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

CANADIAN ENERGY RESEARCH INSTITUTE

BACKGROUND

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 CO2e 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 well-head to burner-tip. Methane emissions from the sectors can be further grouped into source categories such as fugitives (a leak or unintentional release of methane emissions), flared (undestroyed methane at upstream sector from gas flaring due to incomplete combustion), vented (methane released to the atmosphere at upstream, midstream or downstream sector), line heating (undestroyed methane at midstream sector from stationary combustion due to incomplete combustion) and burner tip (undestroyed methane at downstream end-user burners due to incomplete combustion).

STUDY SCOPE

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 CH4 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.

ICERM has three modules for emission quantification, abatement cost analysis and optimized selection of mitigation technologies to meet emission reduction targets cost-effectively. CERI used ICERM to quantify methane emissions from the Canadian natural gas supply chain in 2017 to be 47.5 Mt CO2e. Figure E.1 (above) shows the distribution of emissions across supply chain sectors, while the emission sources are depicted in Figure E.2 (right).

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

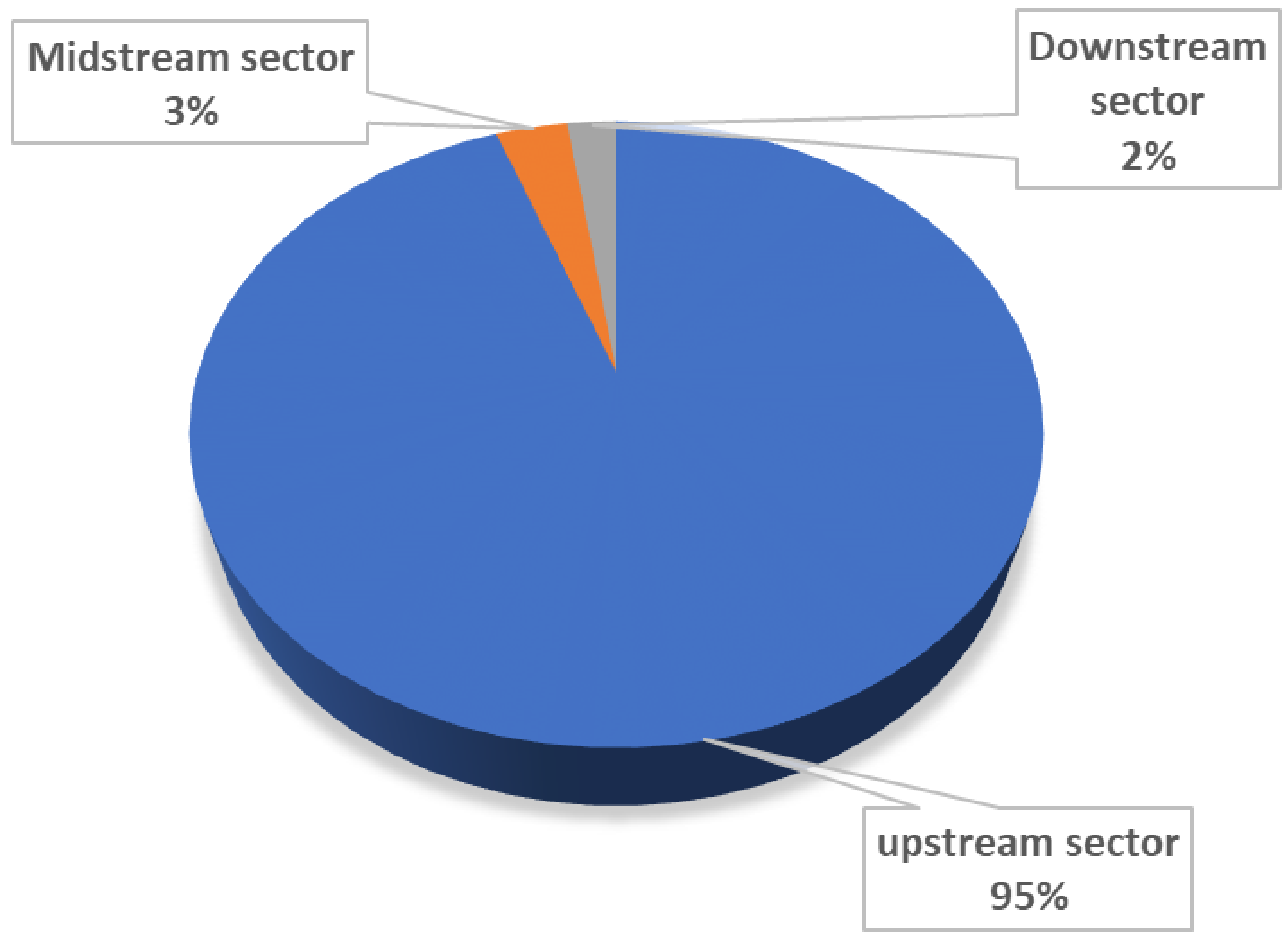
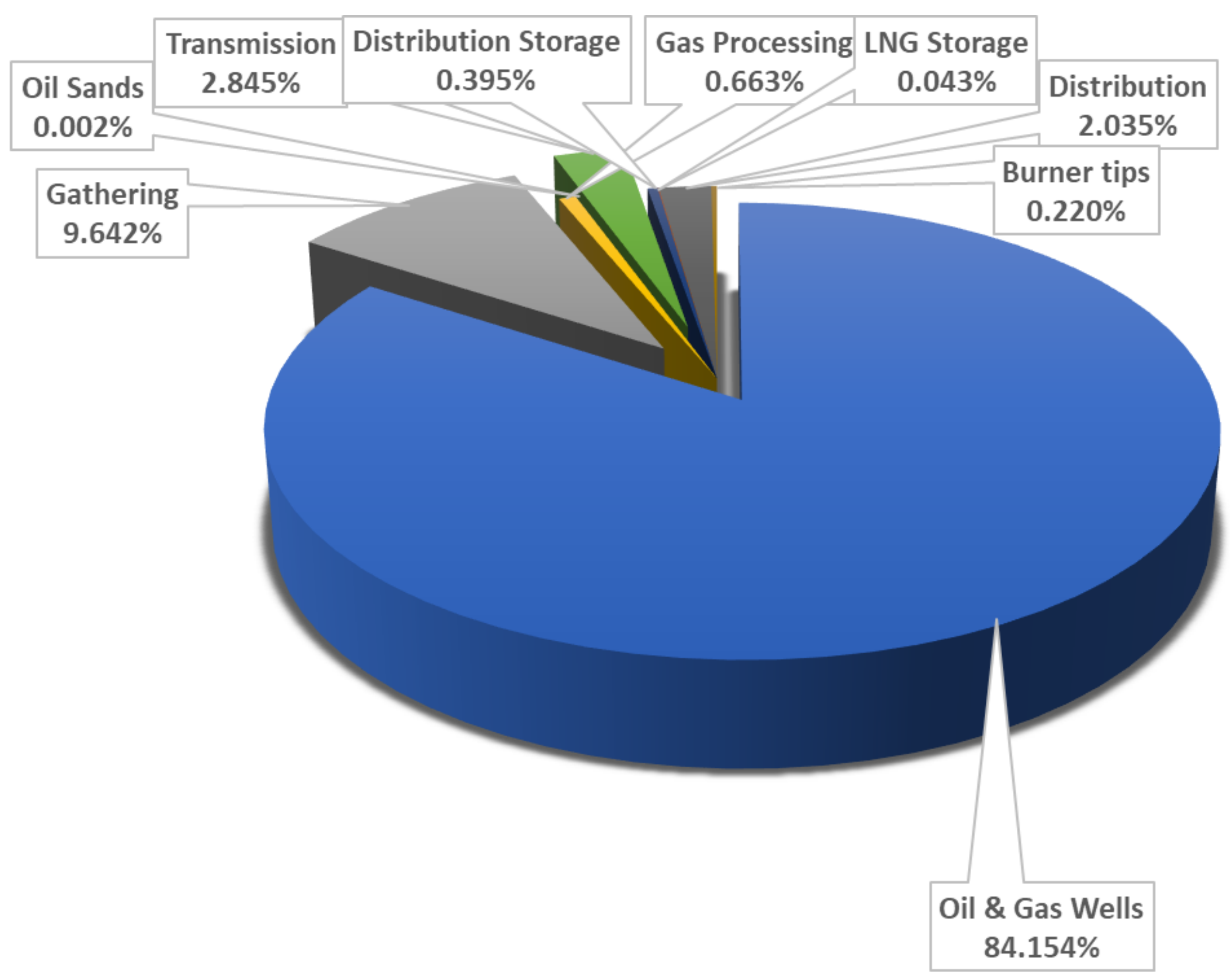


Figure E.2: Overall Canadian Methane Emissions from Natural Gas Supply Chain Sources



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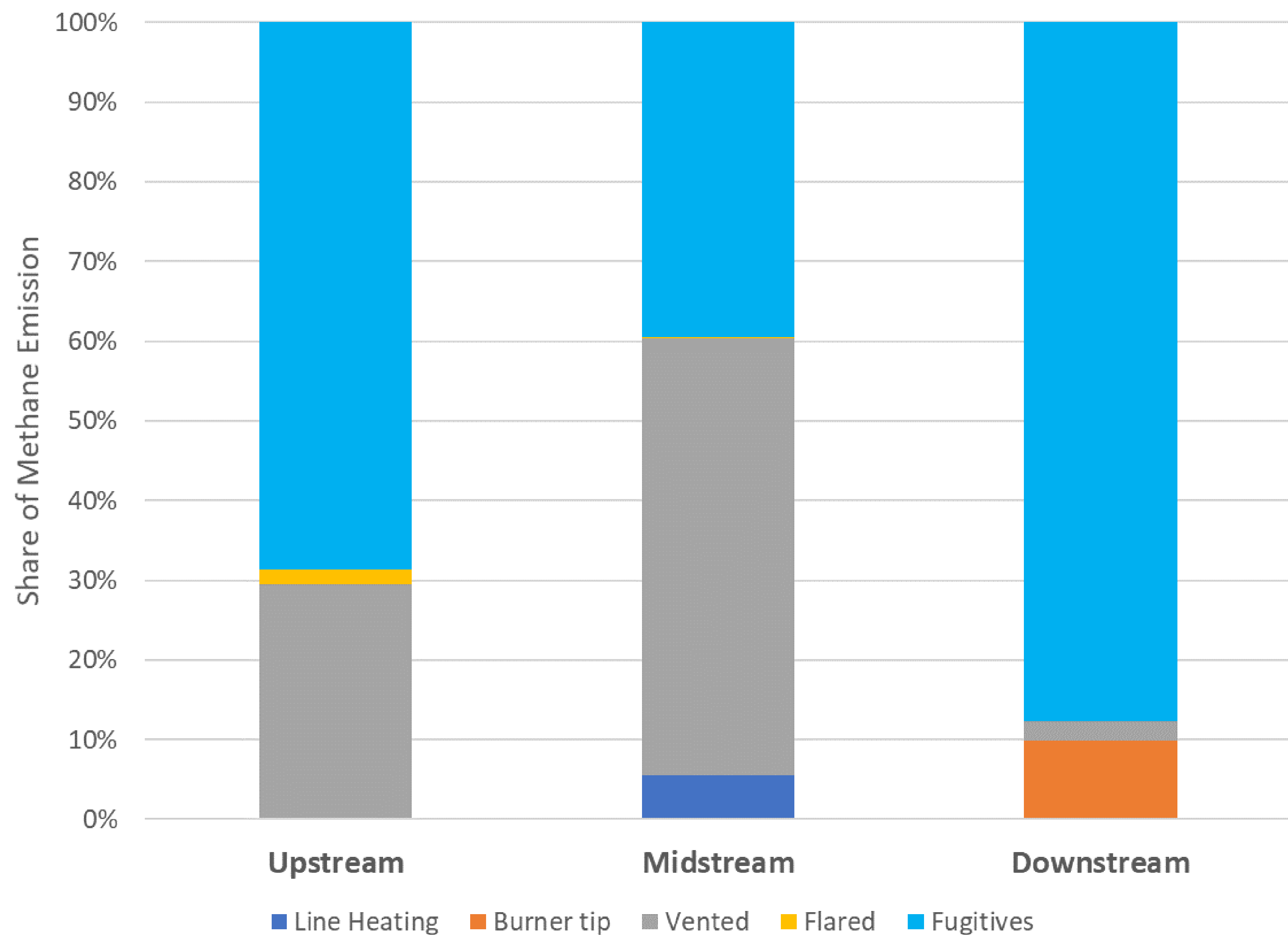
STUDY FINDINGS

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 25.4 Mt CO2e, of which the upstream sector is responsible for up to 96% of this number. These emissions are mainly from oil and gas wells and gathering facilities. Like Alberta, the other western provinces (British Columbia, Saskatchewan and Manitoba) have higher upstream emission footprints with total estimated values of 3.6, 16.2, and 1.3 Mt CO2e respectively.

Figure E.3 (right) shows sectoral emissions according to the source categories. Both upstream and midstream emissions from producing provinces are primarily of the fugitive and venting categories. The downstream emissions are mostly from the fugitive and burner-tip source categories, both representing about 95% of downstream releases in most cases.

Figure E.3: Overall Sectoral Methane Emissions by Source Category



HYPOTHETICAL SCENARIOS

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:

1. 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.

2. 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).

3. Optimal reduction, which identifies a cost-effective mitigation pathway to reduce emissions to 45% of 2012 levels as reported by Canada in the National Inventory Report (this scenario is created to mimic federal methane regulation).

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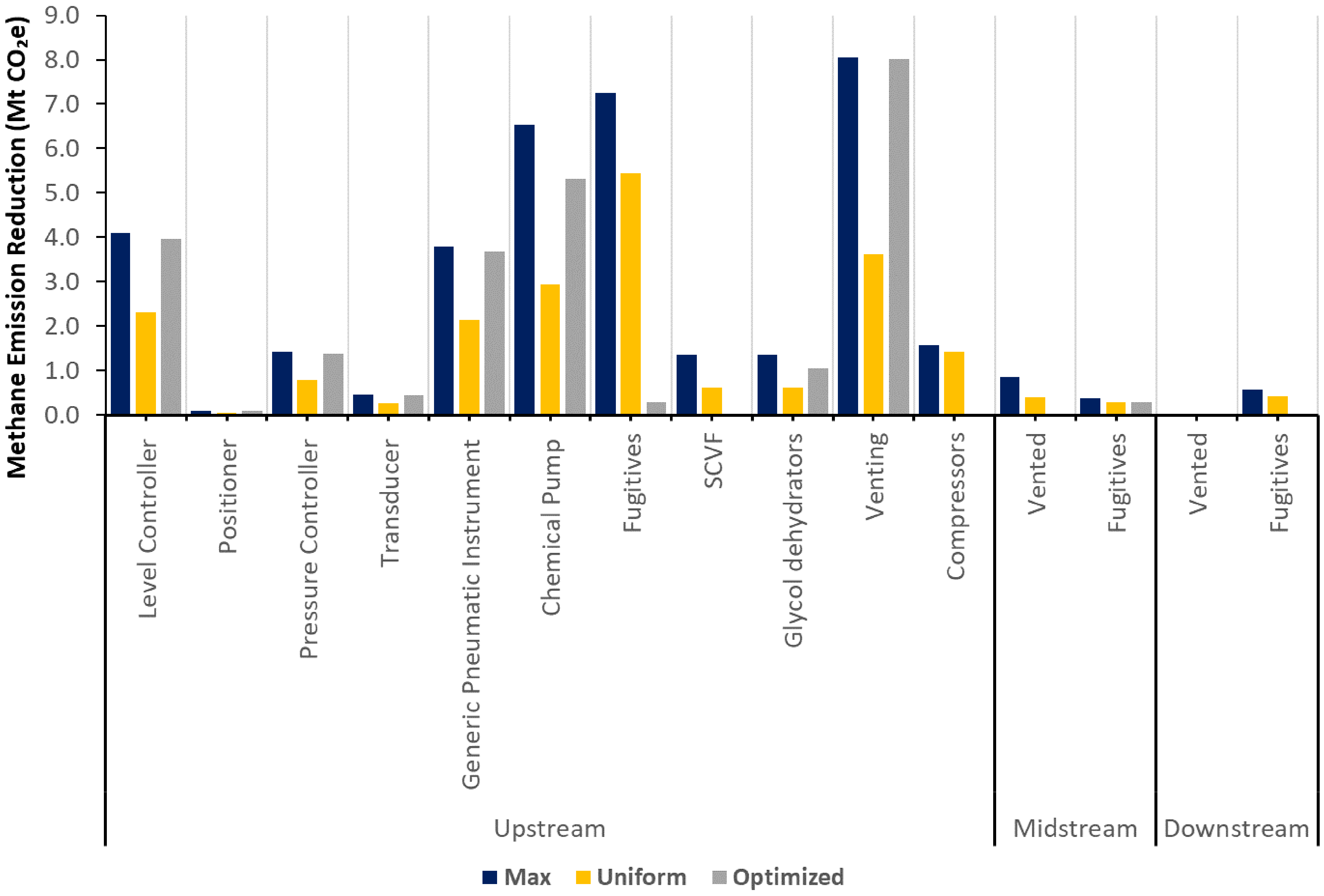
HYPOTHETICAL SCENARIOS

These scenarios are applied to the entire Canadian natural gas supply chain. This is in contrast to the existing federal and provincial regulations which place methane emission reduction targets mainly in the upstream sector. Figure E.4 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.

Figure E.4: Methane Emission Reduction from Various Emission Source Categories under the Three Hypothetical Policy Scenarios for Canada



Please note that in Figure E.4 (above), each colour represents a hypothetical policy scenario and venting refers to non-routine, whereas routine venting is presented in terms of the emitting devices.

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 the expected reduction at both federal and provincial levels.

The 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.4 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.4, 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.

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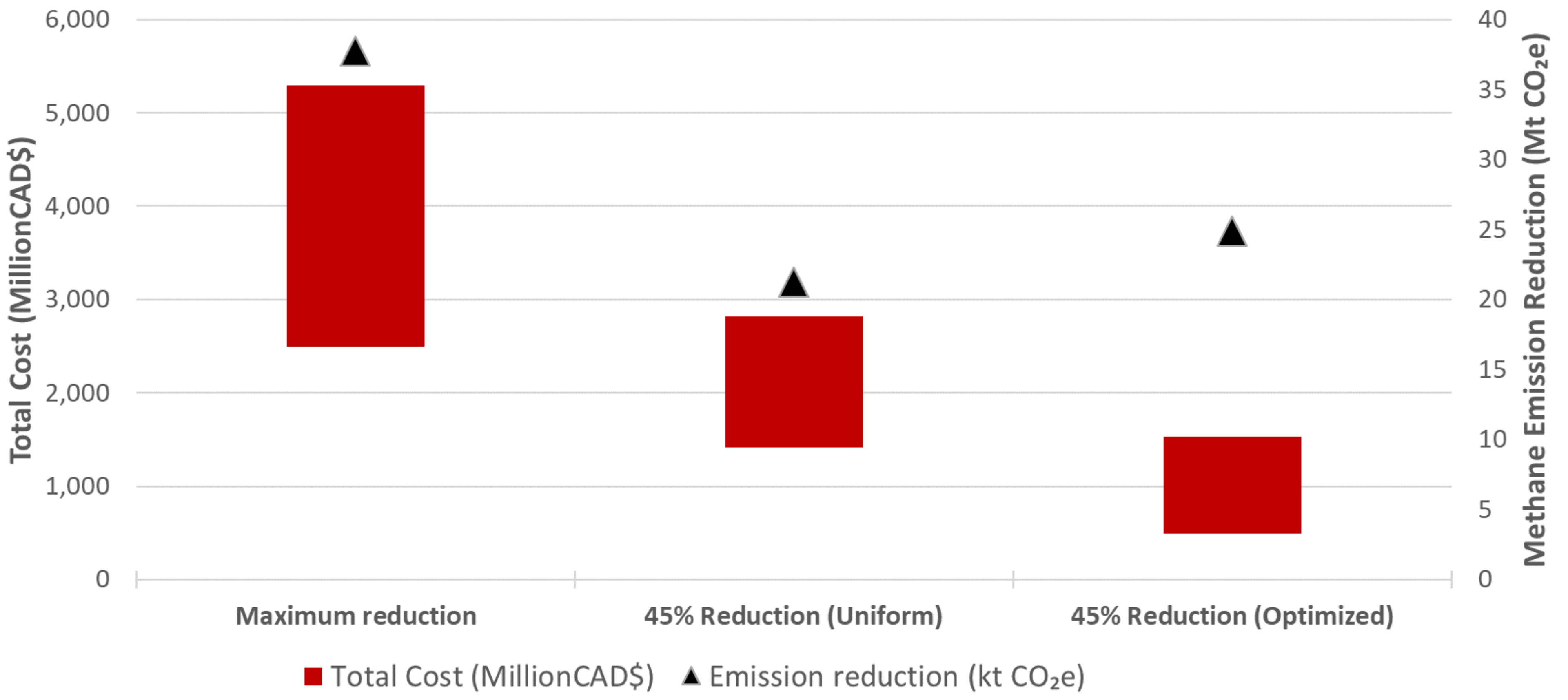
HYPOTHETICAL SCENARIOS

Figure E.5 (right) 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. Please see Chapter 4 of the full report for a provincial breakdown of these costs, along with the emission reductions.

Figure E.5: Emission Reduction and Ranges of Total Cost of Abatement under the Three Hypothetical Policy Scenarios for the Entire Canadian Natural Gas Supply Chain

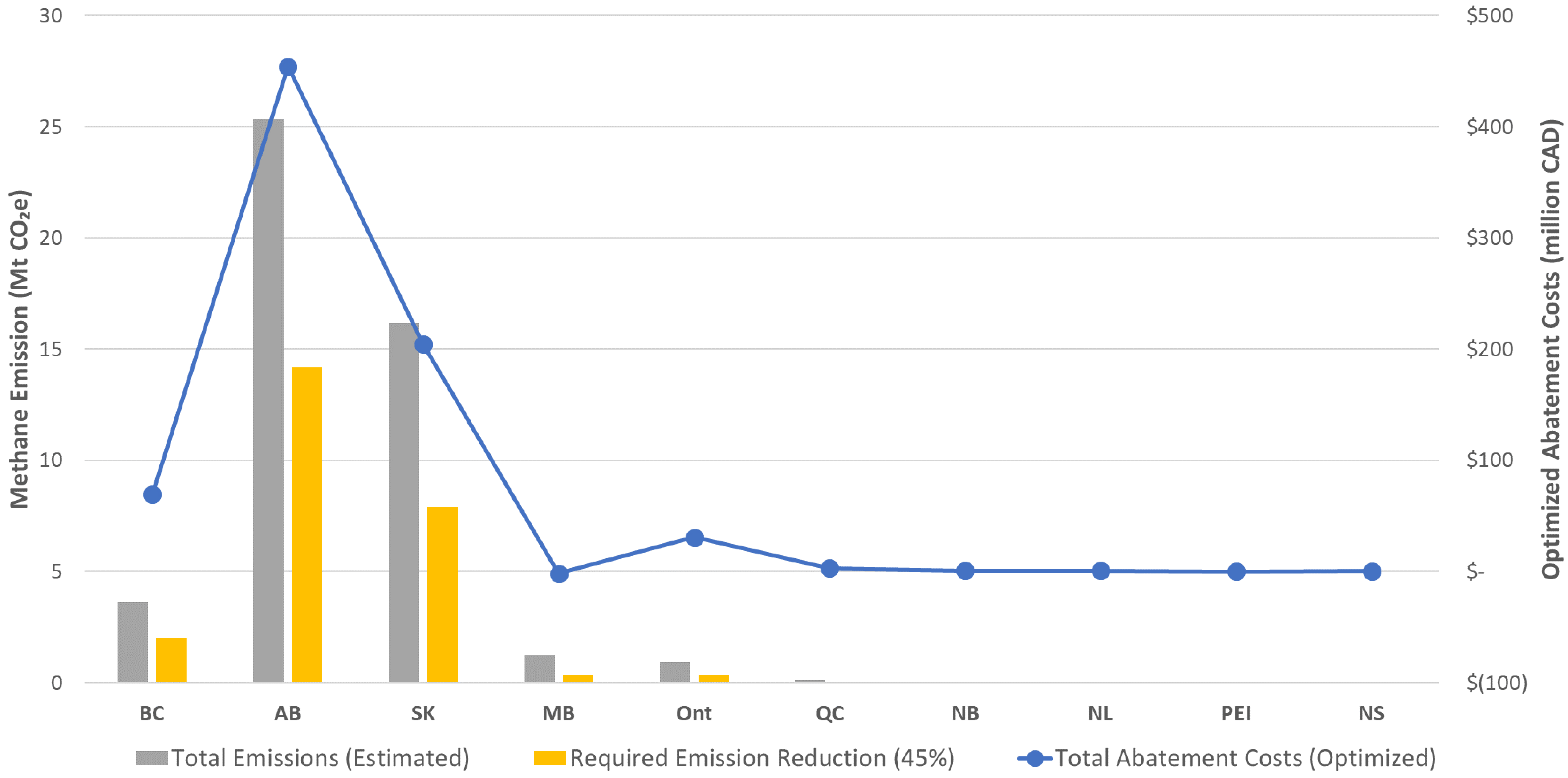


For the three abatement scenarios, the total cost of emissions reduction in the maximum reduction scenario is in the range of $2.5 to $5.3 billion, for a total methane emission reduction of about 38 Mt CO2e. For the uniform scenario, the cost is in the range of $1.4 to $2.8 billion and total reduction of 21 Mt CO2e, whereas the optimal reduction scenario achieves about a 25 Mt CO2e emissions cut for a total cost range of $0.4 to $1.5 billion. We note that these do not include costs of administration, measurement and reporting which are required by existing methane regulations in Canada.

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 CO2e, of which about 51% (55 Mt CO2e) is 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 CO2e, similar to our optimized reduction scenario. 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 CO2e given that most emissions are from the upstream sector.

Alberta and British Columbia regulations are designed to achieve a reduction in oil and gas methane emissions by 45% below 2014 levels by 2025. Similarly, if both regulations covered the entire natural gas supply chain in their respective provinces, Alberta's reduction target would be about 14.16 Mt CO2e and British Columbia's reduction target would be 1.6 Mt CO2e. Relative to the federal regulation with 2012 baseline, the numbers would be 14.2 Mt CO2e and 2.0 Mt CO2e (similar to our optimized scenario), respectively. However, both provincial regulations aim to achieve their methane emission reductions from the upstream sector alone; the numbers would be slightly below these values given the dominance of upstream emissions.

Figure E.6:Provincial Methane Emission Reduction Opportunities and Economic Impacts under a Cost-Effective (optimized) Mitigation



HYPOTHETICAL SCENARIOS

Figure E.6 (above) shows the provincial breakdown of estimated methane emissions, required emission reductions and total abatement cost for an optimal implementation of emission reduction targets at the 45% reduction below 2012 levels. The estimated total abatement cost for Alberta is C$450 million (2017 dollars), for an emission reduction program focusing on upstream oil and gas emissions in line with current regulation, while this cost for British Columbia and Saskatchewan are about C$70 and C$205 million, respectively. In 2017, British Columbia produced 4.98 Bcf per day of natural gas, whereas Saskatchewan produced 0.51 Bcf per day. Saskatchewan generated more emissions than British Columbia over the same year due to higher oil production activities where associated gas is often emitted from upstream facilities.

In the case of Ontario, optimization of mitigation options is not performed because of the small number of source categories available in midstream and downstream supply chain sectors where most of the emissions in the province emanate from. The 45% reduction in the optimized mitigation strategy applies to the provincial contribution to overall Canadian methane emissions in the baseline year. Given the fewer source categories for Ontario's emissions, the emission sources to be mitigated in both the uniform and optimized reduction scenarios are essentially the same. Hence, the abatement costs are also the same. Therefore, the total abatement cost of the uniform (45%) emission reduction scenario of C$55 million is applied to Ontario. Moreover, upstream impacts of US gas imports into Ontario in 2017 of about 2.35 Bcf per day is not accounted for in the current model.

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.