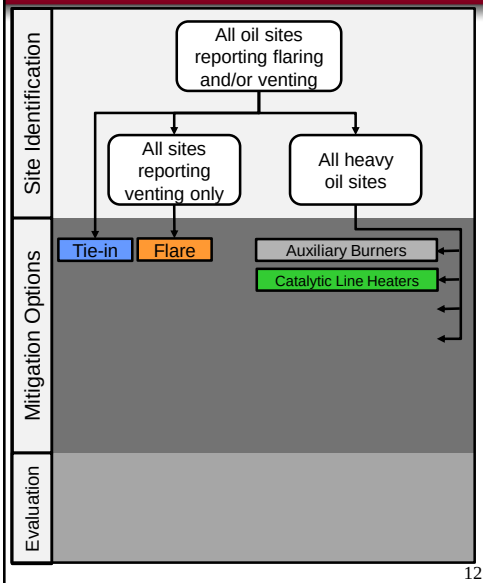
Techno-Economic Methodology





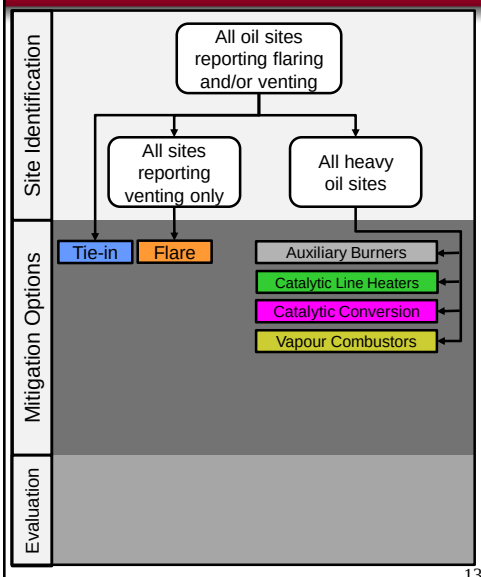
11

Techno-Economic Methodology



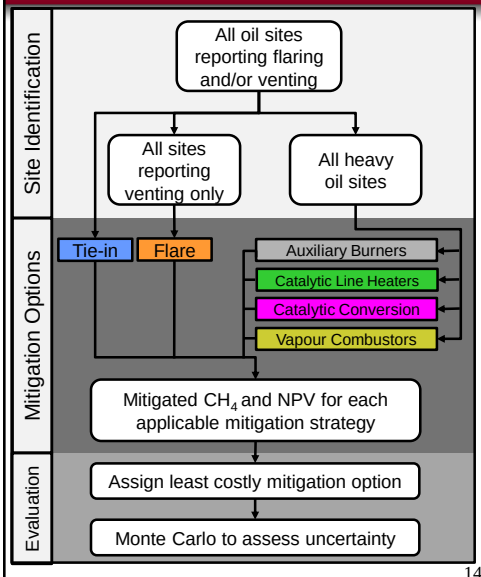
12

Techno-Economic Methodology



13

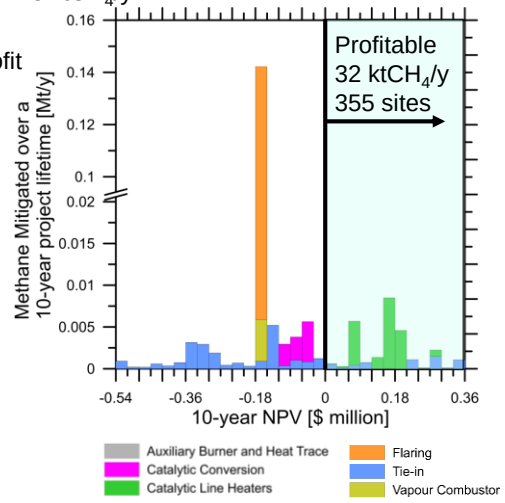
Techno-Economic Methodology



14

NPV results

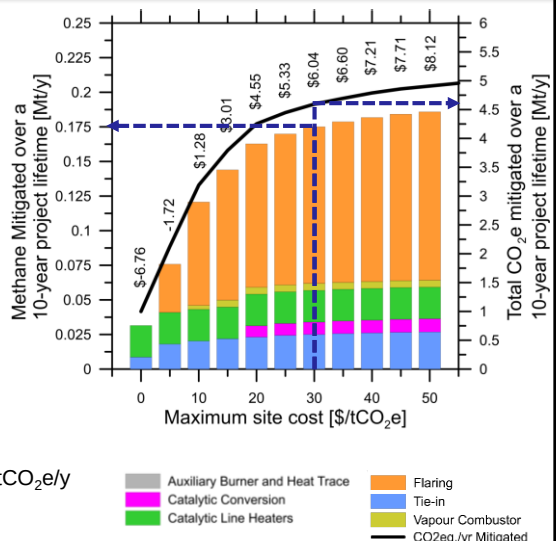
- Average base methane emission 225 $ktCH_4/y$
- 14% reduction at oil sites at a profit
  - 4% of sites
  - Total profit $68 million
  - Site NPV $0 to $3.2 million
- Mitigation at 96% of sites will cost money



15

Mitigation on a $/tCO$_2$e basis

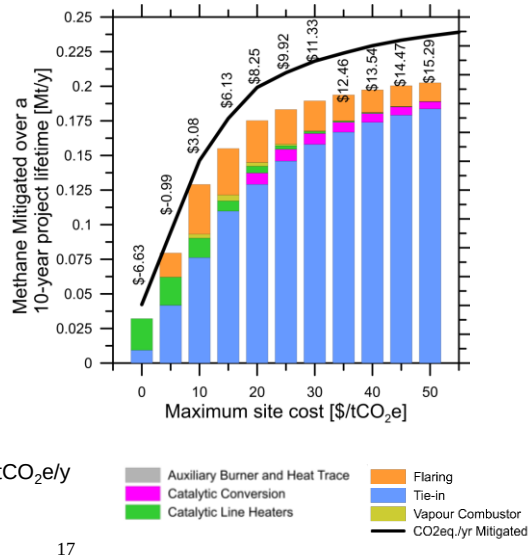
- With **No** site pays > $30/tCO$_2$e in mitigation costs
  - Impacts 29% of sites
- 175 $ktCH_4/y$ mitigated
  - GWP 25 ➡ 4.4 $MtCO_2e/y$
- 4.6 $MtCO_2e/y$ mitigated
  - Average cost ~$6/tCO$_2$e
- Methane destruction over conservation
- Regulations incentivizing tie-in
  - Increases mitigation to 5.24 $MtCO_2e/y$
  - Reduces flaring
  - ~2X cost



16

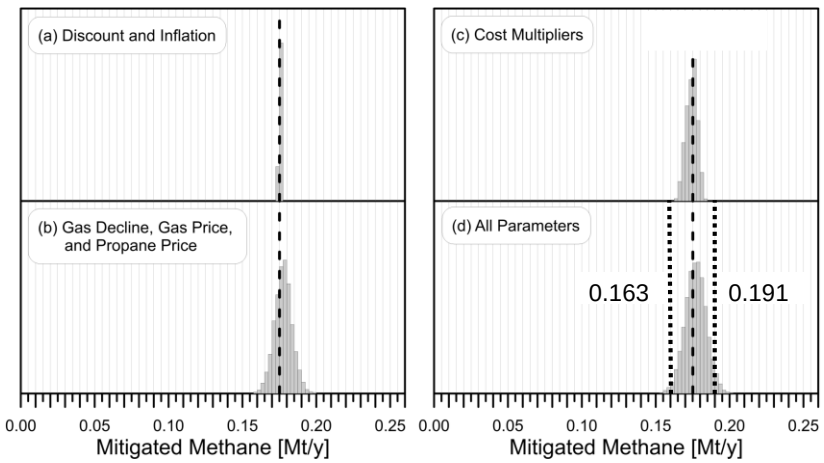
Mitigation on a $/tCO$_2$e basis

- With **No** site pays > \$30/tCO$_2$e in mitigation costs
  - Impacts 29% of sites
- 175 ktCH$_4$/y mitigated
  - GWP 25 ⟹ 4.4 MtCO$_2$e/y
- 4.6 MtCO$_2$e/y mitigated
  - Average cost ~\$6/tCO$_2$e
- Methane destruction over conservation
- Regulations incentivizing tie-in
  - Increases mitigation to 5.24 MtCO$_2$e/y
  - Reduces flaring
  - ~2X cost



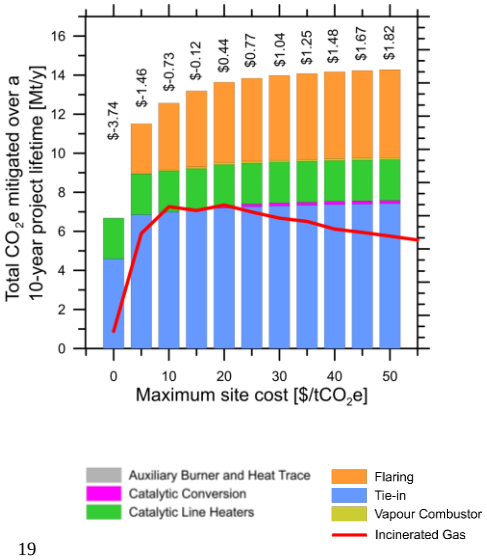
17

Mitigation on a $/tCO$_2$e basis



Inventory Sensitivity

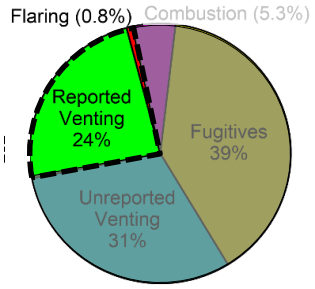
- Reported CHOPS venting increased by ~5x to match recent airborne measurements
- Mitigation potential ~3x greater at $30/tCO$_2$e
  - 259 sites switched to tie-in from flaring
    - 20x more gas conserved at heavy oil sites
  - 550 new sites flaring



19

The big picture: Provincial Reductions

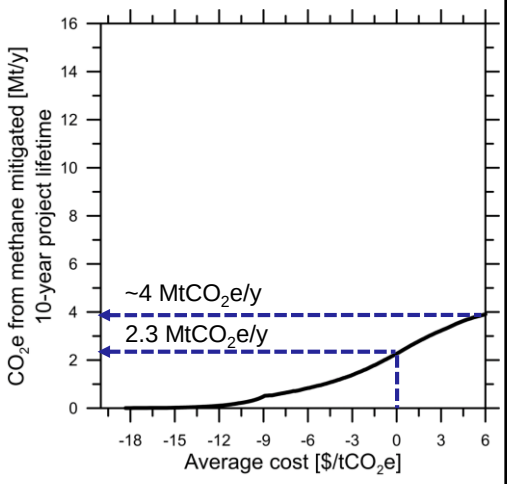
- ECCC methane inventory for Alberta (excluding mined oil sands)
  - ECCC total ≈ 26.4 MtCO$_2$e
    - Reported sources ≈ 6.5 MtCO$_2$e



20

The big picture: Provincial Reductions

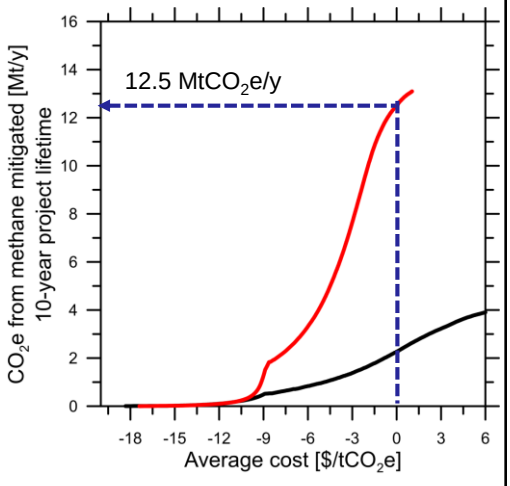
- ECCC methane inventory for Alberta (excluding mined oil sands)
  - ECCC total ≈ 26.4 $MtCO_2e$
    - Reported sources ≈ 6.5 $MtCO_2e$
- With **No** site paying > \$30/tCO_2e in mitigation costs
- Current reported venting
  - Average cost of \$6/tCO_2e
    - 15% reduction overall
    - Net cost 277 million
  - Average cost of \$0/tCO_2e
    - 9% reduction overall
    - **44.6% reduction at oil-sites**



21

The big picture: Provincial Reductions

- ECCC methane inventory for Alberta (excluding mined oil sands)
  - ECCC total ≈ 26.4 $MtCO_2e$
    - Reported sources ≈ 6.5 $MtCO_2e$
- With **No** site paying > \$30/tCO_2e in mitigation costs
- Accounting for increased venting at CHOPS sites
  - New total ≈ 36.9 $MtCO_2e$
  - Average cost of \$0/tCO_2e
    - 34% reduction overall
    - 71% reduction at oil-sites



22

Implications

- Mitigation of **reported venting** at oil sites is technically and economically viable
- Larger volumes suggested by recently published airborne measurements improve economics
- >45% reductions in methane **from reported venting** are possible at conventional oil sites
  - Achievable at minimal **net** cost and <$30/t$CO_2$e at all sites
  - Represents overall reduction of 9% in *current* inventory
  - Represents overall reduction of 34% in *corrected* inventory
- Mitigation opportunities for remaining 75% of methane in current inventory should be considered separately

23

Acknowledgements

NSERC CRSNG

Natural Resources Canada

Carleton UNIVERSITY
Canada's Capital University

eerl ENERGY AND EMISSIONS RESEARCH LABORATORY

More information at:
Website: https://carleton.ca/eerl
Email: David.Tyner@Carleton.ca
Matthew.Johnson@carleton.ca

24