Energy Transportation and Tanker Safety in Canada

by Philip John

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Summary

With several rapidly industrializing emerging economies, world energy demand is booming and this growth trend is projected to continue for several decades to come. Liquid fossil fuels are and will continue to be a primary component of global energy supply. As Canada's traditional market demand in the United States diminishes, new markets must be found for Canada's abundant resources so that Canada's economic growth and prosperity continue to flourish.

Yet opposition to the most logical pathway to additional markets in Asia and Europe continues to grow. Pipelines have been enduring adamant opposition for years, and now, activist groups have focused on restricting ocean transportation as a new point of opposition for blocking the development of Canada's oil sands.

A review of tanker safety in Canada and abroad shows that tankers are a highly reliable and increasingly safe way of transporting oil.

1 There has never been a significant spill of crude oil in Canadian waters despite tens of thousands of transits on the East and West Coasts, including the year-round delivery of crude oil to the Valero refinery at Saint-Romuald, Quebec, on the south shore of the Saint Lawrence River from Quebec City.

2 The only major oil spill in the last 20 years on Canada's West Coast occurred in 2006 when the BC ferry *Queen of the North* sank with 240 tonnes of oil on board. In comparison, the *Exxon Valdez* spilled approximately 40,000 tonnes of oil in 1989, in Alaska's Prince William Sound. The most significant oil spill off Canada's East Coast occurred in 1970, when the tanker *Arrow* spilled over 10,000 tonnes of oil off Nova Scotia. This is about one quarter of the amount spilled by the *Exxon Valdez*.

3 Canadian shipping accidents reached a 38-year low of 236 in 2012, an 18% decrease from the 2011 total of 287 and a 30% decrease from the 2007–2011 average of 337. The Transportation Safety Board of Canada (2014) noted that there were 250 shipping accidents in 2013, a 5% increase from

the 2012 total but an 18% decrease from the 2008–2012 average of 305. Statistical analysis using linear regression indicates that there has been a significant downward trend in the number of shipping accidents since 2003.

4 Particularly for oil, on a global basis, there has been a precipitous decline in oil spilled since the 1970s. Over half the volume, or 56% of the total amount of oil spilled worldwide in 40 years, was in the 1970s. The percentage of the total drops to 20.5% in the 1980s and remains fairly constant at 19.8% in the 1990s. The percentage for the 2000s drops markedly to 3.7% of the total volume of oil spilled over the 40-year period.

All of this is in the face of increased quantities of goods being shipped: the global seaborne oil tanker trade nearly doubled over the last 30 years.

Marine transportation as a crucial and irreplaceable conveyor of fuels to domestic and international markets will always need to be monitored for its reliability and safety. Measures to prevent and mitigate accidents and oil spills will be a necessity as long as oil is moved by water. Canadian regulators will have to strive to preserve the positive trends in safety seen in recent decades.

But such measures are far from the types of bans and restrictions being proposed for tanker traffic off Canada's coasts. While potential areas of improvement must be constantly investigated and acted upon, tanker traffic on Canada's coasts, and especially on the West Coast, should be facilitated—not banned—for national economic progress, sustainable development, and judicious long-term planning in the interest of Canada's current and future citizens.

Key Findings

1 World energy demand is growing and liquid fuels are its main source. This scenario is not likely to change for several decades.

2 Canada's oil sands are a major resource within Canada's energy sector and Canada's proven oil reserves are adequate to meet demand at current rates of production for 140 years.

3 After meeting the domestic demand, a majority of Canada's energy resources are exported.

4 Foreign energy demand in Canada's traditional export market is declining and new export markets need to be found and developed, if Canada is to realize the economic benefits of trade in petroleum products.

5 Various interest groups have proposed imposing restrictions on Canada's tanker traffic on the coasts, and have opposed the deployment of tankers for transportation of exported oil from Canada. Claims about tanker safety, or the lack thereof, are often based on outdated information that has been factually refuted over time.

6 Marine transportation as the crucial and pivotal conveyor of fuels to domestic and international markets must be evaluated for its reliability and safety, and encouraged if the cost-benefit analysis reveals seaborne transportation as the most dependable, secure, and cost-effective mode of conveyance of fuels to markets. Potential areas of improvement must be constantly investigated and pursued.

7 While risks must be evaluated and mitigated, tankers play an important and irreplaceable role in the transportation of Canada's energy resources and other commodities to foreign markets. Volumes of oil shipped on tankers around the world have increased while the oil spill frequency and quantities have dramatically decreased.

8 Canada's marine transportation industry has an excellent safety record and a world-renowned reputation for safety and environmental consciousness.

9 As a cost-effective, efficient, and ecologically sound mode of transportation, the seaborne movement of goods has no equal. The low atmospheric emissions make it the most sustainable mode for the long term.

10 Tanker traffic on Canada's coasts, and especially on the West Coast, should be facilitated for national economic progress, sustainable development, and judicious long-term planning in the interest of Canada's current and future citizens.

Introduction

Energy is the backbone of the world economy and liquid fossil fuels are its key component. Energy consumption has been rising steadily and is predicted to continue rising for several decades to come (EIA, 2013: 1). In Canada, energy is a critical component of the economy. Canada's substantial natural resources put Canada among the largest producers of energy and her advanced stage of economic development, vast land mass, and extreme climate put her among the highest per-capita consumers of energy in the world (Natural Resources Canada, 2013, Nov. 15). Hence, the secure and sustainable production, transportation, distribution, and consumption of our abundant energy resources present challenges and opportunities for Canadians, which must be responsibly and diligently evaluated and understood to ensure a prudent and judicious response. Canada's oil sands are, by far, Canada's foremost energy source (Natural Resources Canada, 2014, Apr. 11). After accounting for domestic consumption, more than half (Statistics Canada, 2013, Dec. 10) of the Canadian primary energy production and about two-thirds (Natural Resources Canada, 2013, Nov. 4) of the crude oil production are exported abroad, most of it to the United States.

The traditional Canadian energy export market has been the United States. However, the extensive American shale deposits and their widespread and successful exploitation in recent years have caused southern import demand to abate (Lewis, 2014, July 14). TransCanada's planned Keystone XL pipeline to the US Gulf coast remains ensnared in the quagmire of diplomatic equivocation. Political polarization in the US and the resulting prevarication and procrastination in decision-making have exacerbated the decline in demand. Thus the imperative of establishing new export networks, especially to the thriving emerging economies of Asia and the Far East, has been thrust to the forefront of Canada's foreign trade agenda.

Servicing these new energy export markets calls for channels of transportation to be prepared for the new directions of flow, so that the transportation infrastructure can smoothly transition to the changing patterns of global energy demand and obtain the best value for Canada's natural resources. The extensive spread of energy extraction sources within Canada

(see Figure 4: Canada's energy map, 2014), Canada's unique northern transcontinental footprint, and frontage on three oceans are prized locational assets for diversification of export markets. Public understanding and support are key factors in cost-effective operations and obtaining the optimum returns for Canada's assets. The transportation routes to the new markets include land-based infrastructure within Canada (pipelines, roads, and rail) and littoral marine infrastructure for loading and carriage to the foreign markets (terminals and ships).

Opposition to tanker transportation

Opposition to tanker traffic in Canada falls into two broad categories: civil society groups and political parties. We will begin by discussing civil society opposition and then address political opposition. It should be noted that most of the comments on oil tanker traffic are aimed at the West Coast of Canada though similar arguments would be expected to arise if plans to ship bitumen eastward for export come to fruition.

Civil society

One group opposing the expansion of oil tanker traffic in the western region is the Island Trust (2014), which covers the islands and waters between southern Vancouver Island and the mainland, representing 5,200 km2 and 25,000 people. Island Trust (2013) has an unequivocal objection to oil pipeline "projects that lead to the expansion of oil export by barge and tanker from Canada's west coast due to concern about the risk of oil spills that could irrevocably damage coastal environments, economies, and communities". The group goes further, by also calling for a reduction in the existing tanker traffic.

Another civil society group involved in anti-tanker traffic movements is ForestEthics. This organization has a campaign titled *Tar Sands SOS: Save Our Shores* that highlights their views on the issue of tanker traffic. Below are the claims that the group makes on their website:

> A *single* tar sands tanker accident could destroy our coastline, wiping out our orca, salmon, and seals . . . each giant tar sands tanker is an accident waiting to happen. And *big* oil companies are proposing over 600 new ones in our waters annually . . . most of the tankers would be full of dirty oil from Canada's tar sands, courtesy of new pipelines to our coast. Risky pipelines, risky tankers, but the riskiest thing of all is the oil itself . . . who's behind it all? *Energy giants* with shoddy track records like Enbridge and Kinder Morgan . . . oil from Canada's tar sands is the dirtiest oil in the world . . . Who pays the price of big oil companies' *inevitable* spills? We do. Our Health does. The salmon and the orca do. Our provincial, state and, local economies do. (2013, emphasis added)

The group goes on to recommend that we stop using tar sands, abandon fossil fuel subsidies, start using wind and solar energy, and get high speed rail and electric cars, along with cleaner fuel standards (ForestEthics, 2013).

The Council of Canadians, which is associated with Canadian activist Maude Barlow, has issued a *No Pipelines! No Tankers!* report. The report issues concerns about increased tanker traffic from the proposed Kinder Morgan expansion. Concerns are also raised with the proposed Northern Gateway pipeline and associated tanker traffic. The report contends that spill response precautions are not adequate and that the waters are exceptionally hazardous. In conclusion, the report argues that the two projects benefit "Big Oil companies while putting millions of people and the planet at risk" and thus we should not allow the projects to move forward (The Council of Canadians, 2012: 25).

The David Suzuki Foundation has also come out against tanker traffic, arguing that tankers threaten Canadian waters. The Suzuki Foundation, while leveling concerns for tankers in the North and West Coasts, has also dissented to tankers on Canada's East Coast (Suzuki Foundation, n.d.).

Finally, work by individuals associated with the Pembina Institute takes a more technical argument against tanker traffic than do other civil society groups. They argue that because of the geographic conditions associated with the Northern Gateway, a spill is not an if but rather a when; because of corrosion—which they cite as being a greater concern because bitumen is more corrosive than conventional oil—spills are more likely to occur; and finally, it will be unknown whether tankers servicing the Enbridge Pipeline will have their cargo tanks protected with special coatings as this requirement came in after January 1, 2013, and further bitumen is more likely to wear away at the protective coating faster than conventional oil (Swift et al., 2011).

Political opposition

There has been a long-standing political opposition to oil tankers in Canada, particularly from the NDP and the Green Party. Numerous attempts have been made to pass bills in the House of Commons that would effectively ban oil tanker exports of oil sands crude. In 2007, NDP MP for Victoria Denise Savoie introduced a private members' bill calling for a federal moratorium on the passage of international tanker traffic off the coast of BC. In 2008, Catherine Bell, the NDP MP for Vancouver Island North, introduced a bill that would prohibit the transport of oil in a tanker off the West Coast. The bill failed when the session ended, but Don Davies, NDP MP for Vancouver Kingsway, introduced an identical bill in 2009. On December 7, 2010, Nathan Cullen, NDP MP for Skeena-Bulkley Valley, introduced a bill that would "ban bulk oil tanker traffic" off BC's West Coast. A week later on December 14,

2010, Liberal MP for Vancouver Quadra Joyce Murray introduced a bill similar to the Bell and Davies bills. On June 14, 2011, Fin Donnelly, NDP MP for New Westminster-Coquitlam, introduced a bill similar to his NDP predecessors and this bill appeared to be aimed at tanker traffic associated with the Northern Gateway pipeline. The bill, however, never moved pass the First Reading in the House of Commons (Hage, 2012).

In the 2013 BC election both the NDP and Green parties took strong stances against oil tanker exports. NDP leader Adrian Dix opposed ending what he described as a 40-year ban on tanker traffic on BC's North Coast and also opposed transforming Metro Vancouver's ports into major exporters of oil (BC NDP, 2013).

The Green Party of BC has taken a radically strong stance against tanker traffic. As presented in the party's Consolidated Policies document (2013), the stance of the party in 1989 was that "all oil tanker traffic off the BC coast should stay outside the 200 mile limit" and "the Canadian Armed Forces and Coast Guard should enforce the 200 mile limit for tanker traffic." In 2012, the party proposed that it would "protect BC's statutory right for final decision on the Northern Gateway (Enbridge) proposal by taking immediate action to exercise its 30 days notice to withdraw from the National Energy Board's (NEB's) Joint Review Process for this project and clarify now that BC will not delegate to the NEB its responsibility to asses Kinder Morgan's proposal" and "Establish . . . a permanent ban on crude oil tankers on the west coast of BC to protect BC's fisheries, tourism, coastal communities and natural ecosystems, forever".

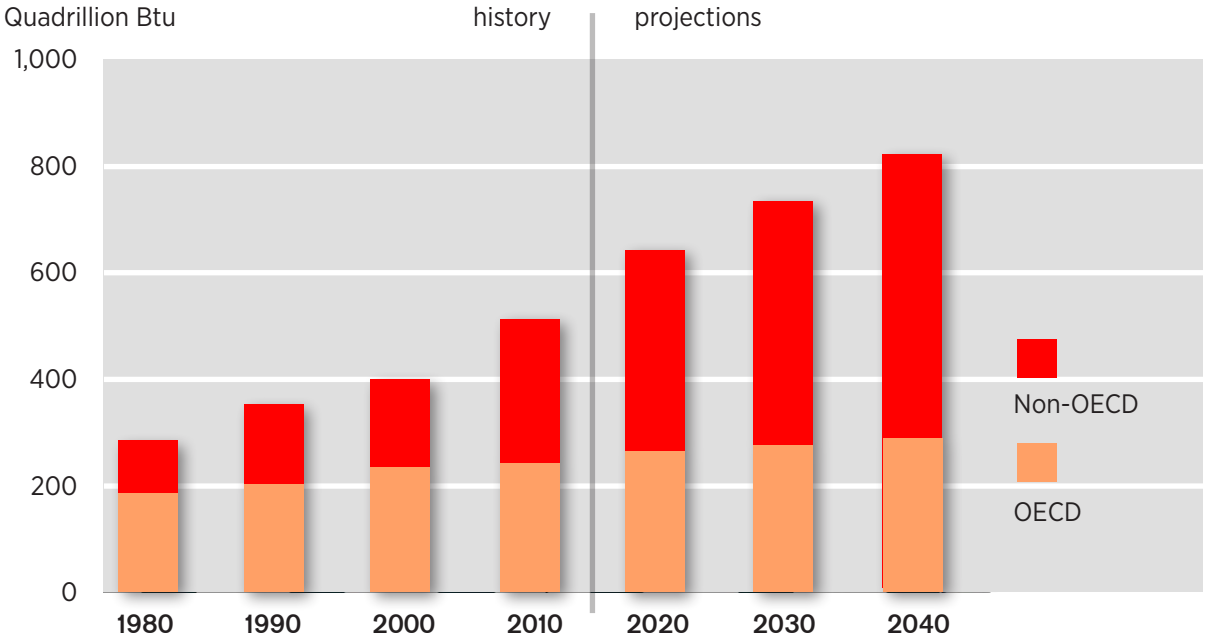
We now turn to a discussion of the potential benefits and risks of shipping oil (or bitumen) by tanker off the shores of Canada.

World energy demand

Energy is the backbone of the world economy and liquid fossil fuels are its primary source. The US Energy Information Administration (EIA) publishes annual reports capturing energy use statistics, trends, and projections in the US and around the world. In the *International Energy Outlook 2013* report, the expert predictions are that world energy consumption will grow by 56% between 2010 and 2040 (EIA, 2013: 1); see **Figure 1** below. The long-term global energy demand growth trend therefore remains on course. However, there is a distinct deceleration in the rate of growth, with the focus of the growth being in the emerging economies led by China and India, which

are not OECD[1] (Organization for Economic Co-operation and Development) countries. Strong, long-term economic growth factors trigger the sustained energy demand surge in these emerging economies where energy consumption is expected to increase by 90%. In the OECD countries the projected rise is 17% in the same time period (2010 to 2040). On a global scale, the projections are that energy use will swell from 524 quadrillion British thermal units (Btu) in 2010 to 630 quadrillion Btu in 2020 and to 820 quadrillion Btu in 2040 (EIA, 2013: 1). Meeting this demand is a challenge that provides a tremendous and unparalleled economic opportunity for Canada and all Canadians. In the national interest, such an opportunity cannot be ignored.

Figure 1: World energy consumption in quadrillion Btu, 1980–2040



Source: EIA (2014), Total Primary Energy Consumption; EIA (2013) International Energy Outlook 2013

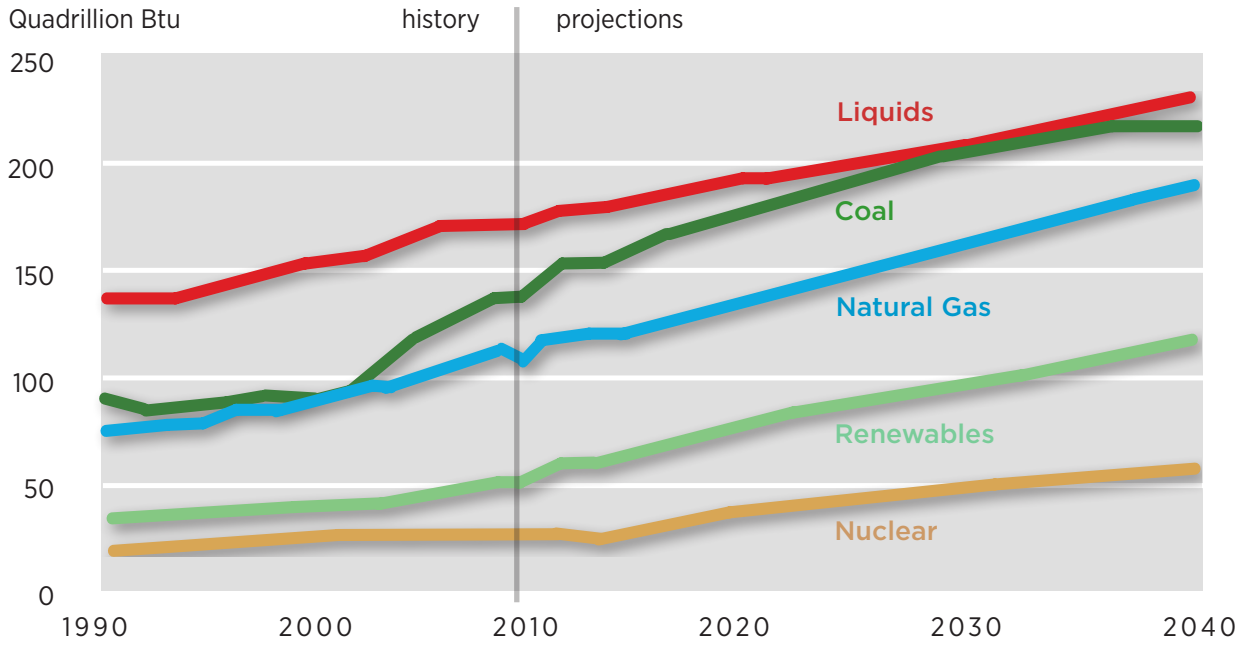
The EIA report (2013) predicts that until 2040 fossil fuels will supply about 80% of world energy use. These projected figures, although speculative,

1. The Organisation for Economic Co-operation and Development (OECD) is a forum of developed countries founded in 1961 for the purpose of stimulating economic progress and world trade. The International Convention on the Organisation for Economic Co-operation and Development was originally signed and ratified by 20 member countries, and the membership currently stands at 34. The OECD exists to promote the market economy, compare policy experiences, identify and pursue best practices, coordinate domestic and international policies of member nations, and uphold the democratic process.

display the best predictable trends with the currently available information. Despite this preponderant reliance on fossil fuels, the fastest-growing sources of energy worldwide currently are renewable energy and nuclear power. As shown in Figure 2, the current annual increase in the use of each of these sources of energy is 2.5%. The annual global increase of natural gas consumption is 1.7%, making natural gas the most rapidly growing fossil fuel in the EIA's Outlook. In these projections, the blossoming of natural gas use across the world is supported by the proliferating supplies of 1) tight gas, 2) shale gas, 3) and coalbed methane. Driven largely by China's expanded consumption of coal to fuel its robust economic growth, along with sluggish increase in the demand for liquid fuels from lacklustre growth in the OECD countries and consistently high oil prices, the use of coal as a source of energy records swifter gains until after 2030 than petroleum and other liquid fuels. As evident from Figure 2, the world's largest source of energy will continue to be liquid fuels well into the future to such an extent that liquid fuels have no viable substitute as the prime source of energy for the next few decades, especially for transportation uses, even though there will be noteworthy advances in alternative energy forms (EIA, 2013: 2). The evolving environmental impact awareness and concern among the public of fossil fuel use and alluring government incentives for boosting renewable energy use in many countries around the world are likely to lead to a gradual levelling-off of the rise in liquid fossil fuel consumption.

2. *Tight gas* refers to natural gas locked in underground hard rock formations or in sandstone or limestone rock formations that are impermeable or nonporous. Unlike conventional natural gas formations, which can be drilled and the gas extracted from the ground or underwater relatively easily, the extraction of tight gas requires the use of modern technology and special procedures known collectively as *hydraulic fracturing* or *fracking*.
3. *Shale gas* is natural gas trapped in hard dense deposits of shale formed from ancient sea basins millions of years ago. It is only in the last few years that the technology to economically access these resources has become available. Consequently, this energy source has assumed a position of preeminence in the United States, where the resource is in abundance. Whereas shale gas accounted for only 1% of US natural gas production in 2000, in 2010 it was over 20%. Shale gas deposits in the Arctic, Europe, and Asia are also being discovered and developed.

Figure 2: World energy consumption by fuel type in quadrillion Btu, 1990–2040

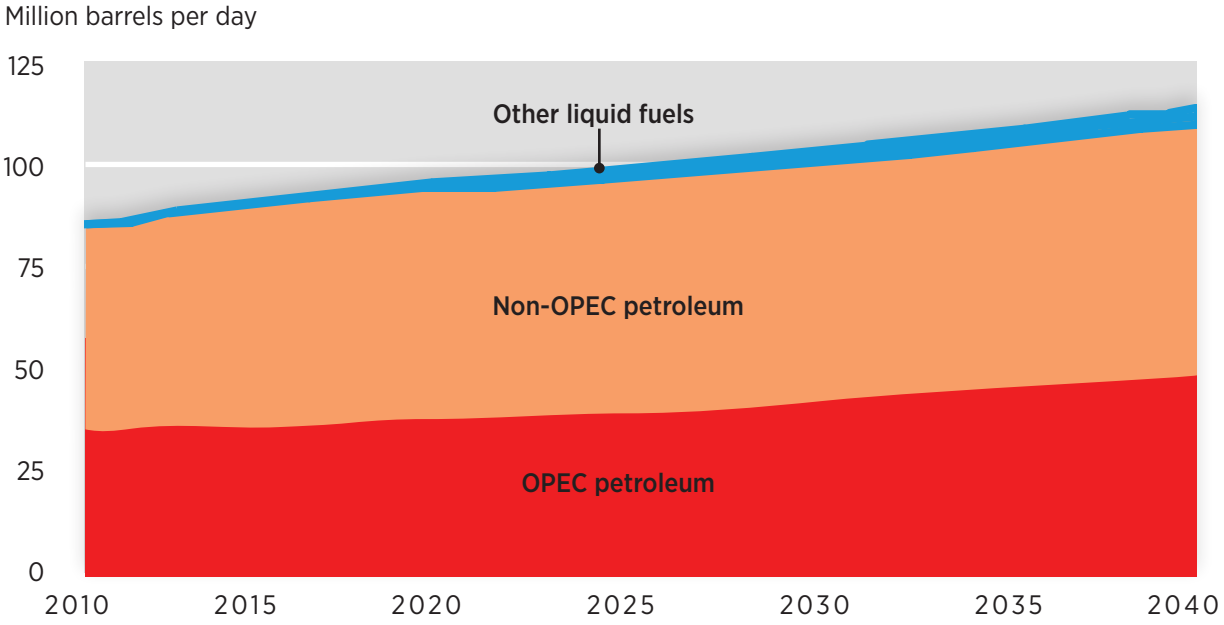


Source: EIA (2013), *International Energy Outlook 2013,* Figure 2.

Across the globe the use of petroleum and other liquid fuels is expected to grow from 87 million barrels per day in 2010 to 97 million barrels per day in 2020 and 115 million barrels per day in 2040 (see Figure 3), with a matching growth in production. The transportation and industrial sectors will account for the major portion of this growth in the use of liquid fuels. Particularly in the transportation sector, most of the energy consumed will be provided by the use of liquid fuels. Furthermore, advances in non-liquid fuel based transportation technologies, although anticipated, are unlikely to offset the rising demand for transportation services worldwide and the associated requirements for liquid fuels (EIA, 2013).

Despite the likelihood of increasing fuel prices, the use of liquid fuels for transportation is likely to rise by an average of 1.1% per year from 2010 to 2040, or by 38% overall. The majority of the total increase in liquid fuel use from 2010 to 2040 (63%) is accounted for by the transportation sector and the remainder is attributable to the industrial sector with a focus on the chemicals industry. For other end use sectors and for electric power generation the use of liquid fuels is projected to decline. In order to meet the growing world demand, liquid fuel production is expected to rise by 28.3 million barrels per day from 2010 to 2040 (EIA, 2013: 2).

Figure 3: World petroleum and other liquid fuels production in millions of barrels per day, 2010–2040



Source: EIA (2013), *International Energy Outlook 2013*, Figure 3.

Canada's energy supply potential

Energy is a critical component of the Canadian economy. Canada's resources and climate put Canada among the largest producers of energy and also among the highest per-capita consumers of energy in the world. Hence, the secure and sustainable production, transportation, distribution, and consumption of our energy resources present challenges and opportunities for Canadians.

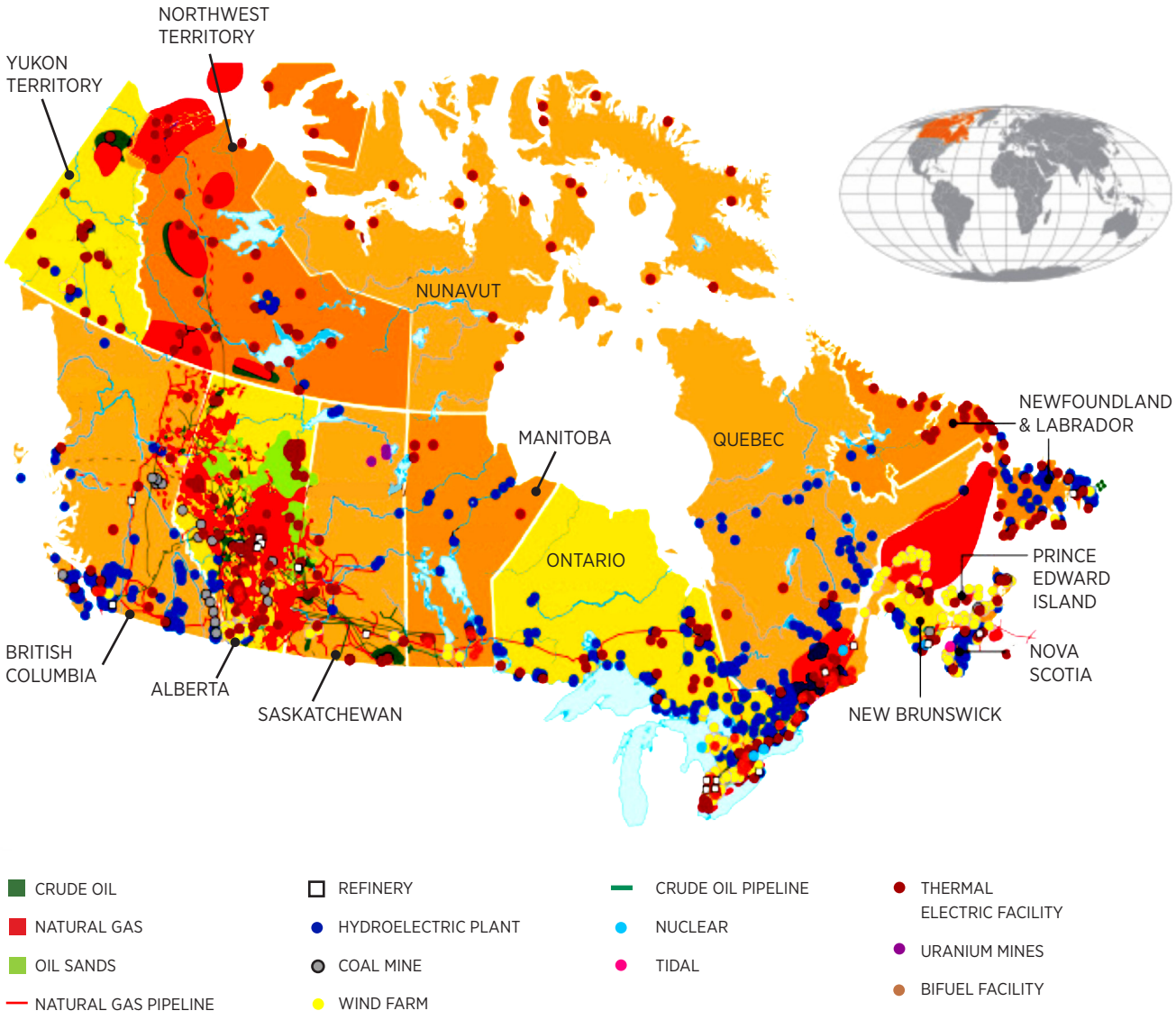
Canada's energy map is shown in **Figure 4** to draw attention to the sources of fuels and the challenges of their distribution to domestic and international markets. The energy sector has a coast-to-coast-to-coast footprint and offers a diversity of energy production sources, ranging from conventional energy sources like oil and gas to new alternative energy sources like wind and solar. The energy sector directly employs more than a quarter of a million people or 1.8% of Canadian employment and the sector represents 6.8% of Canadian gross domestic product (GDP) (Natural Resources Canada, 2013, Nov. 4).

There has been a sturdy link between Canada's oil and gas supply and US energy demand for the past six decades resulting in Canada's

traditional and sole energy market being our neighbours to the south. Technological developments and discoveries of new fields have, however, led to enhanced resource extraction and production, thus outstripping the absorption capacity of the traditional market. The rapid growth in American shale oil and gas production as well as political wrangling and gridlock have adversely affected the southern demand, making the transportation of Canada's resources to the demand intensive and far-flung emerging economies of the world a top priority for economic progress and stability. As can be seen in **Figure 4**, the Canadian sources of oil and gas are largely in landlocked areas, thus requiring an efficient transportation network for distribution to domestic, contiguous, and trans-ocean markets.

Canada's oil sands are a major resource within Canada's energy sector, accounting for 97% of Canada's total oil reserves (Natural Resources Canada, 2014, Apr. 11), bestowing on Canada the number three world ranking in crude oil reserves (after Saudi Arabia and Venezuela) (Natural Resources Canada, 2013, Nov. 4), and making Canada the fifth largest oil producer in the world (Natural Resources Canada, 2013, Sept. 5). Without any escalation in the current rates of production, Canada's proven oil reserves are adequate to meet demand for around 140 years (Natural Resources Canada, 2014, Apr. 9). These proven oil reserves are estimated at 173 billion barrels, of which 168 billion barrels are in Alberta's oil sands. In 2010, energy accounted for 22.5% of merchandise exports. The energy trade balance ranked first as a contributor to Canada's positive overall trade balance (Natural Resources Canada, 2013, Nov. 4). Establishing a sound and secure transportation infrastructure to convey the oil and gas from the oil sands to the West Coast and thence by sea to the demand intensive emerging countries on tankers is a matter of high priority for all Canadians, in the interest of national economic growth and maintenance of our living standards.

Figure 4: Canada's energy map, 2014



Source: Centre for Energy (2014), Canada's Energy Map.

Challenges of oil sands resource transportation

Of Canada's daily oil production of 3.5 million barrels, 54% comes from the oil sands of Alberta. The Canadian Association of Petroleum Producers (2014) expects that share to rise to 75% of the total daily Canadian oil output by 2030, by which time the daily output will be 6.4 million barrels. However, this can happen only if new markets are found and the industry is consequently

incentivized to invest billions of dollars in new and expanded projects, and add an estimated 13,000 personnel to its current workforce of 25,000.

The shale oil and gas boom in the United States has adversely affected American import demand and continues to foster US political indecisiveness regarding approval of TransCanada's planned Keystone XL pipeline, which would transport oil from Alberta to refineries on the Gulf Coast, despite sustained political pressure from the Canadian federal government and the provincial government of Alberta.

The Canadian federal government approval on June 17, 2014 of the CA$6.5 billion Enbridge Northern Gateway Pipeline (1,200 km long) reflects a determination to diversify Canada's export markets and pursue the opportunities presented by the rapidly growing emerging Asian economies. This pipeline project of the oil transportation company Enbridge is intended to carry 525,000 barrels of bitumen a day to Kitimat on British Columbia's Pacific coast for shipment to Asia. Getting the crude oil and natural gas to the West Coast for export on tankers, with the natural gas in liquefied form, is crucial to avoid the risk of stranding an invaluable asset with the associated enormous loss of revenue to producers, governments, and the public at large. Canadian oil is largely landlocked, requiring reliable transportation systems to export both to the US and to overseas markets. The realization of the proposed TransCanada Keystone XL pipeline to the south and the Enbridge Northern Gateway project to the western coast offers the most cost-effective and expeditious means of reaching these foreign markets.

It should be noted, moreover, that even if both these energy distribution infrastructure undertakings were completed and on stream, the energy demand would escalate more rapidly than the distribution capabilities and, by 2030, demand would surpass the distribution capacity (PricewaterhouseCoopers).

There are therefore plans for doubling the capacity of Kinder Morgan's Trans Mountain Oil Pipeline from Edmonton to Vancouver with a CA$5.4 billion investment, and regulatory proceedings have begun. TransCanada's Energy East project seeks to convert 3,000 km of cross country natural gas pipeline to oil and construct 1,500 km of new pipe, with an investment of CA$12 billion for the purpose of shipping various grades of western Canadian oil to eastern refineries and to ocean terminals at Gros-Cacouna, Quebec and Saint John, New Brunswick, from where the markets of the Atlantic Basin and beyond can be accessed. Furthermore, a significant growth in rail-transported oil to Canada's West Coast is predicted, increasing from 200,000 barrels a day at the end of 2013 to 700,000 barrels a day by 2016.

These projects for the movement of resources to the East and West Coasts will require marine transportation for a significant portion of their transit to the foreign market destinations. It is here that Canada has a noteworthy maritime history of providing safe, reliable, and efficient ocean transportation services. This experience and culture of safety gained over many

decades can underpin a dependable marine highway to access these overseas oil and gas markets and thus bolster the national economy, job creation, technical progress, and regional development. The safe movement of oil and liquefied natural gas on tankers to world markets is the keystone in the implementation of these plans and projects.

Canadian shipping

In terms of landmass, Canada is the second largest country in the world, has the world's longest coastline (243,000 km), fronts on three oceans, and has the largest inland waterway system in the world. Canada's isolated northern trans-continental footprint makes water transportation especially vital to the success of the economy. Hence, to compete in a global marketplace and to develop dynamic and flexible trade relationships with other nations, Canada must command a reliable, safe, efficient, and environmentally friendly marine transportation system capable of responding to the changing needs of trading partners and new markets. This will enhance the smooth flow of goods and services while adapting to technological developments, globalization, and emerging economic powerhouses in Asia and Latin America. Transportation is a vital component of the larger energy sector as it enables Canadian producers to deliver demanded energy goods to customers around the globe. Water transportation in particular is critical for Canada's non-North American customers.

Canada has a vibrant marine transportation industry. Around 100,000 vessels transit Canadian waters annually, transporting more than 450 million tonnes of goods with an estimated commercial value of approximately CA$83 billion (Transport Canada, 2011). Marine and marine-related activity in Canada now contributes over CA$9 billion annually to the economy, positively impacting the lives and standard of living of all Canadians from coast to coast, while employing some 93,000 people (Canada's Marine Industry Alliance, 2005). Over 80 million tonnes of oil are shipped off Canada's East and West Coasts annually (Transport Canada, 2014, June 17: 1). The average number of SOLAS Convention ships operating within Canada's exclusive economic zone (200 nautical miles from shore) every day is 180.[4]

Transport Canada reports that, including both domestic and international ships, there were about 18,500 inbound commercial vessel movements in

4. SOLAS (Safety Of Life At Sea) Convention ships are ships over 500 gross tonnes that are regulated by an internationally accepted set of safety rules and procedures, which are respected and enforced by the nations party to the Convention. Canada is a member of the SOLAS Convention.

Canada in 2011 at ports on the West Coast, and tankers accounted for about 246 movements (1.3%). The safe and regular movement of oil tankers along the West Coast has been going on since the 1930s. Most of the oil is moved through the ports of Vancouver, Prince Rupert, and Kitimat and in 2011 the quantity of oil shipped out of Vancouver was about 2.2 million tonnes. The main form of marine transportation of this oil is by barges that ply back and forth along the British Columbia coast to service the littoral communities. Container ships, international and domestic ferries, and other types of private and commercial vessels are also employed to transport smaller quantities of oil. To monitor the marine transportation activities along the West Coast, there were 419.7 patrol hours flown by the National Aerial Surveillance Program (NASP) in the fiscal year 2010–2011. NASP conducted 3,893 vessel overflights in the same period. NASP flew 549.6 surveillance hours and overflew 4,153 vessels in the fiscal year 2012-2013 (Transport Canada, 2014, June 17: 2). Thus a strict, cogent, and reliable monitoring and regulatory compliance system is assured, which is a powerful, robust, and persuasive deterrent.

In the same report, Transport Canada has provided equivalent statistics for the East Coast. There are about 20,483 inbound vessel trips per year on the East Coast, of which 11,434 are domestic and 9,049 are international. About a fifth of these trips (3,890 vessel movements) are accounted for by tankers. The East Coast therefore has 16 times more tanker trips per year than the West Coast (246). The quantity of petroleum and fuel products moved into and out of the 23 ports in Atlantic Canada is over 82 million tonnes, with about 94% of all the crude oil and petroleum products moved in Atlantic Canada being handled at the ports of Come By Chance, Newfoundland and Labrador, Port Hawkesbury, Nova Scotia, and Saint John, New Brunswick. The quantity of crude oil and petroleum products moved into and out of Quebec's 39 ports where cargo is loaded or discharged is 25 million tonnes and 89% of this quantity is handled by ships stopping at the ports of Quebec and Montreal. To monitor the marine transportation activities along the East Coast, there were 1,490 surveillance hours flown by NASP in the fiscal year 2010–2011. NASP conducted 5,326 vessel overflights in the same period (Transport Canada, 2014, June 17: 2).

The maritime activity in Canada's Arctic waters is significantly less than in the Atlantic and Pacific waters with fewer than 150 vessels plying in the Arctic each year. Fewer than 10% of these vessels are tankers. For monitoring and control, the patrol hours flown by NASP in the Canadian Arctic in 2010–2011 was 230 and the number of vessel overflights was 459 (Transport Canada, 2014, June 17: 2). Compliance and enforcement is therefore assured on all the coasts.

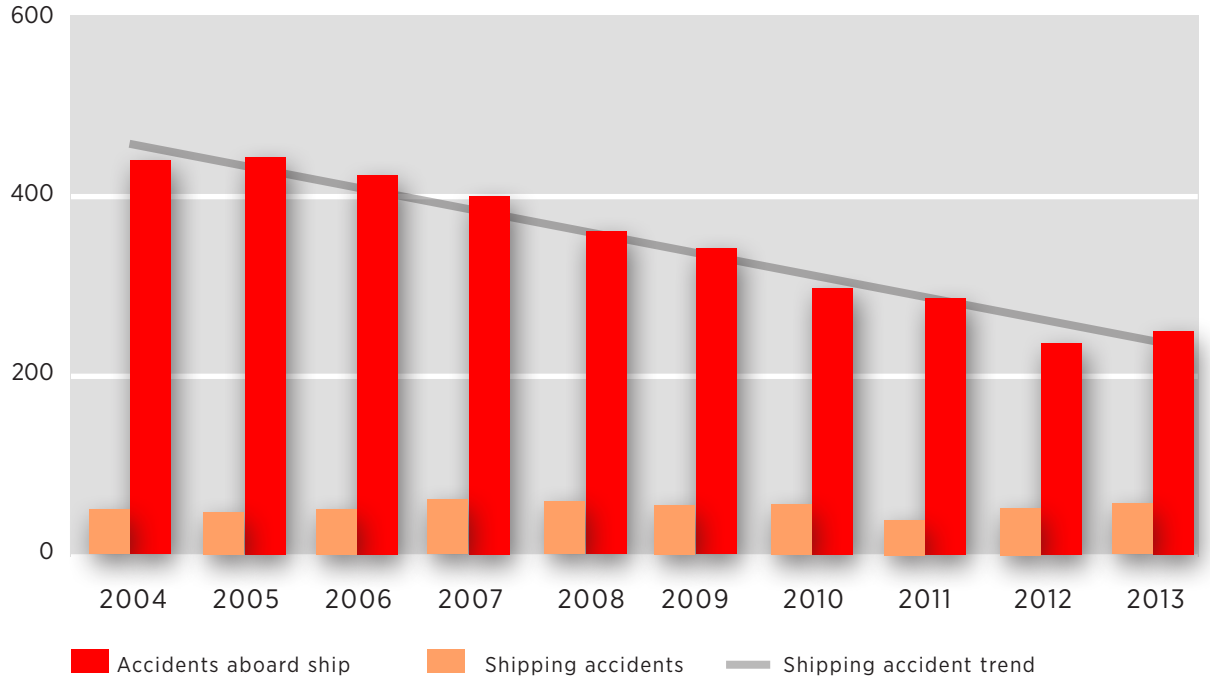
Canada's maritime oil spill record

There has never been a significant spill of crude oil in Canadian waters despite tens of thousands of transits on the East and West Coasts, including the year-round delivery of crude oil to the Valero refinery at Saint-Romuald, Quebec, on the south shore of the Saint Lawrence River from Quebec City.

The effectiveness of the federal government's compliance and enforcement program is borne out in the accident record on the Canadian coasts. There was only one significant oil spill incident on the West Coast in the last 20 years and this occurred in 2006 with the sinking of the *Queen of the North* ferry, after running aground on Gil Island in British Columbia's Wright Sound, with 240 tonnes of oil on board, most of which remained contained within the sunken vessel. To put this in perspective, the famous 1989 *Exxon Valdez* accident in Alaska's Prince William Sound resulted in a crude oil spill of approximately 40,000 tonnes. The only other marine oil spill incident on the west coast was the 1988 oil barge *Nestucca* spill off Grays Harbor, Washington, US, which lost approximately 87 tonnes from collision with a tug. On the East Coast, the 1970 grounding accident of the tanker *Arrow* caused an oil spill off the Nova Scotia coast in Chedabucto Bay of over 10,000 tonnes. This is the most significant incident on the East Coast, and the quantity spilled is only about a quarter of the quantity spilled by the *Exxon Valdez* in 1989 (Transport Canada, 2014, June 17: 2).

There has been a consistently declining trend in Canada's shipping accident history as seen in **Figure 5**. A 38-year low in the total annual number of Canadian shipping accidents was achieved in 2012 when the number of accidents was only 236. This was 18% lower than the 2011 total of 287 and 30% lower than the 2007 to 2011 average of 337 (Transportation Safety Board of Canada, 2014). The number of Canadian shipping accidents in 2013 was 250, which was 5% higher than the 2012 total but 18% lower than the 2008 to 2012 average of 305. When statistical analysis using linear regression is employed, a marked descending trend in the number of shipping accidents since 2003 is evident (Transportation Safety Board of Canada, 2014).

Figure 5: Canadian shipping accidents, 2004–2013



Source: Transportation Board of Canada (2014), *Statistical Summary – Marine Occurrences 2013*, Figure 1.

Tanker safety

Technological improvements and safety enhancements are an inherent component of every area of business activity, be it road transportation, aviation, medical and health services, computing and information technology, or mining and manufacturing. In such industries the improvements and safety enhancements tend to be high profile and are widely publicized in the media. The same phenomenon of technological improvements and safety enhancements has been occurring in the marine transportation industry and especially in the seaborne transportation of crude oil but it has been mostly outside the public view. Hence, the public perception has generally been static and therefore removed from reality. Double hulled tankers, coating protected cargo and ballast tanks, strong inspection regimes, aids to navigation, compulsory training regulations, and mandatory pilotage requirements are some of the measures implemented in Canada to enhance tanker safety, prevent oil spills, and allow technological developments to raise the safety profile of oil tankers and reduce risk. The industry has been dynamic and progressive, although this fact has not received the public attention it deserves. Whereas the major industries (mentioned earlier) employ thousands of people, an oil

tanker carrying, for example, 100 million litres of crude oil has a crew of just 24 persons, thanks to the benefits of modern technology.

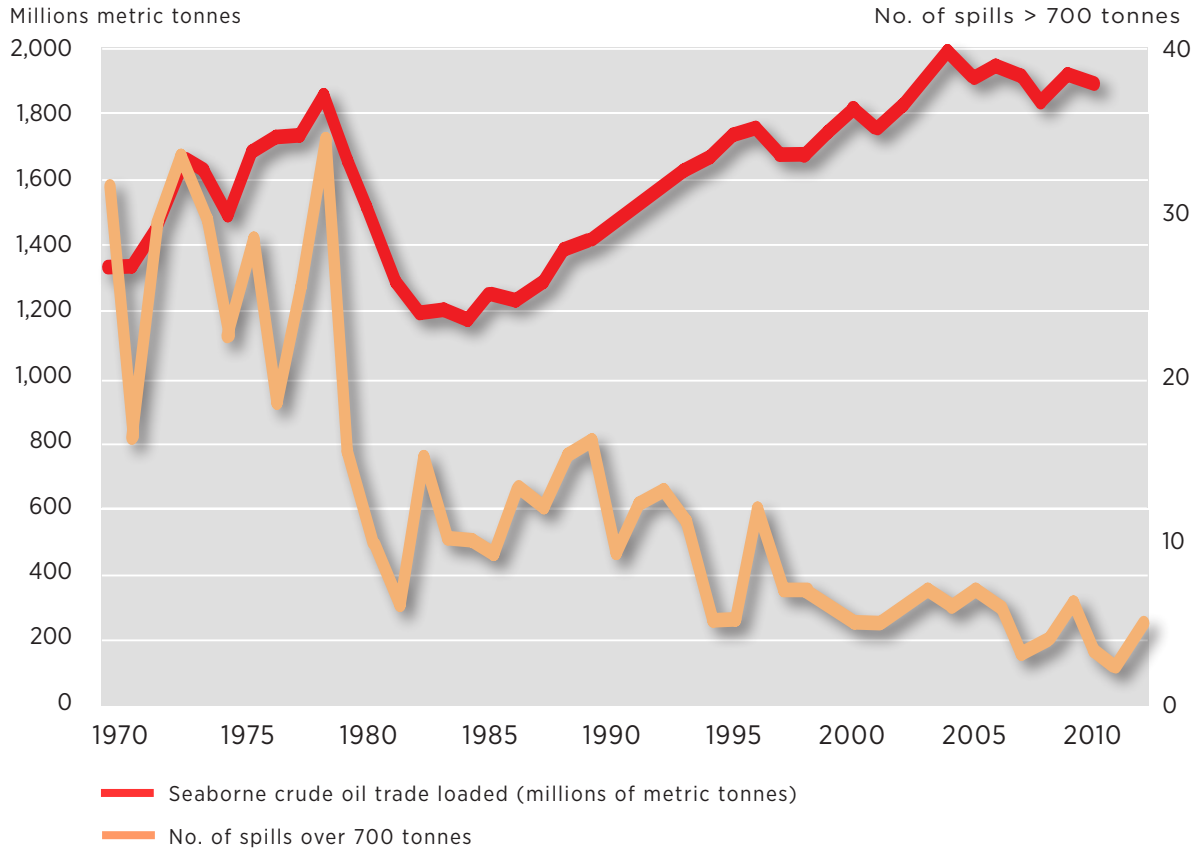
Technology has also been employed with noteworthy success in the prevention of cargo induced chemical corrosion in tankers. For decades tankers have been carrying heavy crude oils with reliable heating systems to maintain the product's fluidity, ease the process of discharge through cargo pumps, and prevent tank surface adhesion and coagulation. These cargo tanks are coated with two component, high build epoxy coatings that have excellent resistance to organic acids, alcohols, edible oils, fats, and solvents. The coating forms a solid barrier between the oil cargo and the steel cargo tank internal surfaces of the ship to obviate corrosion and minimize steel wastage. Carriage of bituminous crude oil of the Alberta oil sands variety in tankers is therefore a practice that the tanker shipping industry is well prepared for. The International Convention for the Prevention of Pollution from Ships (MARPOL Convention) classifies bitumen as a heavy grade oil (HGO) requiring specialized ship characteristics for its carriage, in the interest of safety, asset preservation, and environmental conservation (International Maritime Organization).

Such regulatory mandates and certification of tankers compel adherence to the cargo tank coating scheme best suited to the ship and the cargo it carries. A departure from these regulations or non-compliance will legally block the ship from carrying a product that may corrode or damage the ship's structure. An aggressive cargo like bitumen is therefore prevented from chemically interacting with the ship's steel cargo tank surfaces by the solid, continuous, indissoluble, and impermeable coating barrier, thus eliminating electrolytic action and corrosion. These tankers are also equipped with inert gas blanketing systems to render the tank atmosphere chemically inactive, oxygen deficient, and explosion proof. The cargo tank cleaning machines are designed to access all the tank surface areas and remove residues and possible sources of corrosion after cargo discharge. To facilitate this cleaning process and make the cargo tank bulkheads even, smooth, and easy to clean, the longitudinal girders and transverse web frames are installed on the main deck and in the outer shell of the doubled hulled tankers. Furthermore, corrosion-resistant steels are being developed to improve the corrosion resistance of ship structures compared to that of normal shipbuilding steels. Several ships also have stainless steel cargo tanks that are inherently resistant to corrosion. The chromium in the stainless steel forms a passive film of chromium oxide to exclude oxygen dissemination to the steel surface, thus inhibiting corrosion.

Transportation is a key component of the larger energy sector and Canada has a vigorous marine transportation industry. The demand for energy has been on the rise from year to year and is predicted to continue growing along with the reliance on fossil fuels. Since the mid 1980s, seaborne

oil trade globally has been on the upswing to fuel the world's energy needs but, counterintuitively, the marine environmental damage caused by oil spills has been declining. Over the last four decades, the volume of oil spills from ships has been rapidly decreasing despite growing maritime trade, and Canada's trade and accident statistics reflect this global trend. **Figure 6** illustrates and contrasts the level of worldwide seaborne oil trade against the number of oil spills in excess of 7 tonnes. Seaborne oil trade has been growing steadily since 1970, except for a fall in the early 1980s during the worldwide economic recession. Beginning in 1985, the two trend lines diverge, wherein large decreases are recorded in the number of oil spills while the volume of seaborne oil trade increased substantially.

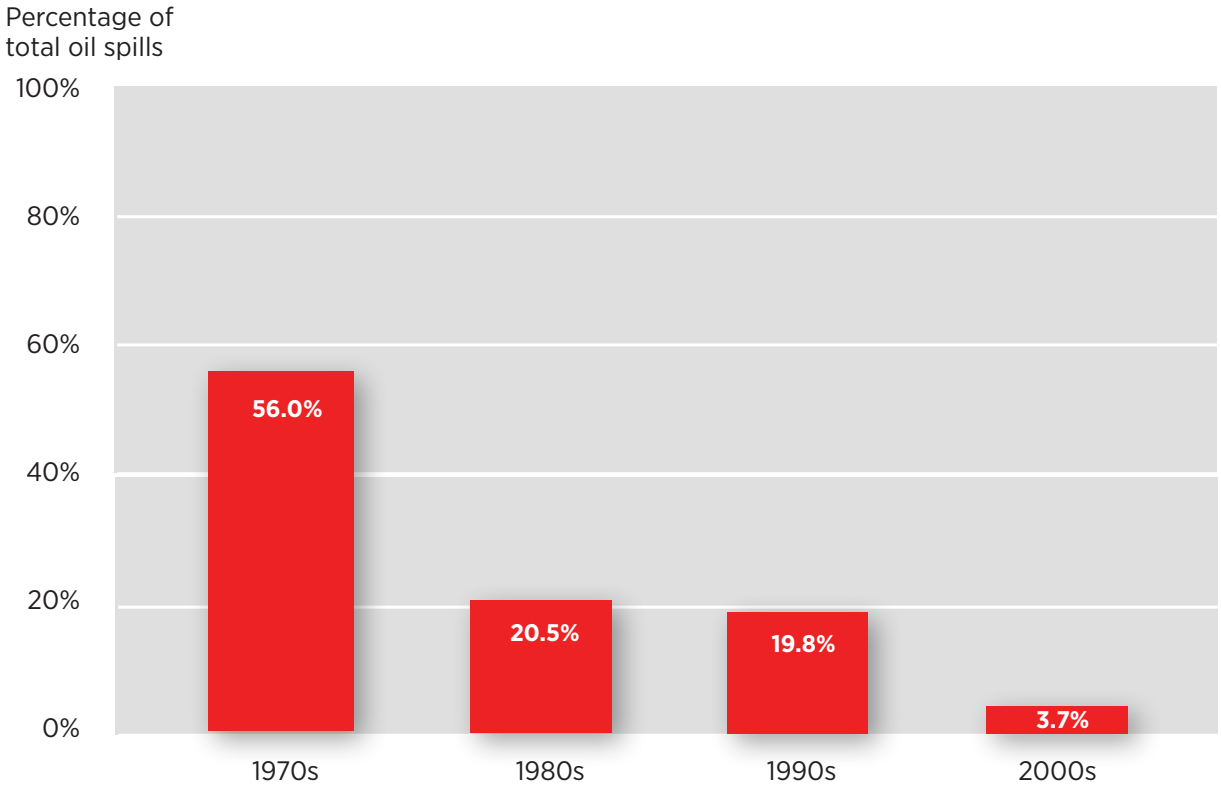
Figure 6: Seaborne oil trade and number of oil spills greater than 700 tonnes, 1970–2013



Source: International Tanker Owners Pollution Federation (2014). Oil Tanker Spill Statistics 2013; UNCTAD (2013), UNCTADstat: World Seaborne Trade by Types of Cargo and Country Groups, Annual, 1970-2011

Figure 7 depicts the percentage per decade of total volume of oil spilled over the last four decades. It is fairly clear that there has been a precipitous decline since the 1970s. Over half the volume, 56% of the total amount of oil spilled worldwide in 40 years, was in the 1970s. The percentage of the total drops to 20.5% in the 1980s and remains fairly constant at 19.8% in the 1990s. The percentage for the 2000s drops markedly to 3.7% of the total volume of oil spilled over the 40-year period.

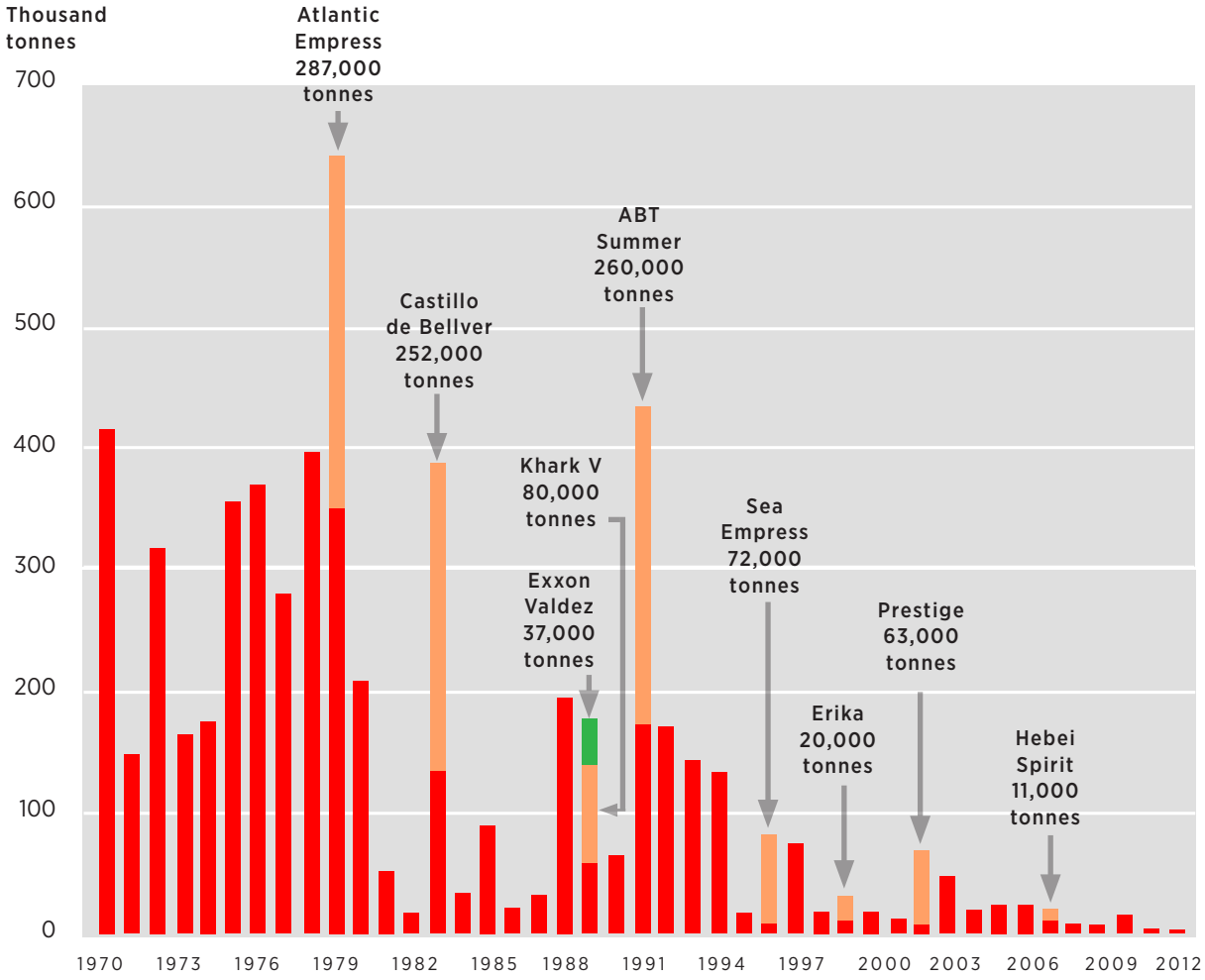
Figure 7: Percentage per decade of total oil spills worldwide by volume over the last four decades, 1970–2009



Source: International Tanker Owners Pollution Federation (2014). Oil Tanker Spill Statistics 2013

In the face of growing maritime trade, the reduction in marine accidents and accidental oil pollution incidents is remarkable, as illustrated in Figure 8.

Figure 8: Quantities of shipborne oil spills, 1970–2013



Source: International Tankers Owners Pollution Federation (2014), Oil Tanker Spill Statistics 2013, Figure 6.

The data contained in Table 1 is illustrative of Canada's performance. The number of major maritime tanker oil spills per decade declined from a high of 18 in the 1980s to 6 during the 1990s, to zero in the 2000s. Canada, along with the Netherlands and Sweden, recorded zero spills during the 2000s. Most other nations, except for South Korea, recorded meaningful losses and environmental damage through maritime oil spills.

Table 1: Number of tanker oil spills by country, 1970–2004

	Number of spills				
Brazil	7	9	7	6	29
Canada	12	18	6	0	36
Germany	9	9	5	3	26
Japan	39	29	14	4	86
Netherlands	20	15	6	0	41
Singapore	12	4	5	7	28
South Korea	1	10	19	4	34
Sweden	19	9	5	0	33
UK	34	27	16	2	79
	1970s	1980s	1990s	2000s*	Total

*Data for the decade is incomplete; it ends in 2004.

Source: Huijer (2005), Trends in Oil Spills from Tanker Ships 1995–2004, Table 3.

To Canadians, the marine environment represents strong and deep ties to our heritage and, consequently, prevention of oil spills as the first line of defence is universally recognized as critical. Simultaneously, preparedness and response for unforeseen contingency situations have been established nationwide as a second line of defence by the development of a network of human and material resources for deployment to combat, contain, and minimize accidental damage to the marine environment.

Canada's safety performance with respect to tanker transportation has improved over the last four decades, as has much of the maritime world. Canada is now a world leader in minimizing the number of accidents and oil spills in an environment of markedly increasing maritime transportation volume. During the past few years, the Canadian federal government has undertaken and completed a number of important initiatives related to transportation policy and has increasingly recognized the critical role that marine transportation plays in achieving broader economic and social objectives.

Although increased oil movement intuitively implies increased risk, the downward trend in marine oil spill incidents demonstrates superior

construction and regulatory standards and a keen sense of awareness, safety, and environmental consciousness in the tanker shipping industry. Improved codes of practice, training, and technology over the last four decades have had a marked positive effect on tanker safety worldwide and especially in Canada.

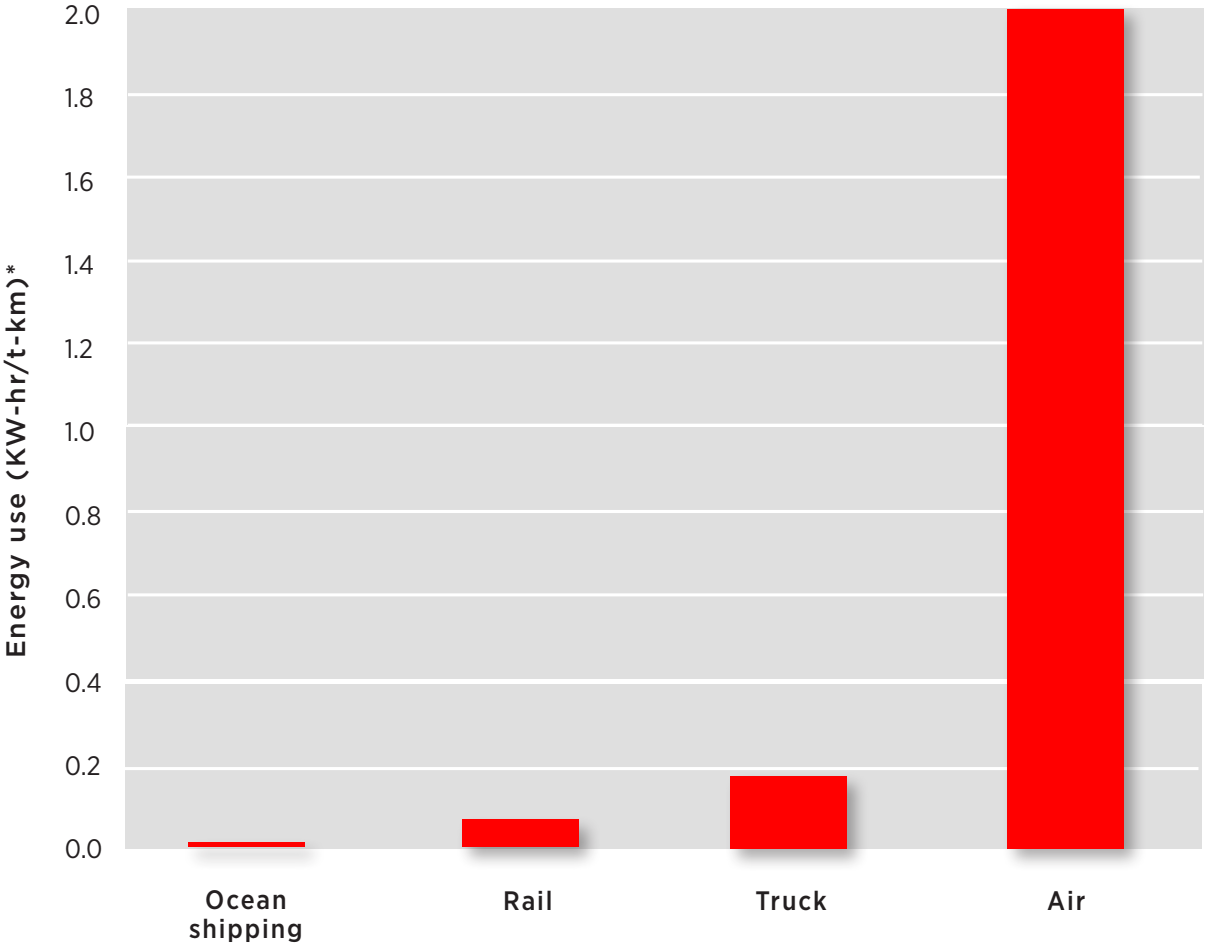
Cost-effectiveness and efficiency of shipping

The physical properties of water conferring buoyancy and limited friction make maritime transportation the most effective and efficient transportation mode for moving large quantities of cargo over long distances. Although the main maritime routes are composed of oceans, coasts, seas, lakes, rivers, and channels, the location of economic activities serve to concentrate the density of traffic to specific sections of the maritime space, particularly over the North Atlantic and the North Pacific. These sections are the vital trade highways for Canada's economic development and trade diversification.

Compared to other modes of transportation, ocean shipping has significantly improved its efficiency. The implementation of new technological concepts like double-hulled oil tankers, container ships, liquefied natural gas (LNG) carriers, open-hatch forest-product ships, chemical carriers, and car carriers have revolutionized the way goods are moved. The high productivity of shipbuilding, a rise in the efficiency of hulls and propulsion systems, a reduction in manpower requirements through automation, and economies of scale brought about by large ship sizes are other improvements made in maritime transportation (Michel and Noble, 2008: 34).

As shown in **Figure 9,** shipping is an extremely energy efficient mode of moving cargo over long distances based on energy consumption. The high carrying capacity of marine tankers translates into low costs to customers and the consuming public, when compared to other modes of transportation. For example, the typical cost to a Canadian consumer of transporting crude oil by sea on tankers from the Middle East, in terms of purchase price per litre of gasoline at the pump, is about half a cent (Michel and Noble, 2008: 34).

Figure 9: Comparative efficiencies of transportation modes

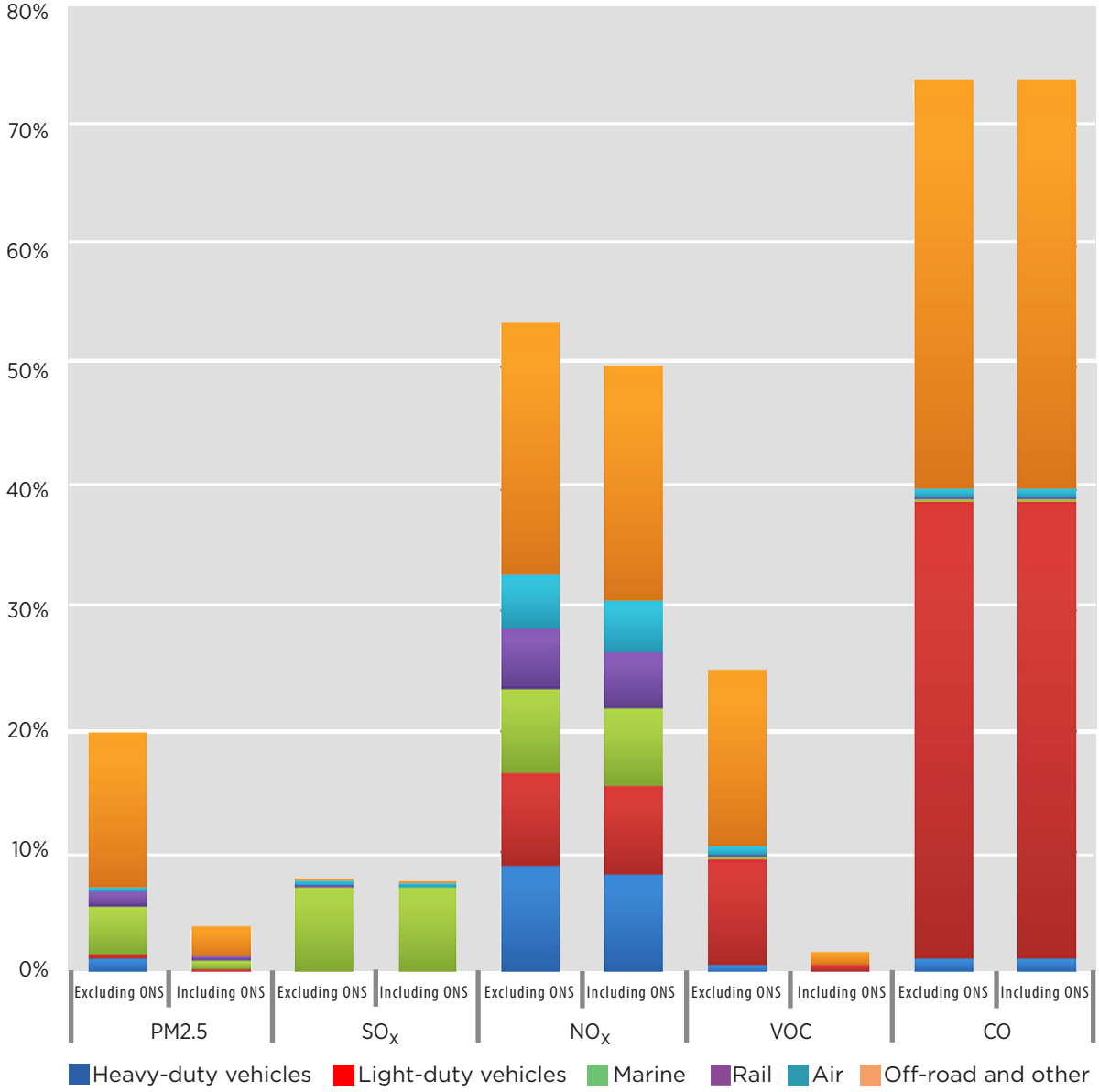


* The units are kilowatt-hours consumed per ton of mass moved over one kilometer.

Source: Michel and Noble (2008), Technological Advances in Maritime Transportation, Figure 2.

The high efficiency of maritime operations also contributes to comparatively lower GHG emissions per tonne-mile of cargo moved by ships than by other modes of transportation, as seen in **Figure 10**. This assures the sustainable and viable nature of commercial maritime activity. If we are to remain committed to leaving behind a responsible and rational trade and economic legacy for future generations, we have no option but to embrace the most efficient, safe, and cost effective mode of transportation. Furthermore, this is the only way of economically transporting large quantities of oil to overseas markets.

Figure 10: Share of total air pollutants and GHG emissions in the Canadian transportation sector, 2012



Note: ONS refers to Open and Natural Sources.

Source:Environment Canada (2013), National Emission Trends for Key Air Pollutants, 1985-2012, <http://www.ec.gc.ca/inrp-npri/>, as of October 6, 2014

From the perspectives of efficiency, productivity, cost-effectiveness, and reduced emissions, the maritime mode of transportation excels compared to other modes of transportation. However, in our dynamic world of perpetual progress and development we cannot afford to rest on our laurels. The evolving needs of maritime traffic growth, technological advancement, and trade diversification call for responsible environmental stewardship in all

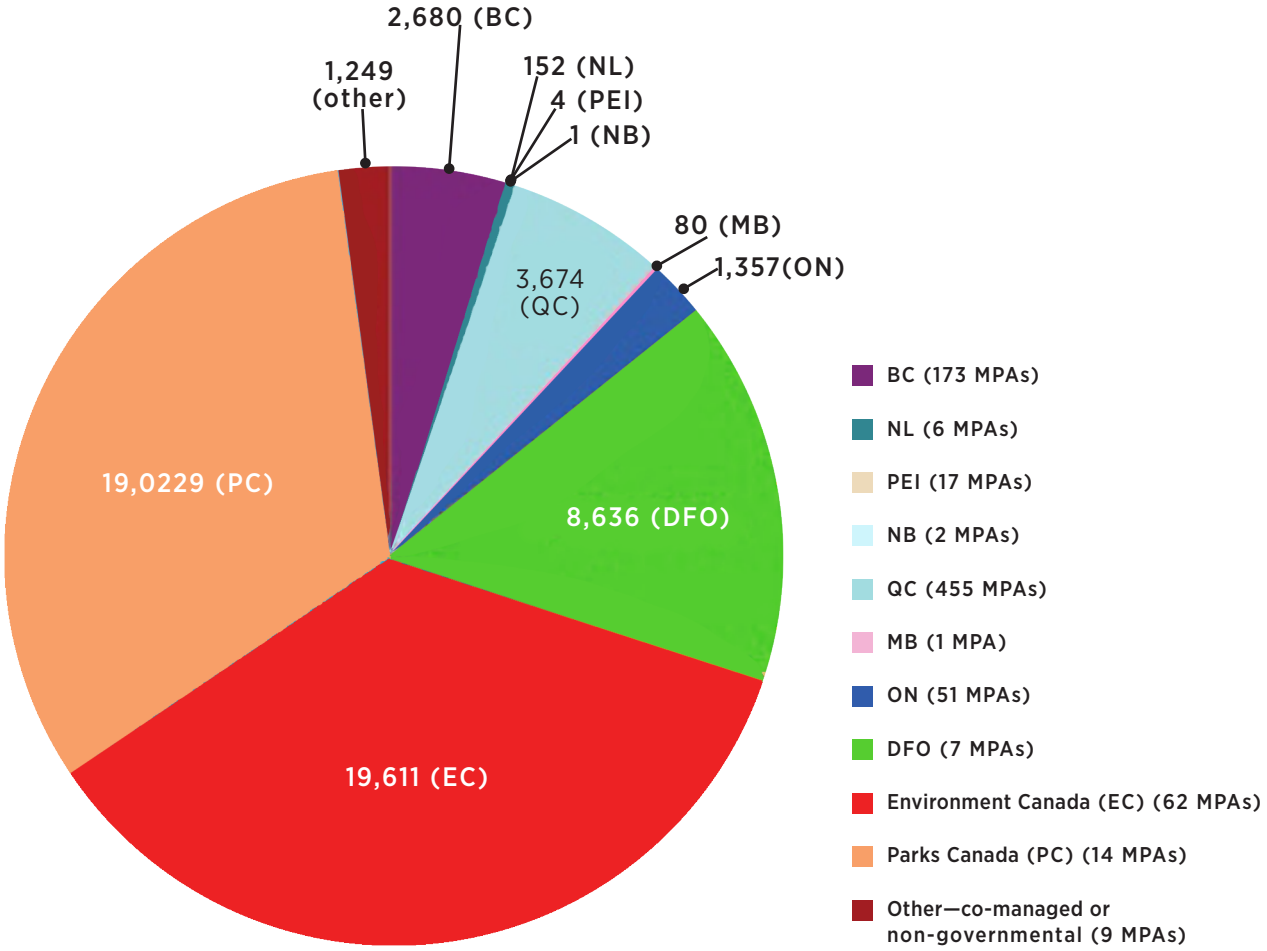
sectors of the oil industry, promotion of short sea shipping, a national policy on places of refuge for ships in need of assistance, and the establishment of a national risk assessment strategy for Canada's ports.

Ecological sensitivity and tanker traffic

As a maritime nation Canada is uniquely privileged from the marine trade perspective but simultaneously bears the responsibility of protecting and conserving the marine environment. Surrounded by three oceans, the Great Lakes and the enormous, icy Arctic frontier, Canada has the world's longest coastline, which bestows on Canada an elaborate and complex natural environment of marine life to be carefully safeguarded. By designating and developing marine protected areas (MPAs), the federal government and the provincial and territorial governments are constantly seeking and pursuing ways to husband Canada's marine ecosystems and guarantee their vigour and well-being. The MPA designation confers the force of law and a genuine national interest in assuring the preservation of the marine environment to enhance biodiversity and sustain the health, integrity, productivity, and augmentation of our natural resources. As a consequence, the importance of maintaining the vitality of Canada's coastal communities and industries is affirmed.

The designated MPAs cover a surface area equivalent to the surface area of the province of Nova Scotia (over 56,000 km^2) and include sections of Canada's oceans and the Great Lakes. The square kilometre breakdown of the MPAs in terms of jurisdictional authority (federal, provincial, or non-governmental agencies) is shown in Figure 11. On the left side of the figure, the total number of MPAs under the management of each jurisdictional authority is indicated in brackets. There are currently 797 MPAs, 83 of which fall under federal jurisdiction, 705 under provincial jurisdiction, and 9 are managed by non-governmental organizations or through co-management arrangements (Government of Canada, 2011).

Figure 11: Marine protected areas (MPAs) in square kilometers, protected by each jurisdiction



Note: The governments of Nova Scotia, the Northwest Territories, Nunavut, and the Yukon do not currently have established marine protected areas.

Source: Government of Canada (2010), Spotlight on Marine Protected Areas in Canada, 7.

Canada's major oil-handling ports and the ecologically sensitive waterways leading to them are highly efficient, with extremely low-risk cargo movement procedures. All these ports and waterways have areas of environmental and ecological sensitivity within their boundaries as well as in their vicinity, which have remained pristine and unspoiled despite decades of oil-handling activity.

These ports and waterways—including Vancouver, west coast tanker lanes from Alaska, Hamilton, Montreal, Quebec, the Saint Lawrence River, Saint John, the Bay of Fundy, Passamaquoddy Bay, Halifax, the Gulf of Saint Lawrence, St. John's, Come by Chance, Placentia Bay, and St. Mary's Bay—have

earned strong international reputations for their cargo-handling safety and environmental consciousness. Their emergency response plans are supported by environmental assessments, continuous monitoring, and oil-spill trajectory modeling for rapid response, containment, and clean-up (John, 2010: 195). In the highly unlikely event of the need arising, British Columbia's northwest coast would be similarly protected by such rigorous control systems.

Canada's ongoing tanker safety efforts

Canadian regulators continue to be aggressive in maintaining and enforcing high maritime standards. As the federal body responsible for the Government of Canada's transportation policies and programs, Transport Canada has recently introduced 10 new measures to strengthen tanker safety and environmental protection on Canada's coasts. These are outlined in the Government of Canada publication entitled *World-Class Tanker Safety* and illustrated in Transport Canada's environmental protection infographic "Protecting Canadian Waters from Oil Spills". These 10 new measures are summarized below.

- *Tanker Inspections*: Enhanced inspections of all tankers in Canadian ports and enforcement of double hull requirements in Canadian waters.

- *Systematic Ship Surveillance and Monitoring*: Sophisticated state-of-the-art remote sensing equipment used to monitor shipping activity and satellite tracking of oil spills, with a focus on the waters of northern British Columbia and off the east coast of Newfoundland and Labrador.

- *Incident Command System*: As the lead federal agency to ensure an appropriate response to a ship-source oil spill, the Canadian Coast Guard will integrate its operations with key partners in the private and public sectors.

- *Pilotage Requirement Review*: Review of the existing pilotage and tug escort requirements to determine the legislative and regulatory changes needed, with a focus on tankers.

- *Public Port Designations*: The Government of Canada will designate Kitimat as a public port. This will allow the port to put better traffic control measures in place to promote the safe movement of vessels. A national review will help to identify other ports suitable for this designation.

- *Scientific Research*: Environment Canada, Fisheries and Oceans Canada, and Natural Resources Canada will research non-conventional petroleum products to learn more about their chemical and physical properties and how they behave in the marine environment. This will assist in response plans, response technologies, environmental protection, and shoreline preservation.

- *New and Modified Aids to Navigation*: The Canadian Coast Guard will modify and implement an enhanced system of aids to navigation such as buoys, lights, and other devices to warn of obstructions and to mark preferred shipping routes.

- *Modernized Navigation System*: Enhancement of Canada's current navigation system with modern electronic technology for real-time navigational information availability. This will improve Canada's navigation safety and efficiency.

- *Amendments to the Canada Shipping Act, 2001*: Proposed amendments to strengthen current requirements for pollution prevention and response at oil handling facilities,

    a. increase Transport Canada's oversight and enforcement capability,

    b. introduce new offences for violations and extend pollution penalties, and

    c. enhance response to oil spills by removing legal barriers

- *Tanker Safety Expert Panel*: A Tanker Safety Expert Panel is conducting a pan-Canadian review and assessment of Canada's Marine Oil Spill

    a. the system currently in place south of 60 degrees north latitude, and

    b. the requirements for the Canadian Arctic and the development of a hazardous and noxious substances regime including liquefied natural gas.

Recommendations and Conclusion

As a littoral nation bordering three oceans and the Great Lakes, Canada has a solid and resilient maritime tradition. Even so, management and regulatory practices must be dynamic and keep pace with the evolving needs of maritime traffic growth, technological advancement, and trade diversification. The recommendations and conclusion of the study are presented below.

Four specific safety and environmental conservation recommendations are of particular significance to the oil and natural gas tanker shipping industry:

- Growing world energy demand and Canada's abundant natural resources and energy supply potential present outstanding opportunities for national economic progress and development. A slackening of demand in the traditional market calls for the establishment of trade links with blossoming trans-ocean markets and the expansion of supporting transportation infrastructure. The exceptional safety and environmental conservation record of the shipping industry makes it ideally suited as the conduit for transportation of Canada's energy resources to worldwide markets. The shipping mode of transportation also eclipses the other modes in cost-effectiveness, efficiency, and environmental emissions. Transportation of Canada's abundant energy resources to overseas markets on tanker ships is a vital necessity for national growth and prosperity, and should be encouraged.

- The vitality and security of the marine environment is of paramount importance to all Canadians and any threat to it negatively affects all associated businesses. The consuming public, as the end-user of fossil fuel energy, wants assurances from all the upstream sectors of the oil industry—exploration, production, transportation, storage, distribution, and retail supply. The oil tanker transportation sector is therefore intimately concerned with events in any of the sectors that could be potentially hazardous to our national marine heritage. A chain is only as strong as its weakest link. Responsible environmental stewardship is an imperative obligation for all the links of the oil supply chain. As a consequence of

the Deepwater Horizon drilling rig disaster in the Gulf of Mexico in April 2010, Canada needs to strengthen the inspection and maintenance regime of offshore oil and natural gas exploration and production equipment, especially in view of Canada's burgeoning offshore development activity on the East Coast.

- Lastly, responsible management of Canada's environmental resources and growing maritime trade requires the establishment of a national risk assessment strategy for Canada's ports. Such a risk assessment strategy would identify the shortcomings (if any) of the ports in dealing with emergencies and offer suitable alternative plans to account for those shortcomings or provide the resources needed to upgrade the emergency response capability of the ports. Hence, a Canadian risk assessment strategy should be discussed and prepared, and this strategy implemented to identify, assess, quantify and mitigate the risks in all Canadian ports.

The health of Canada's economy, communities, and ecology is irreversibly intertwined with the sustainable development of our natural resources. As a source of energy, particularly for transportation uses, fossil fuels have no alternative for the foreseeable future. The safety, cost-effectiveness, and efficiency of marine tanker transportation have been exemplary, especially in Canada. The focus of growing energy demand being in the emerging economies brings added impetus and urgency for opening and rejuvenating marine trans-ocean tanker traffic from and to Canada's coasts. We can continue to let the benefits of resource development flow through our society, even as we allocate resources to sustain and augment the vigour and biodiversity of our ecological heritage. The designation of marine protected areas ensures the awareness and understanding of preservation and protection of our rich environmental heritage.

The solution to the problem of potential oil spills is not to ban economic activity, but to boost responsible activity. Banning oil tanker traffic in coastal waters will not prevent the consumption of this essential source of energy. It will only force its delivery by other modes of transportation—an action that will increase its price and exacerbate environmental risk and atmospheric emissions. New prohibitions will jeopardize our economic security with little or no environmental benefit. Unless explicitly and unambiguously warranted, interdiction measures are likely to adversely affect Canada's economic development, international reputation, and status as an economic and environmental role-model. The cost, pollution, and sustainability implications of banning tanker traffic on the West Coast are far too severe and the benefits far too uncertain to make it pragmatic or viable.

Canada is one of the very few developed countries with a significant opportunity to capitalize on the many advantages offered by its abundance

of natural resources that exceed the in-country demand. The energy export challenges related to infrastructure development and diminishing US demand must be addressed rapidly but need the understanding and support of the Canadian public. The confluence of burgeoning global energy demand, Canada's pervasive supply potential, rational business opportunity, excellent maritime safety and environmental responsibility record, the superiority of the maritime mode of transportation over all other modes, and national economic progress and development is redoubtable and cannot be neglected.

References

BC Green Party (2013). *Consolidated Policies 2013*. BC Green Party. <http://d3n8a8pro7vhmx.cloudfront.net/greenpartybc/pages/935/attachments/original/1392927190/Consolidated_Policies_2013_(updated_October_11).pdf?1392927190>, as of August 19, 2014.

BC NDP (2013). *Dix Challenges Clark to Take Clear Position on Expansion of Oil Tanker Traffic.* News release (May 4). BC NDP. <http://www.bcndp.ca/newsroom/dix-challenges-clark-take-clear-position-expansion-oil-tanker-traffic>, as of August 19, 2014.

Canada's Marine Industry Alliance (2005). *Canada's Marine Industry: A Blueprint for a Stronger Future.* Canada's Marine Industry Alliance. <http://www.acpa-ports.net/advocacy/pdfs/MarineBlueprint-E.pdf>, as of September 3, 2014.

Canadian Association of Petroleum Producers (2014). *Crude Oil: Forecast, Markets & Transportation.* Canadian Association of Petroleum Producers. <http://www.capp.ca/getdoc.aspx?DocId=247759&DT=NTV>, as of October 8, 2014

Centre for Energy (2014). *Canada's Energy Map.* <http://www.centreforenergy.com/factsstats/MapsCanada/CA-EnergyMap.asp>, as of September 3, 2014.

David Suzuki Foundation (n.d.). *How Tankers and Drills Threaten Canadian Waters.* <http://www.davidsuzuki.org/issues/oceans/science/marine-planning-and-conservation/how-tankers-and-drills-threaten-canadian-waters/>, as of August 18, 2014.

Energy Information Agency [EIA] (2013). *International Energy Outlook 2013.* Energy Information Agency.

Energy Information Agency [EIA] (2014). *Total Primary Energy Consumption.* < http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=44&pid=44&aid=2&cid=CG6,CG5,&syid=1980&eyid=2010&unit=QBTU>, as of September 3, 2014.

Environment Canada (2013), *National Emission Trends for Key Air Pollutants, 1985-2012*, <http://www.ec.gc.ca/inrp-npri/>, as of October 6, 2014

ForestEthics (2013). *Tar Sands SOS: Save Our Shore.* <http://tarsandssos.org/>, as of August 18, 2014.

Government of Canada (2010). *Spotlight on Marine Protected Areas in Canada.* Fisheries and Oceans Canada. <http://www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/spotlight-pleinsfeux/spotlight-pleinsfeux-eng.pdf>, as of September 3, 2014.

Government of Canada (2011). *Spotlight on Marine Protected Areas in Canada, Overview of Marine Protected Areas in Canada.* Fisheries and Oceans Canada. <http://www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/spotlight-pleinsfeux/index-eng.htm#s1-1>, as of September 30, 2014

Government of Canada (n.d.). World-Class Tanker Safety. News release (no date). <https://www.tc.gc.ca/media/documents/marinesafety/world-class-tanker-safety.pdf>, as of September 3, 2014.

Hage, Robert (2012). Legal Aspects of an Oil Tanker Ban: Bill C-211 as a Case Study. In *Making Oil and Water Mix: Oil Tanker Traffic on Canada's West Coast*. Macdonald-Laurier Institute.

Huijer, Keisha (2005). *Trends in Oil Spills from Tanker Ships 1995-2004*. International Tanker Owners Pollution Federation. <http://www.itopf.com/fileadmin/data/Documents/Papers/amop05.pdf>, as of September 3, 2014.

International Maritime Organization (n.d.). *MARPOL73-78: Brief history - List of Amendments to Date and Where to Find Them.* <http://www.imo.org/KnowledgeCentre/ReferencesAndArchives/HistoryofMARPOL/Documents/MARPOL%2073-78%20Brief%20History%20-%20List%20of%20amendments%20and%20how%20to%20find%20them.htm#Amendment_Procedure>, as of October 22, 2014.

International Tanker Owners Pollution Federation (2011). *Oil Tanker Spill Statistics 2010. International Tanker Owners Pollution Federation.* <http://www.safety4sea.com/images/media/pdf/2011.3.4-Statistics.pdf?phpMyAdmin=3x%2CnNHjMtgZepucN80hdp6UT0n7>, as of September 3, 2014.

International Tanker Owners Pollution Federation (2014). *Oil Tanker Spill Statistics 2013. International Tanker Owners Pollution Federation.* <http://www.itopf.com/fileadmin/data/Documents/Company_Lit/OilSpillstats_2013.pdf>, as of September 3, 2014.

Island Trust (2013). *Summary: Trust Council Oil Tanker Opposition and Oil Spill Prevention Advocacy*. Island Trust. <http://www.islandstrust.bc.ca/media/247097/oiladvocacysummary.pdf>, as of August 18, 2014.

Island Trust (2014). *About the Island Trust.* <http://www.islandstrust.bc.ca/connect/about-us.aspx>, as of August 18, 2014.

John, Philip (2010). *A Canadian Policy on Places of Refuge for Ships in Need of Assistance.* LAP LAMBERT Academic Publishing.

Lewis, Jeff (2014, July 14). Even in Canada, Booming U.S. Petroleum Elbowing Out Alberta Producers. *Financial Post.* <http://business.financialpost.com/2014/07/14/even-in-canada-booming-u-s-oil-exports-are-elbowing-out-albertas-crude/?__lsa=d2c9-c864>, as of September 3, 2014.

Michel, Keith and Peter Noble (2008). Technological Advances in Maritime Transportation. *Transportation Infrastructure* 38, 2 (Summer): 33–40.

Natural Resources Canada (2013, September 5). *Crude Oil and Petroleum Products Market.* <http://www.nrcan.gc.ca/energy/crude-petroleum/4541>, as of October 16, 2014.

Natural Resources Canada (2013, November 4). *Additional Statistics on Energy.* <http://www.nrcan.gc.ca/publications/statistics-facts/1239>, as of September 3, 2014.

Natural Resources Canada (2013, November 15). *Energy.* <http://www.nrcan.gc.ca/energy>, as of September 3, 2014

Natural Resources Canada (2014, April 9). *Proven Oil Reserves.* <http://www.nrcan.gc.ca/energy/crude-petroleum/4543>, as of October 16, 2014.

Natural Resources Canada (2014, April 11). *Oil Sands.* <http://www.nrcan.gc.ca/energy/oil-sands/5849>, as of September 3, 2014.

PricewaterhouseCoopers (n.d.). *Oil and Gas Export Challenges.* <http://www.pwc.com/ca/en/doing-business-in-alberta/oil-and-gas-export-challenges.jhtml>, as of September 3, 2014.

Statistics Canada (2013, December 10). *Energy Supply and Demand, 2012.* The Daily. <http://www.statcan.gc.ca/daily-quotidien/131210/dq131210a-eng.pdf>, as of September 3, 2014.

Swift, Anthony, Nathan Lemphers, Susan Casey-Lefkowitz, Katie Terhune, and Danielle Droitsch (2011). *Pipeline and Tanker Trouble: The Impact to British Columbia's Communities, Rivers, and Pacific Coastline from Tar Sands Oil Transport.* Pembina Institute. <http://www.pembina.org/reports/nrdc-pipeline-and-tanker-trouble-for-web.pdf>, as of August 19, 2014.

The Council of Canadians (2012). *No Pipelines! No Tankers!* The Council of Canadians. <http://www.canadians.org/sites/default/files/publications/Report-NoPipelinesNoTankers.pdf>, as of August 19, 2014.

The Economist (2014, June 21). Canada's Northern Gateway Project: A Go or a No? *The Economist.* <http://www.economist.com/news/americas/21604615-tepid-government-endorsement-new-oil-pipeline-go-or-no>, as of September 3, 2014.

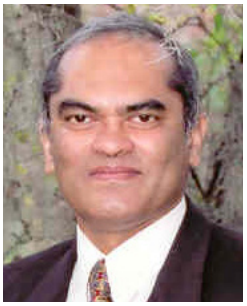
Transport Canada (2011). *Transportation in Canada 2011: Statistical Addendum.* <http://www.tc.gc.ca/media/documents/policy/Stats-Addend-2011-eng.pdf>, as of September 3, 2014.

Transport Canada (2014, June 17). *Tanker Safety and Spill Prevention.* <http://www.tc.gc.ca/eng/marinesafety/menu-4100.htm>, as of September 3, 2014

Transportation Safety Board of Canada (2014). *Statistical Summary – Marine Occurrences 2012. Overview of Accidents and Casualties.* <http://www.tsb.gc.ca/eng/stats/marine/2012/ss12.asp>, as of October 20, 2014.

United Nations Conference on Trade and Development [UNCTAD] (2013), *UNCTADstat: World Seaborne Trade by Types of Cargo and Country Groups, Annual, 1970-2011.* <http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx>, as of November 12, 2014.

About the Author



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