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## **Shale Gas in Canada: Resource Potential, Current Production and Economic Implications**

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**Jed Chong  
Milana Simikian**

Economics, Resources and International Affairs Division  
Parliamentary Information and Research Service

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# SHALE GAS IN CANADA: RESOURCE POTENTIAL, CURRENT PRODUCTION AND ECONOMIC IMPLICATIONS

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## 1 INTRODUCTION

In the last decade, the North American energy market has seen a dramatic increase in the production of unconventional natural gas extracted from shale formations, also known as shale gas. This shift in natural gas supply can be primarily attributed to recent advances in technology that began in the United States, which combine hydraulic fracturing and horizontal drilling into a commercially viable method of extraction. Some observers suggest that the potential for shale gas is enormous, and that this energy source can become a “game changer”<sup>1</sup> in a global energy market where conventional supplies are already on the decline, and the demand for energy is on the rise.<sup>2</sup>

Shale formations are present in every region of the world, with China, Argentina, Algeria, the U.S. and Canada being the top five countries with technically recoverable shale gas reserves.<sup>3</sup> For Canada, a rise in shale gas production at home and abroad could mean unprecedented economic opportunities and future prosperity, but it could also mean increased competition in the global energy market, a loss of export revenue, and new environmental and social challenges. This paper examines Canada’s shale gas resource potential, its current production and the economic implications for Canadian gas producers and consumers.

## 2 WHAT IS SHALE GAS?

Shale gas is one of the several types of natural gas<sup>4</sup> found in unconventional reservoirs. Unconventional and conventional reservoirs differ by their geological characteristics and location, which in turn affects the process, cost and level of ease associated with gas extraction.<sup>5</sup>

A conventional gas reservoir contains “free” natural gas that has migrated from a source rock into an area capped by an impermeable layer of rock, and where the gas remains in concentration and under pressure.<sup>6</sup> Generally, conventional natural gas can be easily accessed with a traditional vertical well, drilled directly into the reservoir. The pressure within the reservoir causes the gas to flow naturally to the surface, where it can be gathered for commercial use.<sup>7</sup>

An unconventional gas reservoir consists of impermeable rock formations from which deposits of natural gas must be freed. Shale gas is typically trapped in shale, a sedimentary rock that was originally deposited as clay and silt.<sup>8</sup> Unconventional gas, including shale, is generally more difficult and more expensive to extract than conventional natural gas because of high up-front costs, which can range from \$3 million to \$9 million per well. However, IHS Global Insight (U.S.A.) Inc. found that the full-cycle cost of shale gas wells in 2011 was 40% to 50% cheaper than conventional wells.<sup>9</sup> The lower full-cycle cost stems from the higher productivity of shale gas wells, since the new technology allows for better access to the source rock from a single well pad.<sup>10</sup>

Shale gas can be developed through a variety of drilling and completion techniques, including those used for conventional shallow gas extraction.<sup>11</sup> However, due to the low permeability of shale rock, the primary method of shale gas extraction involves combining two well-established technologies – horizontal drilling and hydraulic fracturing (sometimes referred to as “fracking”). In North America, the technique of horizontal drilling became commercially viable in the 1980s, and has been widely used to increase production volumes from all forms of natural gas and oil wells.<sup>12</sup> Hydraulic fracturing has also been used to facilitate oil and gas recovery in conventional wells for over 60 years.<sup>13</sup> Although these techniques have been employed separately for decades, their combined application is relatively new and largely responsible for making shale gas commercially viable.

### **3 WHAT IS CANADA’S SHALE GAS RESOURCE POTENTIAL?**

In recent years, Canada’s natural gas industry has reported the discovery of large volumes of in-place and recoverable shale gas resources. However, due to Canada’s short history with development and production of shale gas, its full potential is not yet known.<sup>14</sup> Existing estimates of Canada’s shale gas resources vary widely, and remain subject to significant uncertainty. In many cases, potential shale gas resources have not been fully assessed because of their very early stage of development, especially in jurisdictions outside of western Canada.<sup>15</sup> As well, federal and provincial governments are still in the process of developing a comprehensive and standardized approach to evaluating Canada’s unconventional resources. With the exception of only a few shale gas areas,<sup>16</sup> industry claims of potential Canadian shale gas resources have not been independently verified by public authorities.<sup>17</sup>

#### **3.1 ESTIMATES OF SHALE GAS RESOURCES**

There are different types of estimates that measure and describe the volume of available shale gas resources: the estimate of “gas in place,” the estimate of gas that is “technically recoverable,” and the estimate of gas that is “economically recoverable” or “marketable.” These estimates fluctuate frequently due to changes in economic conditions, technology and available information related to shale gas resources.

##### **3.1.1 GAS IN PLACE**

The gas-in-place estimate typically refers to the total volume of gas contained in any given pool or reservoir. This estimate includes both the portion that can be recovered and the portion that will remain in the reservoir after production operations. Generally, estimates of gas in place are much larger than those that are considered “recoverable” or “marketable.”<sup>18</sup>

As of August 2013, the Geological Survey of Canada estimated that Canada has approximately 4,995 trillion cubic feet (Tcf) of shale gas in place, a large portion of which is located in the Western Sedimentary Basin.<sup>19</sup> Shale gas resources can be found in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec,

New Brunswick, Nova Scotia, the Northwest Territories, and Yukon.<sup>20</sup> However, gas-in-place estimates are available for certain provinces only, as shown on the map in the appendix to this paper.

### 3.1.2 TECHNICALLY RECOVERABLE GAS

An estimate of technically recoverable gas is the volume of gas that could be extracted with current technology, regardless of economic conditions such as gas prices and production costs.<sup>21</sup> Typically, the amount of shale gas that can be recovered is equivalent to a small fraction of the gas in place (20% to 30% on average). The recoverable gas estimates are considered to be less reliable than the gas-in-place estimates, especially in the early phase of development, because they involve various geological and engineering factors that increase uncertainty. The estimates of technically recoverable volumes of gas can also change over time due to advancements in available data and technology.<sup>22</sup>

The U.S. Energy Information Administration estimates that 573 Tcf of Canadian shale gas is technically recoverable, which represents nearly 8% of the global estimated total.<sup>23</sup> According to this assessment, Canada has the world's fifth largest shale gas deposit, after China (1,115 Tcf), Argentina (802 Tcf), Algeria (707 Tcf) and the U.S. (665 Tcf).<sup>24</sup> From a consumption perspective, Canada's shale gas resource potential, combined with that of the U.S., substantially increases the North American natural gas supply from 80 years to more than 100 years at current consumption rates.<sup>25</sup>

### 3.1.3 ECONOMICALLY RECOVERABLE OR MARKETABLE GAS

Economically recoverable gas, also sometimes referred to as marketable gas, is the volume of gas that can be recovered under current technical and economic conditions. Estimates of marketable gas can be important for supporting decision making in both business and public policy. However, these types of estimates tend to be more vulnerable to frequent changes in economic conditions, as they often rely on short- and medium-term price forecasts for oil and gas.<sup>26</sup>

Making comparisons between marketable gas estimates is often difficult, because estimators use different methods and assumptions to arrive at their conclusions. In the Canadian context, the definitions of marketable gas estimates are not always the same. For example, the Canadian Society of Unconventional Resources (CSUR) defines marketable gas as "the volume of gas that can be sold to the market after allowing for removal of impurities and after accounting for any volumes used to fuel surface facilities."<sup>27</sup> Based on this definition, the CSUR estimates that between 343 Tcf and 819 Tcf of Canadian shale gas is marketable.<sup>28</sup> A recent study by the National Energy Board in collaboration with the governments of Alberta and British Columbia estimates that the Montney play<sup>29</sup> (a shale formation that extends across both provinces) contains 449 Tcf of marketable gas. In this case, the National Energy Board defines marketable gas as the volume of in-place gas that is recoverable under foreseeable economic and technological conditions and in a condition ready to be used by the market.<sup>30</sup>

## 4 WHAT ARE CANADA'S CURRENT SHALE GAS PRODUCTION AND EXPLORATION ACTIVITIES?

Canada is the world's third largest producer and second largest exporter of natural gas, with an average annual production of 6.4 Tcf.<sup>31</sup> Despite Canada's rich natural gas resource-base, production peaked around 2006, and began to decline along with natural gas exports to the U.S. Until recently, the projected future for the natural gas sector in Canada was one of gradually declining production that would supply a tight and high-priced North American market with an increasing reliance on liquefied natural gas (LNG) imports.<sup>32</sup> However, the situation quickly changed when technological advancements in the U.S. made shale gas exploitation commercially viable, changing production prospects in North America.

In 2012, shale gas accounted for 39% of total natural gas production in the U.S., and 15% in Canada, making North America the world's largest producer of shale gas.<sup>33</sup> Despite this, Canada's shale gas production is still in its nascent stages compared to that of its southern neighbour. As discussed in section 4.1 of this paper, production activities concentrate primarily in western Canada, and notable industry exploration has been pursued in only four provinces. Elsewhere in Canada,<sup>34</sup> there has been little to no activity on shale gas exploration.

### 4.1 SHALE GAS IN WESTERN CANADA

In British Columbia, shale gas is extracted in the northeastern part of the province. In 2012, British Columbia produced a daily average of 2 billion cubic feet (Bcf) of shale gas,<sup>35</sup> and accounted for more than 25% of total Canadian production.<sup>36</sup> It was estimated in November 2013 that there is 2,900 Tcf of in-place shale gas in the province.<sup>37</sup>

Some shale gas production currently occurs in Alberta, although it remains a very small fraction – less than 0.1% – of the province's total natural gas production.<sup>38</sup> In 2012, Alberta produced approximately 2.7 Bcf of gas from shale formations. Most shale gas-producing wells in Alberta are shallow vertical wells, but this is beginning to change, with an increasing number of horizontal wells being drilled.<sup>39</sup> As for Alberta's shale gas resource potential, recent estimates suggest that the province has between 843 Tcf and 1,986 Tcf of gas in place.<sup>40</sup>

Very little is known about the shale gas potential in Saskatchewan; a gas-in-place estimate for this province is not readily available. Between 2001 and 2008, several exploration wells were drilled in the Colorado Group shale formation. Since then, no exploration activity appears to have taken place.<sup>41</sup>

### 4.2 SHALE GAS IN QUEBEC

Latest available data suggest that Quebec has between 100 Tcf and 300 Tcf of gas in place in shale formations.<sup>42</sup> In total, 31 exploration wells have been drilled in the Utica shale play between Montréal and the city of Québec.<sup>43</sup> However, in 2011, the Quebec government placed a moratorium on shale gas exploration while waiting for the completion of the Strategic Environmental Assessment of this

resource development.<sup>44</sup> The committee responsible for the assessment released its synthesis report in January 2014.<sup>45</sup> Following the committee's work, the Office of Public Hearings on the Environment will conduct extensive public consultation during spring 2014.<sup>46</sup>

### **4.3 SHALE GAS IN ATLANTIC CANADA**

Between 2007 and 2008, several exploration wells were drilled in Nova Scotia's Horton Bluff formation, allowing the industry to discover a potential 69 Tcf of shale gas in place.<sup>47</sup> However, since 2011, the Government of Nova Scotia has not approved any shale exploration or development activities that involve hydraulic fracturing. This policy will remain in place until summer 2014, when a provincially commissioned review of hydraulic fracturing and its effects is expected to be completed.<sup>48</sup>

Elsewhere in Atlantic Canada, New Brunswick has approximately 80 Tcf of in-place natural gas in the Frederick Brook shale formation.<sup>49</sup> The reservoir has been the focus of recent shale gas exploration, with several exploratory wells drilled since 2008 by a number of companies.<sup>50</sup> Exploration activities have become increasingly controversial among First Nations and other members of the local community, with protests occurring throughout the fall of 2013.<sup>51</sup>

## **5 WHAT ARE THE ECONOMIC IMPLICATIONS OF SHALE GAS PRODUCTION?**

### **5.1 THE DROP IN THE PRICE OF NATURAL GAS**

The rise in shale gas production has resulted in a dramatic shift in North American natural gas supply and contributed to the decline of gas prices by nearly 75% from July 2008 to January 2013.<sup>52</sup> In 2013, the continent's natural gas prices averaged about \$3.70 per million British thermal units (mmbtu) and are expected to stay in the \$4–\$5 mmbtu range in the coming years.<sup>53</sup> By contrast, the average price of natural gas in Europe and the Asia-Pacific region has hovered at around \$10 mmbtu. The International Gas Union reports that since 2005, wholesale gas prices have increased consistently in all regions, except North America.<sup>54</sup>

In this price environment, and with the U.S. as Canada's sole natural gas export market, Canadian western producers are increasingly at a competitive disadvantage. Specifically, depressed gas prices have had a negative impact on Canadian natural gas production. Since 2008, production has fallen by 15% as a direct result of the reduced number of natural gas wells drilled annually.<sup>55</sup>

Further affecting the state of Canada's natural gas industry have been increased gas imports from the U.S. into eastern Canada and increased domestic consumption.<sup>56</sup> These have contributed to a decline in Canada's net gas exports.<sup>57</sup> Indeed, net exports of natural gas decreased from 8.5 Bcf a day (Bcf/d) in 2008 to 5.4 Bcf/d in 2012, the lowest level in 10 years, and 41% lower than net export volumes in 2007.<sup>58</sup>

The advent of shale gas and the concomitant decline in prices has not been an entirely negative experience for Canada. One should note that the low gas prices

have and will continue to have positive implications for Canadian consumers – be they in households, businesses, or industry. For example, an economics research firm estimates that in 2011, Canadian households saved approximately \$1.9 billion due to low gas prices. In the longer term, the extent of the benefits related to shale gas is uncertain because of the unpredictable nature of the natural gas market.<sup>59</sup>

The low gas prices relative to other energy sources are also beneficial for energy-intensive businesses and industries. Canada is attracting increasing investment in such sectors of the economy as bitumen production and the fertilizer industry.<sup>60</sup> Canadian utilities are also beginning to concentrate their efforts on developing gas-fired electricity generating stations. According to the National Energy Board, electricity generation and bitumen production will be primarily responsible for growth in Canada's natural gas demand over the next two decades.<sup>61</sup>

## 5.2 NEW OPPORTUNITIES

To remain competitive, Canadian producers are drilling an increasing number of gas wells that target deep formations in western Canada (because these wells have higher productivity rates than shallow wells).<sup>62</sup> Both U.S. and Canadian producers are also placing a greater focus on developing gas deposits that are rich in liquid hydrocarbons (propane, butanes and pentanes). These natural gas liquids are driven by oil prices, and therefore sell at a higher price than dry natural gas, giving producers an additional source of revenue.<sup>63</sup>

The low prices and oversupply of natural gas in the North American market have also prompted the Canadian gas industry and governments to concentrate their efforts on developing export markets beyond North America. The rising energy demand of emerging economies in Asia, as well as the higher gas price, offers export opportunities for Canadian liquefied natural gas (LNG).<sup>64</sup> While Canada does not currently export LNG, capital projects that would facilitate LNG trade across the Pacific have gained new momentum. Several companies have announced plans for gas liquefaction plants, pipelines and export terminals in British Columbia.<sup>65</sup>

As for overall industry investment, the Conference Board of Canada estimates that \$386 billion (2012 dollars) will be invested in the natural gas sector by 2035. Of this total, approximately 76% will be concentrated in the upstream segment (i.e., the exploration and production stages) of the industry. These investments are expected to benefit the Canadian economy through both the resulting infrastructure and increased natural gas production.<sup>66</sup>

Despite these opportunities, the future of shale gas in Canada and the pace of its development are hard to predict, and will depend on a number of factors. A recent report by the National Energy Board estimates that shale gas will account for 28% of Canada's total natural gas production by 2035.<sup>67</sup> However, this forecast is based on a series of assumptions, including the assumption that growing LNG exports will support higher drilling levels and natural gas prices.<sup>68</sup> The forecast also does not account for potential environmental and regulatory challenges that may influence the pace of shale gas development.

NOTES

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2. KPMG International, [Shale Gas – A Global Perspective](#), 2011.
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12. Sakmar (2011).
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15. Energy and Mines Ministers’ Conference, [Responsible Shale Development: Enhancing the Knowledge Base on Shale Oil and Gas in Canada](#), August 2013.
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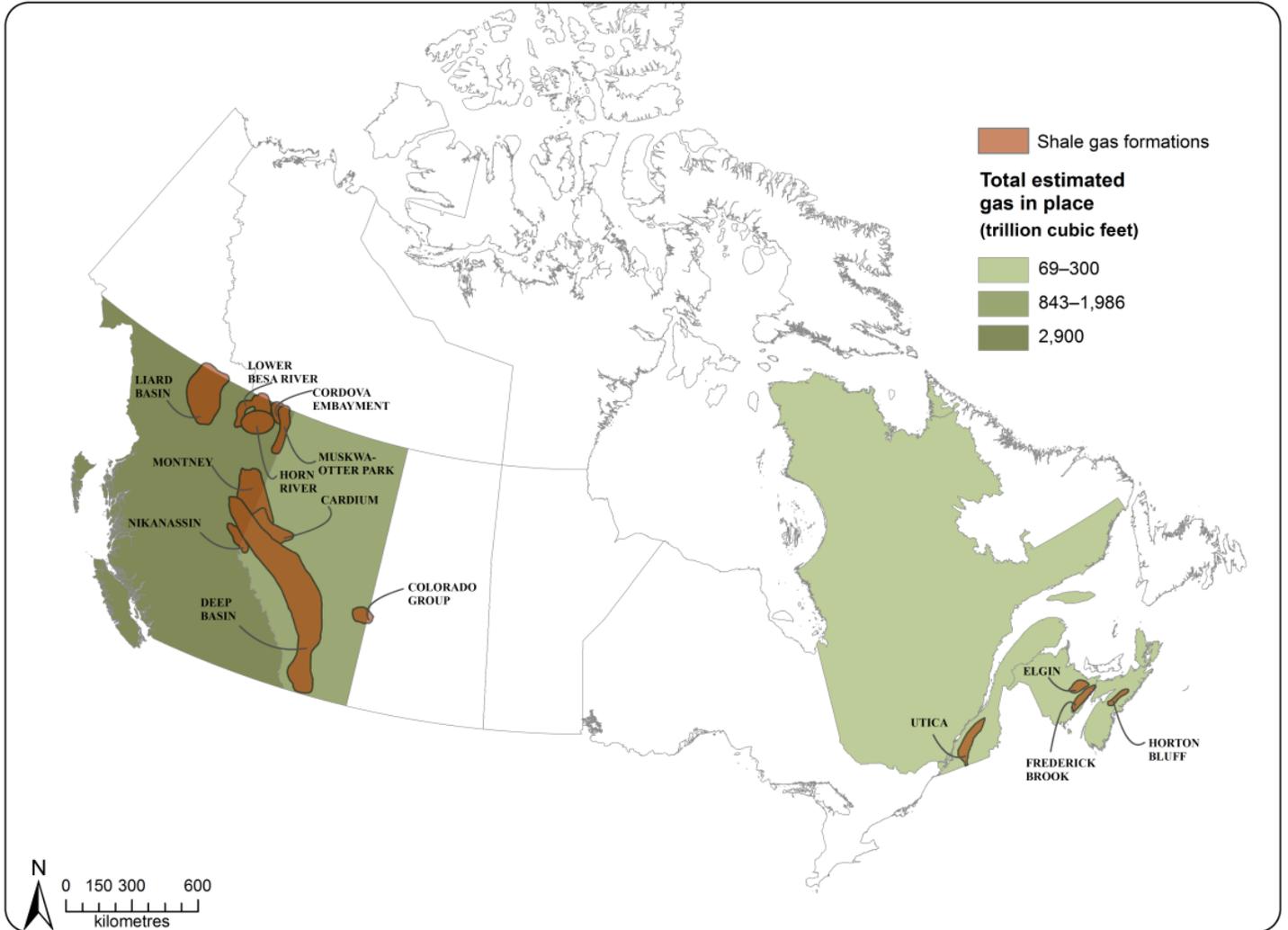
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# APPENDIX – SHALE GAS IN CANADA: FORMATIONS AND ESTIMATES OF GAS IN PLACE\*

Figure 1 – Shale Gas in Canada: Formations and Estimates of Gas in Place



GIS data sources: CANVEC; PacWest Consulting Partners (georeferenced shale plays); and Statistics Canada.

Coordinate system: Canada Atlas Lambert (NAD 83 CSRS)

\* Gas-in-place estimates are available for certain provinces only. The estimates presented are for the respective provinces and not for individual formations. Formations for which no estimates are available are not depicted.

Sources: Map prepared by the Library of Parliament based on gas-in-place estimates gathered from the following sources:

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