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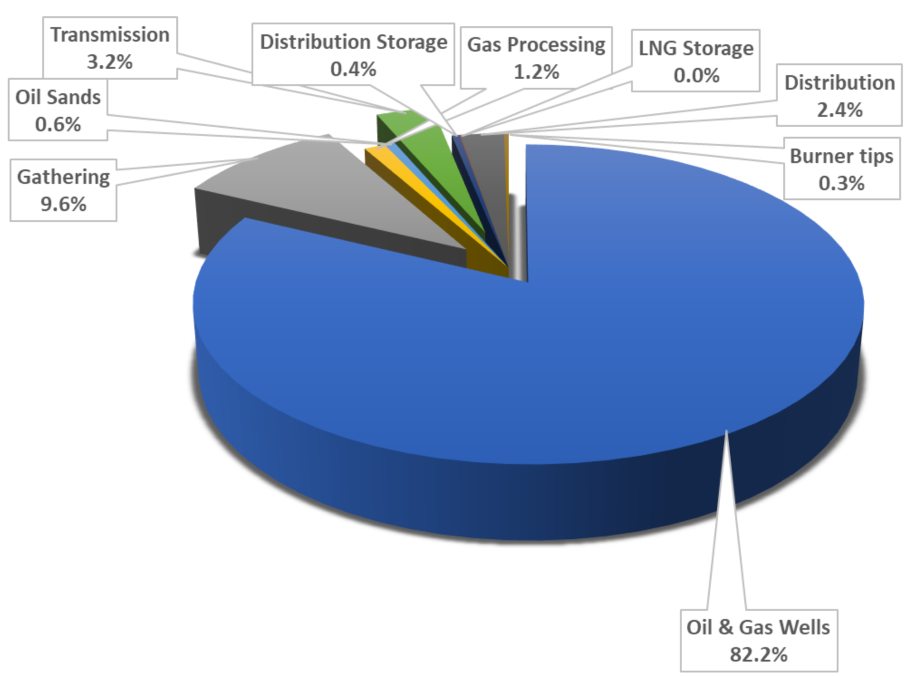
ECONOMIC AND ENVIRONMENTAL IMPACTS OF METHANE EMISSIONS REDUCTION IN THE NATURAL GAS SUPPLY CHAIN

Executive Summary

The Canadian government, along with some provincial governments, have set policies to cut methane emissions from between 40-45% of baseline value by the year 2025. Baselines might differ between governments, but the overall targeted reductions by Canada are about 25 Mt CO_2e of methane emissions by 2025. The gas supply chain can be broadly divided into upstream, midstream and downstream sectors where sources of methane emissions are identified, and mitigation technologies are assessed from wellhead to burner-tip. Methane emissions from the sectors can be further grouped into source categories such as fugitives,[i] flared,[ii] vented,[iii] line heating,[iv] and burner-tip.[v]

In line with the ongoing debate on the economic and environmental impacts of methane emissions from natural gas supply chains, the Canadian Energy Research Institute (CERI) developed a modelling tool, the Integrated CH_4 Emission Reduction Model (ICERM), with the objective to quantify methane emissions and assess reduction opportunities covering end-to-end of the Canadian natural gas supply chain. CERI used ICERM to quantify methane emissions from the Canadian natural gas supply chain in 2017 to be 40.4 Mt CO_2e. Figure E.1 details the emissions along the entire value chain for natural gas.

Figure E.1: Overall Canadian Methane Emissions from Natural Gas Supply Chain Sources



[i] A leak or unintentional release of methane emissions
[ii] Undestroyed methane at upstream sector from gas flaring due to incomplete combustion
[iii] Methane released intentionally to the atmosphere at upstream, midstream or downstream sector
[iv] Undestroyed methane at midstream sector from stationary combustion due to incomplete combustion
[v] Undestroyed methane at downstream end-user burners due to incomplete combustion

Western provinces with more upstream oil and gas activities generate more emissions than eastern provinces where natural gas demand may be high but supplied from other provinces. Alberta contributes more emissions than other provinces with an estimated total in 2017 of about 24.5 Mt CO_2e, of which the upstream sector is responsible for up to 97% of this number. These emissions are mainly from oil and gas wells and gathering facilities. The oil and gas wells emissions include methane emissions from all equipment at the wellhead and field operations. Like Alberta, the other western provinces (British Columbia, Saskatchewan and Manitoba) have higher upstream emission footprints with total estimated values of 2.2, 11.7, and 0.8 Mt CO_2e, respectively.

The optimization module in ICERM combines emission quantification and abatement cost data to evaluate emission reduction and economic impacts of various policy scenarios. This study evaluated three different hypothetical policy scenarios to achieve emission reductions by adopting various combinations of mitigation technologies. These scenarios are:

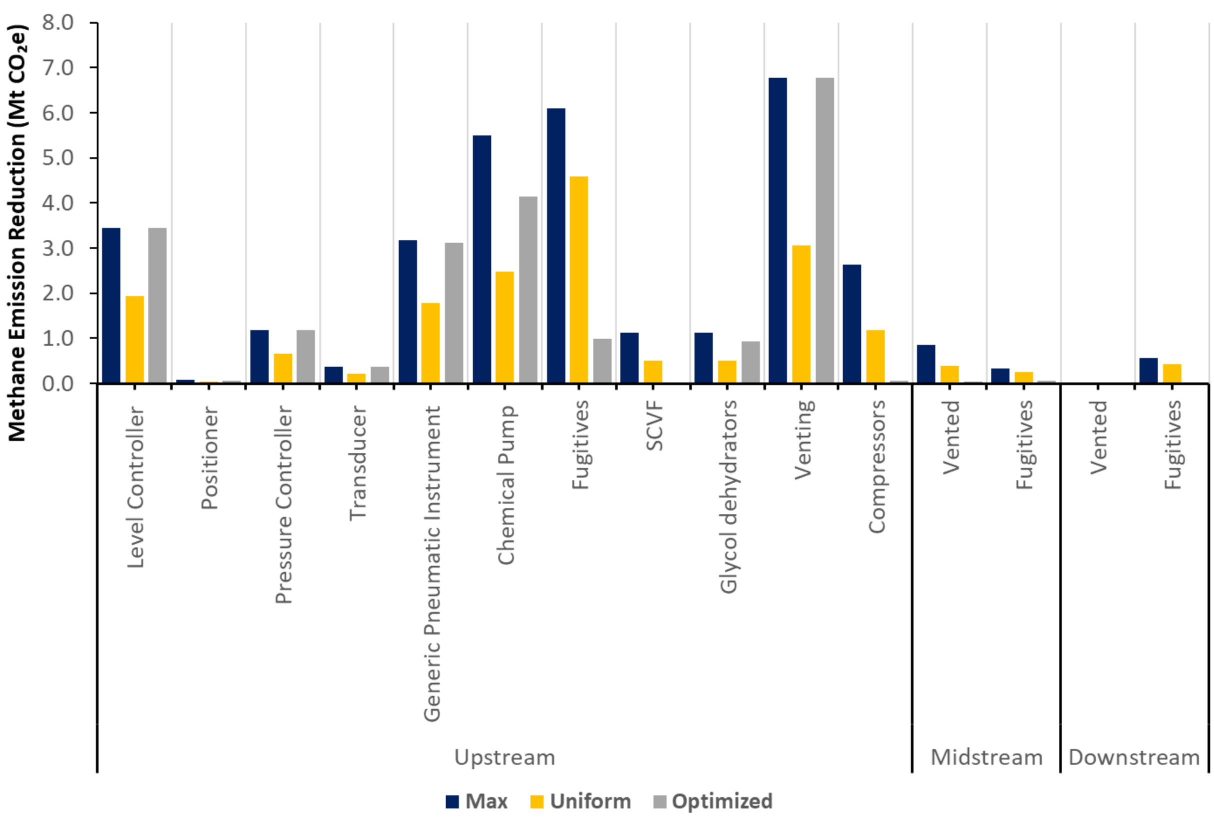
- **Maximum reduction**, which evaluated the economic cost and the maximum amount of emission reduction that can be achieved using the mitigation technologies assessed in this study.
- **Uniform reduction**, which evaluated the economic cost and emission reduction achieved if a 45% reduction target is assigned to each emitting device in the supply chain (except burner-tip emissions).
- **Optimal reduction**, which identifies a cost-effective mitigation pathway to reduce emissions to 45% of baseline levels as reported in the National Inventory Report (this scenario is created to mimic methane regulations in Canada).

These scenarios are applied to the entire Canadian natural gas supply chain. This contrasts with the existing federal and provincial regulations which place methane emission reduction targets mainly in the upstream sector. Figure E.2 shows methane emission reductions from each supply chain sector and emitting devices for the entire Canadian natural gas supply chain under the three hypothetical policy scenarios. In order to realize the most economic reductions in the optimal scenario, some of the emission source categories are omitted when choosing where mitigation should be deployed. These include emissions from midstream venting, upstream fugitives, compressors and surface casing vent flow. Optimal emission reduction is calculated from the average of the results obtained using the lower and upper ranges of the abatement costs. This scenario does not arbitrarily specify what emission sources should be controlled but uses linear programming to determine the cost-effective mitigation to meet expected reduction at both federal and provincial levels. For provinces with existing methane emissions regulations (such as British Columbia, Alberta, and Saskatchewan), the optimal scenario specifies methane emission reduction targets according to provincial baselines as reported in the National Inventory Report. For other provinces, federal methane regulation baseline year (2012) emissions are adopted.

Reductions in the maximum and uniform scenarios are predominantly from upstream venting, fugitives and pneumatic pumps. In the optimal scenario, reductions are mainly from upstream venting and pneumatic devices including pumps, controllers and generic instrumentation. Figure E.2 allows close comparison of emission reductions from each emission source category under the hypothetical policy scenarios. At the provincial level, optimal (45%) reduction of emissions is based on contributions to total Canadian methane emissions during 2012.

According to Figure E.2, mitigation of emissions from surface casing vent flow (SCVF) and compressors are not done in the optimal adoption scenario due to their higher abatement costs. Most emission reduction opportunities are identified from pneumatic, venting and fugitive sources under each mitigation scenario. Also, in line with the distribution of overall emissions across supply chain sectors, the upstream sector is the major source of the emissions where significant mitigation efforts are to be channelled to achieve deeper cuts in emission reductions.

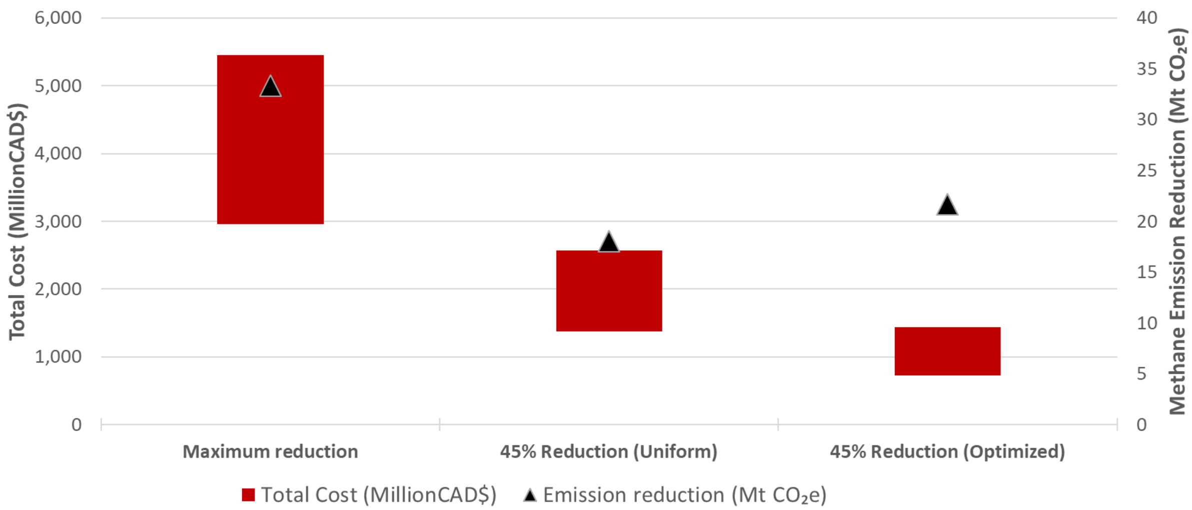
Figure E.2: Methane Emission Reduction from Various Emission Source Categories under the Three Hypothetical Policy Scenarios for Canada



Notes:
1) Each colour represents a hypothetical policy scenario. 2) Venting in this figure refers to non-routine, whereas routine venting is presented in terms of the emitting devices.

Figure E.3 presents a results summary showing total emission reductions and cost of achieving those reductions under the various abatement analysis scenarios for the entire Canadian natural gas supply chain. The provincial breakdown of these costs, along with the emission reductions, is presented in Chapter 4. For the three abatement scenarios, total cost of emissions reduction in the maximum reduction scenario is in the range of \$3.0 to \$5.5 billion,[vi] for a total methane emission reduction of about 33 Mt CO_2e. For the uniform scenario, the cost is in the range of \$1.4 to \$2.6 billion and total reduction of 18 Mt CO_2e, whereas the optimal reduction scenario achieves about a 22 Mt CO_2e emissions cut for a total cost range of \$0.7 to \$1.4 billion. We note that these do not include costs of administration, measurement and reporting which are required by existing methane regulations in Canada.

Figure E.3: Emission Reduction and Ranges of Total Cost of Abatement under the Three Hypothetical Policy Scenarios for the Entire Canadian Natural Gas Supply Chain



In comparison to existing methane regulations, Canadian federal regulation has a target of 40-45% reduction below 2012 levels by 2025. Canadian national inventory report data indicate that total methane emissions in that baseline year (2012) was 107.5 Mt CO_2e, of which about 51% (55 Mt CO_2e) was from oil and gas. Therefore, if the regulation covered all sectors of the natural gas supply chain for a reduction target of 45%, that would amount to about 25 Mt CO_2e. If our optimal reduction scenario applies the 2012 baseline reduction target across all provinces, the total cost of emissions reduction would be in the range of \$0.9 to \$1.7 billion. However, the federal regulation aims to achieve reductions from the upstream sector and transmission (midstream), so if the 45% reduction is applied to these components alone, the reduction target would be slightly below 25 Mt CO_2e given that most of the emissions are from upstream sector.

CERI acknowledges that more accurate data for modelling will become available over time as new field measurements are reported. Hence, future versions of ICERM will incorporate updated information in order to improve the accuracy of results.

[vi] All values throughout the report are in 2017 Canadian dollars.