# An Assessment of the Importance of Arctic Gas

**Undertaken By**

**Angevine Economic Consulting Limited**

**For**

**The Northwest Territories'**
**Department of Industry, Tourism and Investment**

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## Introduction

The importance of Arctic Gas in relation to carbon emissions and the availability and cost of gas to consumers was assessed by Gerry Angevine of Angevine Economic Consulting Ltd. in August 2007. For this purpose, Energy and Environmental Analysis, Inc. ("EEA", an ICF International Company) of Arlington VA were engaged to provide the results of two model run scenarios developed especially for this purpose for comparison with certain aspects of their June 2007 Base Case projection of the North American natural gas market. EEA's Base Case model scenario has significant quantities of Arctic gas being made available to the North American market but the sensitivity cases do not. By comparing the respective sensitivity results with the Base Case results, estimates of the importance of Arctic gas for reducing power sector carbon emissions and of the value of Arctic gas to consumers, by reducing their cost of gas, were derived for the U.S. Lower-48 States and for Canada. This report summarizes the findings of the analysis.

EEA's gas market model was selected for this purpose because of its credibility and detail. Simulation results generated by the model have been used as the basis for numerous market assessments by the National Petroleum Council in response to requests by the U.S. Secretary of Energy. EEA and the firm's parent company (ICF) have also used the model to undertake gas market studies for numerous states, corporations and industry associations including the American Gas Association and the Interstate gas Association of America. Also, the EEA model output facilitated the development of the detailed comparisons of carbon emissions and the cost of gas both by region and by sector that were required.

The Base Case assumes that an Alaskan natural gas pipeline running from the Alaskan North slope to connect with the North American gas transmission system in Alberta commences service with an initial throughput of 4.0 billion cubic feet per day (bcfd) during the fourth quarter of 2017 and that the capacity is expanded in 2020 to allow additional throughput of 2 bcfd. It is also assumed that the gas pipeline from the Mackenzie Delta enters service in 2013 with an initial throughput of 1.5 bcfd. In addition, Arctic gas from LNG facilities in both northern Russia and Norway (the Snovit LNG project) flow into North America in the Base Case.

## 1. Lower Power Sector Carbon Emissions

In the model sensitivity undertaken by EEA for the purpose of assessing the potential role of Arctic gas in lowering emissions, labeled the "Coal Case", the Alaskan and Mackenzie Delta gas pipelines were assumed not to commence service during the forecast horizon which runs to 2025. In addition, all future Arctic LNG projects not yet developed in Russia were eliminated. Further, the size of the Norwegian Snovit LNG project was halved from approximately 1 Bcfd to 0.5 Bcfd. Finally, incremental coal-fired generation capacity was added in the U.S. and Canadian electric sectors to create a scenario in which natural gas prices levels were about the same as in the Base Case.

The extent of the difference in the additions to coal-fired generation capacity between the two cases is indicated in the Table below. In the Coal Case, 81 more GigaWatts (i.e. 81,000 MegaWatts of coal-fired capacity are added than in the Base Case.

**Increase in U.S. Lower 48 Power Generation Capacity**
GigaWatts 2010 to 2025

| | Base Case | Coal Case | Difference |
|---|---|---|---|
| Coal | 72 | 153 | 81 |
| Oil and gas | -5 | -5 | 0 |
| Total | 67 | 148 | |

Comparison of power sector carbon emissions in the Coal Case with the Base Case provide an indication of the extent to which such emissions could be avoided by utilization of Arctic gas. In the Coal Case, with greater use of coal and less reliance on natural gas for power generation because Arctic gas is not available, carbon emissions from power generation using coal are greater. However, emissions from gas-fired generation facilities are less than in the Base Case. The indicated increases in carbon emissions because of the increased reliance on coal in the Coal Case (or, alternatively, the implied decreases in carbon emissions because of the benefit of available supplies of Arctic gas) that are reported in this section are estimates of the net changes in total carbon emissions in the power sector over all hydrocarbon fuels.[1]

The following Table summarizes the extent to which Arctic gas could reduce power sector emissions in the U.S. Lower-48 States and Ontario.

[1] The carbon emissions rates assumed by EEA in relation to fuel consumed in power generation were as follows: natural gas: 31.89 lbs./Million Btu; coal: 55.95 lbs./Million Btu; fuel oil: 45.03 lbs./Million Btu.

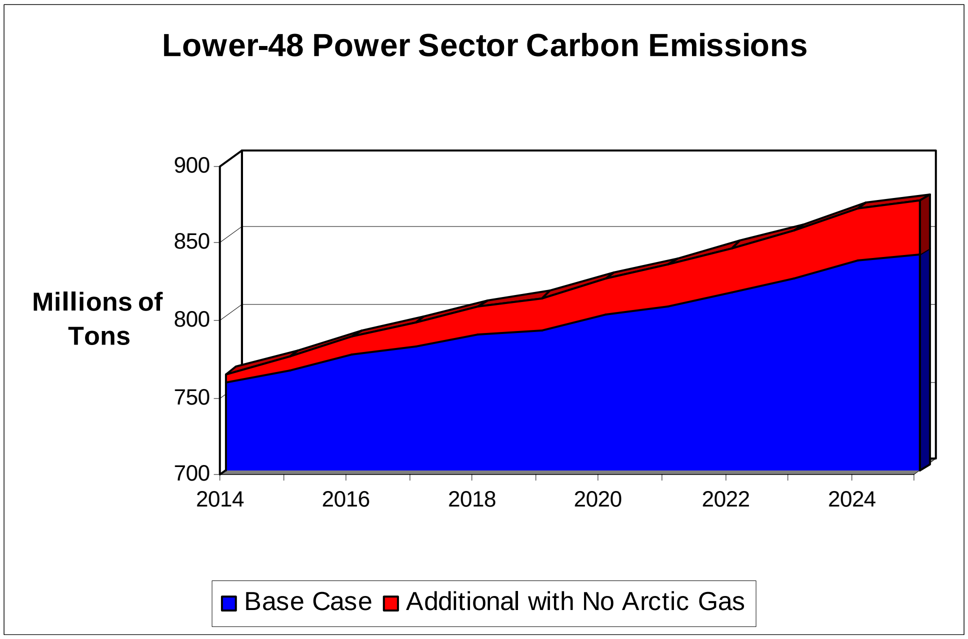
**Lower-48 & Ontario Power Sector Emissions Impact of Arctic Gas**
**(Assuming that Increase in Coal Demand in Coal Case Neutralizes Impact on Gas Prices)**
**( Changes in Annual Emissions in Millions of U.S. Tons)**

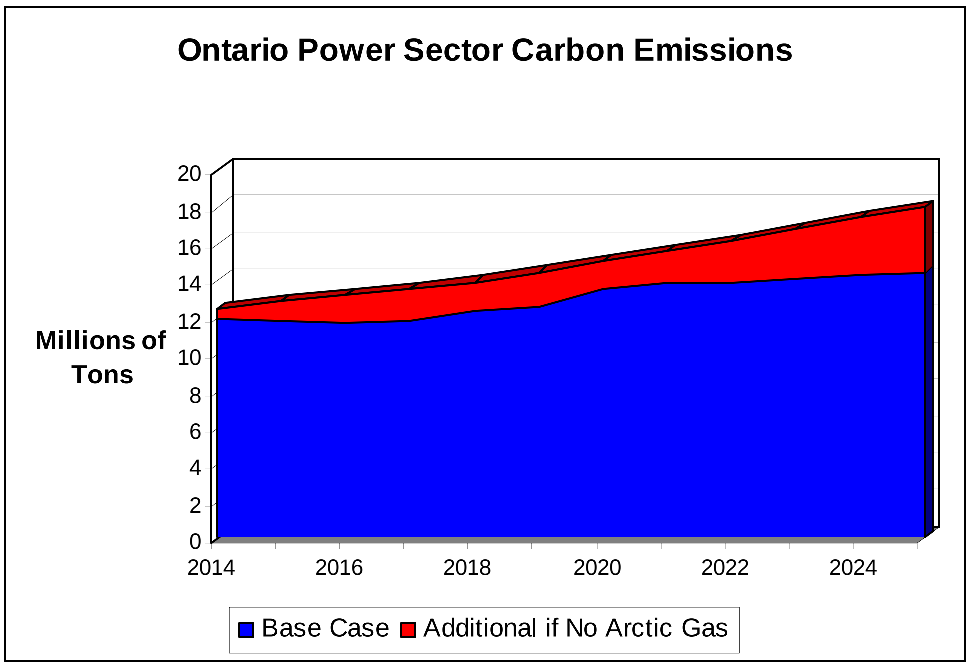
| | 2014 | 2018 | 2021 | 2025 | | cumulative 2014-25 |
|---|---|---|---|---|---|---|
| Texas | 1.4 | 5.1 | 7.7 | 10.5 | Texas | 74.6 |
| Southeast | 1.1 | 3.6 | 5.4 | 7.8 | Southeast | 54.1 |
| South Central | 0.7 | 2.9 | 4.6 | 6.1 | South Central | 42.3 |
| Rockies | 0.4 | 1.3 | 1.8 | 2.3 | Rockies | 17.8 |
| Northwest | 0.3 | 1.1 | 1.8 | 2.6 | Northwest | 17.4 |
| Mid-Atlantic | 0.4 | 1.3 | 1.9 | 1.6 | Mid-Atlantic | 16.3 |
| Florida | 0.2 | 0.8 | 1.2 | 1.8 | Florida | 11.6 |
| Michigan/Ohio+ | 0.0 | 0.5 | 1.2 | 0.9 | Michigan/Ohio+ | 7.6 |
| Mid America | 0.4 | 0.7 | 0.4 | 0.3 | Mid America | 6.7 |
| New England & NY | 0.2 | 0.4 | 0.7 | 0.7 | New England & NY | 5.9 |
| CA, NV, ILL, & WIS. | 0.3 | 0.3 | 0.4 | 0.4 | CA, NV, ILL, & WIS. | 3.7 |
| **Total Lower-48** | **5.2** | **18.0** | **26.9** | **35.0** | **Total Lower-48** | **258.0** |
| Ontario | 0.5 | 1.5 | 1.7 | 3.6 | | 23.1 |

According to the EEA estimates, without Arctic gas carbon emissions in Texas would be about 75 million tons greater through the 2014-2025 period. The increase in emissions if Arctic natural gas were not available would also be quite large in the southeast and south central states where, as in Texas, there presently is substantial coal-fired capacity. However, the increase is indicated to be much less in states such as Wisconsin and Illinois where virtually all of the baseload generation capacity is coal-fired.[2] In the U.S. Northeast and California, where coal generation is small in absolute terms to begin with, the allocated share of additional of coal capacity does not result in a large increase in emissions compared with areas like Texas where the same percentage increase in coal capacity implies a large increase in carbon emissions.

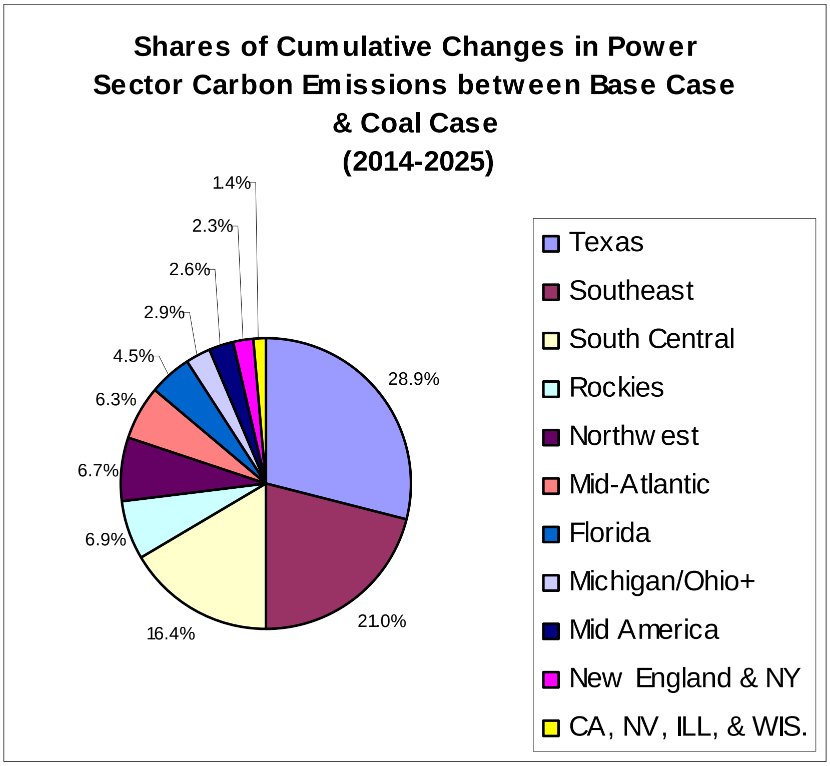
During the 2014-2025 period the potential reductions in power sector carbon emissions in the Lower-48 and Ontario are 258 million tons and 23 million tons, respectively. This is illustrated by the two following Figures.

[2] This reflects the methodology chosen by EEA which assumes that the reduced availability of gas would be offset by an increase in coal-fired capacity. In states with little gas generation capacity the availability of Arctic gas would not be critical and, therefore, no need to add to the coal generation fleet because of a reduction in overall gas supply.




The shares of jurisdictions in the Lower-48 of the cumulative reduction in carbon emissions that one could expect to flow from the availability of Arctic gas are illustrated by the figure on the next page.




As indicated by the Table below, the potential percentage reduction in carbon emissions from utilization of Arctic gas would be rather small, even in Texas and the south central states. Over the 2014-2025 period the potential reduction in emissions the Lower-48 as a

**Percent Changes in Regional Power Sector Carbon Emissions: Coal Case Compared with Base Case, 2014-2025**
**(Assuming that Coal Demand Increases Sufficiently to Neutralize Impact on Gas Prices)**

| | 2014 | 2018 | 2021 | 2025 | cumulative 2014-25 |
|---|---|---|---|---|---|
| Texas | 1.4 | 4.9 | 7.3 | 9.9 | 5.9 |
| South Central (AR, KS, LA, MS, OK) | 1.1 | 4.3 | 6.5 | 8.3 | 5.1 |
| Northwest | 0.7 | 2.5 | 4.1 | 5.5 | 3.3 |
| Southeast | 0.8 | 2.5 | 3.7 | 5.0 | 3.1 |
| Rockies | 1.0 | 2.8 | 3.9 | 4.8 | 3.2 |
| Florida | 0.6 | 2.0 | 2.9 | 4.0 | 2.4 |
| MId-Atlantic | 0.8 | 2.8 | 3.8 | 2.9 | 2.8 |
| Northeast (New England & NY) | 0.4 | 1.3 | 2.1 | 2.8 | 1.7 |
| California & Nevada | 0.3 | 1.0 | 1.6 | 1.8 | 1.2 |
| **Lower-48** | **0.7** | **2.3** | 3.3 | **4.2** | **2.7** |
| **Ontario** | **4.0** | **12.4** | 12.2 | **24.7** | 15.4 |

whole would only be about 3 percent. In large part this is because the reduction in carbon emissions made possible by the reduction of about 7 percent in total coal-fired generation through the 2014-2025 period would be partially offset by an increase in emissions from higher utilization rates of natural gas generation facilities.[3] The differences in the quantities of electricity generated by coal and gas-fired facilities from one case to the other are about the same, with gas generation greater in the Base Case where Arctic gas is available and less in the Coal Case, where it is not. As illustrated by the following Table the opposite is true for coal-fired generation.

**Total Power Generation in the U.S. Lower 48 States**
2014 to 2025 GigaWatthours

| | Base Case (Arctic gas) | Coal Case (No Arctic Gas) | Differences |
|---|---|---|---|
| From Coal | 29,053.0 | 31,141.0 | 2,088.0 |
| From Natural Gas | 11,813.0 | 9,771.0 | -2,042.0 |

In Ontario, where reliance on coal-fired generation is still quite significant, the EEA findings indicate that the potential reduction in emissions from the availability of Arctic gas would be quite significant. A possible 15 percent reduction is indicated for the 2014-2025 period.

2. Lower Gas Costs

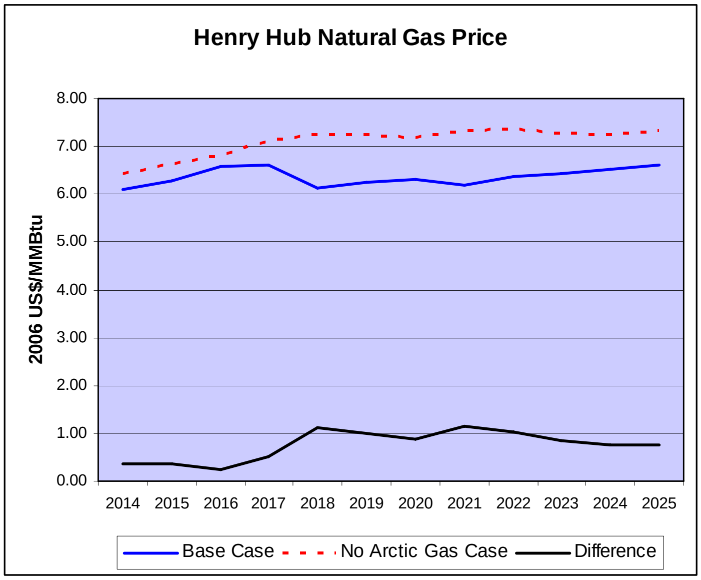
In the second sensitivity, simply labeled the "No Arctic Gas" Case, EEA eliminated Arctic gas relative to the Base Case in precisely the same manner as in the first sensitivity (the Coal Case) but kept power generation capacity, both in total and by type, the same as in the Base Case.

For each of the Base and No Arctic Gas cases EEA calculated the cost of gas to consumers in each of the residential, commercial, industrial and power sectors by multiplying estimates of the monthly burner-tip prices of gas in each region by the monthly gas consumption volumes projected by the model.[4] Subtracting the estimated

[3] The difference in generation of electricity using coal results from the assumed increase in coal-fired capacity in the Coal Case.

[4] EEA estimated burner-tip gas prices by states or regions using algorithms that take into account sales taxes, the transportation cost from closest market hub, and the market-clearing price of gas at that hub as estimated by the model simulation. Because EEA has not developed similar algorithms for Canada, for the Canadian estimates the burner-tip price in the U.S. state or region in closest proximity was used. For somewhat similar analysis undertaken for the Canadian Energy Pipeline Association during 2005, Angevine Economic Consulting Inc. used Canadian market-clearing prices instead of burner-tip gas prices in contiguous U.S. states as proxy measures. Because the objective was to estimate the difference in cost

cost of gas in the Base Case from the higher cost (because of the higher market-clearing prices) in the No Arctic Gas Case provided regional and sectoral estimates of the potential cost savings to consumers from the availability of Arctic gas.[5]




As illustrated by the above figure the availability of Arctic Gas lowers the market-clearing price of gas considerably at the major Henry Hub market centre. Although not shown, the same is true throughout Canada and the United States because of the degree to which the various regional markets are interconnected via the extensive North American gas transmission system.

At Henry Hub the average difference in the market prices projected by EEA with and without Arctic Gas is US $0.75/MMBtu over the 2014-2025 period or 11.8 percent. From 2018, just after the Alaskan pipeline is assumed to come into service in the Base Case, the differential averages close to a dollar per MMBtu.

The price differences projected by the model result in gas consumption growing more slowly after 2013 in the US Lower-48 states and Canada in the No Arctic Gas Case than in the Base Case. This is indicated by the changes in the compound annual growth rates of gas consumption in the Lower 48 and Canada during the 2013 to 2025 period as shown in the Table on the next page.

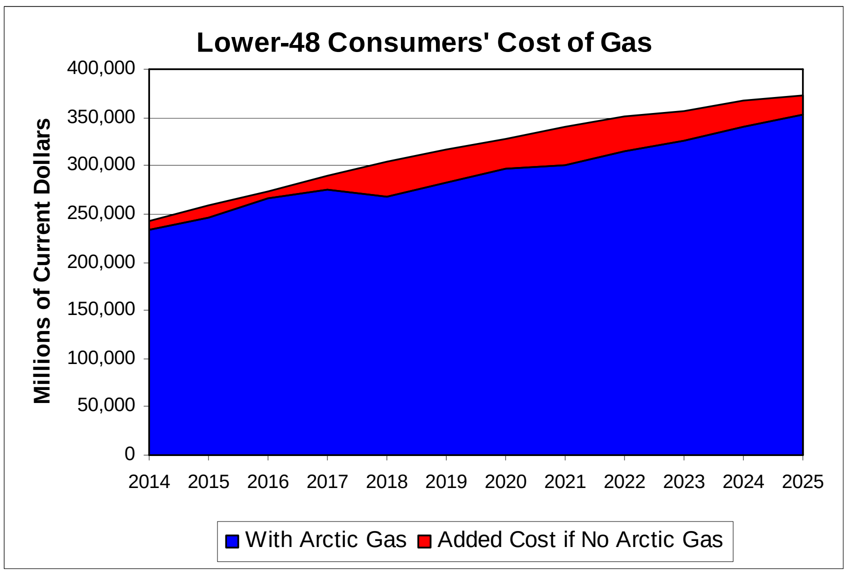
between two scenarios it is unlikely that the Canadian results would have been significantly different if the alternative approach had been used, nor is it clear which approach would yield the more accurate result.

[5] The EEA model's 'market-clearing prices' are the estimated price of the last quantity of gas required to balance supply and demand and 'clear' the market at each point in time addressed by the model.

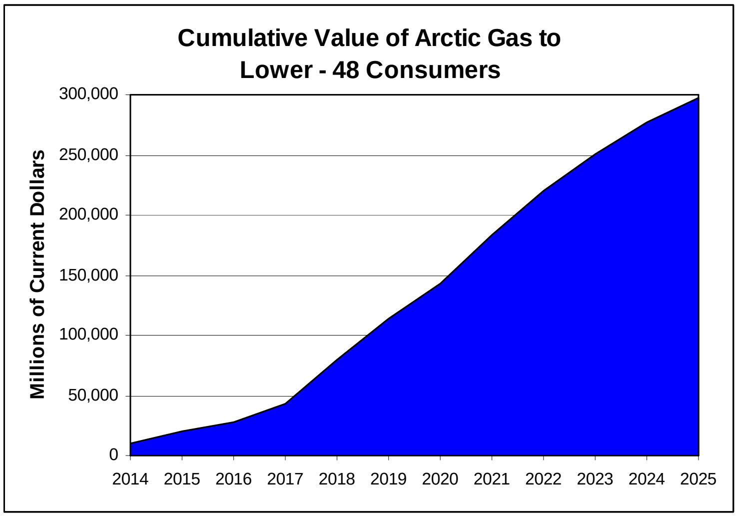
Growth in Gas Consumption
(compound annual growth rates 2013-2025)

| | Base Case | No Arctic Gas |
|---|---|---|
| Lower-48 | 1.05 | 0.98 |
| Canada | 1.29 | 1.01 |

In spite of its modifying impact on the growth of gas consumption the higher price of gas results in significant increases in consumers' gas costs throughout North America. In other words, Arctic gas could lower consumers' costs of gas considerably in the years ahead. The difference in costs between the two scenarios is illustrated by the red zone in the Figure below.




Our analysis suggests that in the absence of Arctic gas consumers in the US Lower-48 could expect to pay about $300 billion more for natural gas over the 2014-2025 period as illustrated by the Figure at the top of the following page. (For the US Lower-48 and Canada together the increased cost during the same 12-year period could approach $340 billion.)




The following Table provides regional details on the impact of Arctic Gas on consumers' cost of natural gas. For example, in the Northeast the increased cost would be close to $50 billion. In Eastern Canada (mainly Ontario) the increased cost would likely be in the vicinity of $20 billion.

**Impact of Arctic Gas on All Gas Consumers' Cost of Gas**
**(res., comm., indust., and power sectors combined)**
**Millions of Nominal US $**

| | 2014 | 2018 | 2021 | 2025 | Cumulative 2008-2013 | Cumulative 2014-2020 | Cumulative 2014-2025 |
|---|---|---|---|---|---|---|---|
| Northeast | 1,582 | 5,682 | 6,202 | 4,553 | 2,550 | 23,045 | 49,110 |
| South Atlantic | 1,218 | 4,881 | 5,766 | 4,094 | 2,004 | 19,390 | 42,899 |
| Central | 1,179 | 4,030 | 4,502 | 3,559 | 2,248 | 15,792 | 34,967 |
| Midwest | 2,065 | 7,876 | 8,280 | 3,041 | 3,411 | 30,490 | 60,658 |
| Texas | 1,356 | 5,153 | 5,864 | 4,345 | 2,577 | 20,121 | 44,356 |
| Southwest | 1,663 | 6,234 | 6,658 | 987 | 3,025 | 23,788 | 46,335 |
| Pacific NW-Mountain | 688 | 2,860 | 2,879 | -252 | 993 | 10,743 | 19,176 |
| **Lower 48** | **9,750** | **36,716** | **40,153** | **20,328** | **16,808** | **143,369** | **297,500** |
| | | | | | | | |
| Eastern Canada | 605 | 2,609 | 2,758 | 1,387 | 1,015 | 9,350 | 19,534 |
| Western Canada | 851 | 3,163 | 2,869 | 1,716 | 1,312 | 11,605 | 21,009 |
| **Canada** | **1,456** | **5,772** | **5,627** | **3,103** | **2,327** | **20,956** | **40,543** |
| **Lower 48 & Canada** | **11,206** | **42,488** | **45,780** | **23,431** | **19,135** | **164,325** | **338,043** |

**Region Notes:**
Northeast region includes all New England states plus New York, New Jersey, and Pennsylvania.
South Atlantic includes east coast states from Florida to Delaware, plus West Virginia.
Central includes Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, and Tennessee.
Midwest includes midwestern great lakes states plus Iowa, Nebraska, Kansas, Missouri, and the Dakotas.
Southwest includes Arizona, California, Nevada, and New Mexico.
Pacific NW-Mountain includes the Rocky Mountain states plus Oregon and Washington.
Lower 48 total includes the 48 continuous continental states.

Eastern Canada includes Ontario, Quebec, and the Canadian Maritimes Provinces
Western Canada includes Alberta, British Columbia, Manitoba, and Saskatchewan.