Advantages, Disadvantages and Economic Benefits Associated with Crude Oil Transportation

Overview

Oil production is an important source of energy, employment, and government revenue in the United States and Canada. Production of crude oil is undergoing a boom in North America due to development of unconventional[1] crude sources, including the Alberta oil sands and several geologic shale plays, primarily the Bakken fields in North Dakota and Montana, in addition to the Permian and Eagle Ford fields in Texas. In recent years, domestic production of crude oil in the United States has increased at tremendous rates and is predicted to continue this trend, with total production reaching an estimated 7.4 million barrels per day (bbl/d) in 2013, up from 5.35 million bbl/d five years prior in 2009.[2] The forecasted output for 2015 (9.3 million bbl/d) represents what will be the highest levels of domestic production in the United States since 1972.[3] This production is coupled with a decline of crude oil imports, with the share of total U.S. liquid fuels consumption met by net imports hitting a low of 33 percent in 2013, down from 60 percent in 2005.[4] Canadian crude oil production has also increased dramatically with 3.3 million bb/d produced in 2013, up from 2.57 million bbl/d in 2009.[5] As the primary source of imported crude oil to the United States, the Canadian and U.S. oil economies are tightly linked despite declining U.S. imports.[6]

The rise in crude oil production has accelerated industry demand for transportation to move crude oil from extraction locations to refineries in both nations. Crude oil transportation modes have traditionally included pipeline and oceangoing tankers but, increasingly, producers are turning to rail transport and even trucks to transport crude oil to help alleviate the capacity bottlenecks, especially in the pipeline network. The binational Great Lakes-St. Lawrence region, home to eight U.S. states, two Canadian provinces and a number of tribal governments, is a hub of transportation and refining activity within the two nations. This issue brief will examine key benefits and disadvantages associated with increasing production as well as with the use of each individual mode of transport. The intent is to build an understanding of the implications of these changes for the Great Lakes-St. Lawrence region. For an analysis of risks and impacts associated with oil spills, including ecological and economic, please see *Issue Brief 3: Risks and Impacts*.

Economic Benefits Associated with Crude Oil Production and Transportation

Revenues to government – Oil production is a critical source of revenue for U.S. and Canadian federal, provincial, state and tribal governments. In fiscal year 2013, revenue from the oil and gas industry paid to the U.S. government, including royalties, rents, bonuses and other payments, totaled $12.64 billion. Oil industry payments are one of the largest sources of non-tax federal revenue.[7] The U.S. and Canadian oil and gas industry and associated businesses also supply billions of dollars of income taxes, with $2.15 billion paid by oil and gas extraction corporations and $4.87 billion paid by petroleum refineries in the U.S. alone in tax year 2010.[8,9] In Canada, the province of Alberta received $3.56 billion in royalties related to oil sands production in 2013 alone,[10] while Canadian oil and gas extraction and supporting activities accounted for $2.42 billion in income taxes to the national government in tax year 2012.[11,12]

Revenue structures are typically tied to percentages of profits based on barrel sales. Thus, increases in net profit per barrel contribute positively to government revenue. Government revenues from the oil industry are crucial public funds, often used to finance essential public services and public policy initiatives in a wide range of sectors, which contribute significant economic and social benefits to the public. In the Great Lakes-St. Lawrence region, the eight states and two provinces bordering the lakes, as well as tribal governments, experience some revenues from local

crude oil extraction, refining of oil produced in the region and elsewhere, and transportation of oil, but the range and magnitude of these benefits vary greatly. One such example of public benefits is the Michigan Natural Resources Trust Fund: created by Michigan residents through legislative action, this fund collects revenues from mineral leases, such as production, and is a source of funding for natural resource protection and conservation, development of outdoor recreation facilities, and maintenance of the state park system.[13]

Employment – The increase in domestic production of unconventional crudes has had a significant impact on the provision of direct and indirect employment. From 2009 to 2013, despite job losses due to the recession in the first two years of the period, total average annual employment across all industries in the United States saw an increase of 4.17 percent – from 128.6 million to 134 million jobs.[14] In comparison, total employment in the nation's oil and gas industry[15] increased by 39.02 percent in the same period – an estimated change over double that of the national average, representing an absolute change of 164,685 jobs.[16] In Canada, total average annual employment increased by 5.78 percent – from 17.08 million to 18.07 million jobs during the same period. Employment in the oil and gas industry included varying percentage changes, with an 8.52 percent increase in oil and gas extraction, an 18 percent increase in support activities for oil and gas, and a 57 percent increase in oil and gas engineering construction, despite a 10.76 percent decline in non-conventional oil extraction.[17]

In the Great Lakes-St. Lawrence region, oil and gas industry employment impacts are mixed and vary widely. For example, the provinces of Ontario and Québec, as well as New York State, saw net losses in oil and gas industry jobs between 2009 and 2013, while some states, such as Pennsylvania, Indiana and Minnesota, each saw increases of over 100 percent in industry employment numbers.[18] Increases in employment have been largely focused in production-heavy regions and should not be considered equally distributed throughout both nations or across all states and provinces.[19] In addition, the net impact of continued employment changes across multiple sectors cannot be accurately predicted, as employment increases in the oil production sector may be offset by decreases in other industries or augmented by increases in supplementary goods and services.[20,21] The U.S. Department of Labor predicts that strong employment growth in oil and gas extraction and support will persist, [22] but this growth may likely continue to benefit some parts of the region more than others.

Flexibility of transport increases industry profit margins; minimizes price instability – The monetary value of crude oil is tied to it being a consistently fungible commodity,[23] which relies on oil being easily stored and transported throughout market locations. Traditionally, crude oil was shipped via oceangoing tankers or transported via pipeline to reach coastal refineries, but the rise in domestic production of unconventional crude oil has generated the need for increased transportation capacity to and from new areas. Constraints in pipeline construction related to protracted permitting and regulatory processes have incentivized producers to utilize rail lines and other modes to transport oil at increasing volumes each year over the past seven years.[24,25]

In particular, transportation of crude oil from the Bakken shale play in North Dakota and the Alberta oil sands is motivated by differences in sale value per barrel that vary based on where the oil is sold. When crude oil is landlocked due to transportation limitations and/or when surplus oil remains in storage instead of reaching refineries, the oil is less valuable, and producers must discount their sale price relative to the prevailing crude oil benchmark price to attract buyers. For example, the price of West Texas Intermediate (WTI), a light, sweet[26] blend sold out of a key trading hub located in Cushing, Okla., is used as the prevailing benchmark in the U.S. The price of WTI has ranged from $4 to $28 higher per barrel, on average, than the price for inland Bakken crude due to discounts, despite the comparable quality and properties of both crudes.[27]

This differential in price represents lost potential revenue for producers. If the Bakken crude oil were to reach the market at Cushing, it could compete for buyers based on the WTI benchmark price with no need for discounting. Similarly, producers also benefit from reaching marine coastal ports. At markets with access to the ocean, their crudes can now compete for buyers based on international prices, such as North Sea Brent, the European benchmark, which tends to be at higher prices than WTI.[28] Ultimately, this means that for producers, their profit per gallon of crude oil – the "netback" revenue from sales minus the transportation costs – can be significantly higher when they transport their oil to better markets. Higher demand at these markets allows producers to sell their crude oil for more

money than it cost them to transport it there, creating very strong demand for increased capacity of transportation modes as production increases.

Furthermore, Alberta crude producers face compounded discounts when they are unable to transport their crude, as oil sands crude is heavy and sour relative to the more desirable light, sweet characteristics of Bakken shale crude and WTI. However, market access can partially mitigate this effect. For example, Maya, a comparable heavy, sour Mexican crude, generally sells at a higher price than western Canada crude because it has direct access to the Gulf of Mexico.[29] Thus, Canadian producers have additional incentives to move their crude out of production areas toward coastal markets to achieve higher international prices per barrel.[30,31] Overall, increased North American production combined with transportation infrastructure development has also supported stability of global oil prices, with 2013 spot prices for crude oil remaining relatively stable despite supply interruptions in other locations.[32]

Economic Disadvantages Associated with Crude Oil Transportation

Public

Local and provincial governments absorb costs of first responder training and capacity development – Particularly in rural areas that tend to face a lack of resources, local, state and provincial governments incur costs associated with infrastructure development, training and capacity building in preparation to fulfill their obligation as first responders to oil spills.[33,34] For some municipalities, this means that local taxpayers are left shouldering the economic costs of resource development for potential emergencies without necessarily receiving substantial gains from oil production, extracting or refining activities, and associated royalties or taxation or other revenues from industry.

Corporate/Private

Non-oil industries affected by usage impacts on shared natural resources or infrastructure – The presence of various modes of oil transportation may have effects on the overall transportation infrastructure in the region. Depending on the mode, increased transportation of crude oil could displace transport access by other industries or accelerate wear and tear on infrastructure. Additionally, if the day-to-day operations of a particular mode of transport have adverse impacts on a natural resource upon which other industries are reliant for their operations, this could also hamper productivity. For more details, see the following descriptions of the economic advantages and disadvantages of the individual transportation modes.

Uncertainty about risks to health of Great Lakes-St. Lawrence, adverse impact could harm regional economy – See *Issue Brief 3: Risks and Impacts* for details about the economic impacts of an oil spill in the region.

Advantages and Disadvantages Associated with Transportation Modes

In addition to the benefits and disadvantages of crude oil transport as a whole, each mode is associated with unique aspects that should be considered individually. This is crucial to understanding why some modes may be selected over others, to evaluate each in the context of the others, and to frame the implications of the presence of these modes within the Great Lakes-St. Lawrence region.

These various individual modes of crude oil transportation infrastructure also represent collective capacity. Expansion of capacity in any individual mode poses possible cumulative impacts on secondary transportation markets: expansion of infrastructure development in one mode has potential side effects on demand for others. For example, allowing shipping via vessels on the Great Lakes-St. Lawrence may incentivize additional crude oil transport infrastructure development over land in surrounding jurisdictions, or alternatively, current approvals of pipeline network expansions may decrease the demand for vessel or rail transport as a substitute mode. Expansions may also present a cumulative impact on crude oil transportation across modes by facilitating overall capacity for multi-modal transport.

Rail

Limitations facing pipeline transport combined with spot price differentials have spurred demand for crude oil transportation via rail. The Association of American Railroads reports that for the first half of 2014 compared to the same period in 2013, seven percent more tank cars in the United States and 7.7 percent more tank cars in Canada were on the track – totaling 380,961 cars and 188,423 cars carrying petroleum and petroleum products in each nation by mid-year, respectively.[35] In the United States, 9,500 carloads of crude oil were carried by train in 2008, with 650,000 carloads forecasted by the end of 2014.[36]

In recent years, construction of additional transportation capacity by rail has narrowed the discounts applied to inland Bakken and oil sands crudes relative to WTI prices. As other forms of infrastructure development improve transport capacity between production areas and markets, the gap in price may continue to decrease. A decline in cost effectiveness could eventually incentivize producers away from rail and toward a cheaper transport mode if available.[37,38] Additional constraints, including shortages in availability of tank cars, may also affect the popularity of rail transport of crude oil. In the United States alone, the backlog of tank cars as of September 2013 numbered at nearly 60,000 – an estimated 20 percent of the entire rail fleet delayed in production.[39]

In the Great Lakes-St. Lawrence region, much of the Bakken crude oil traveling by rail is being transited through to refineries in other areas, including the east coast,[40] and this is creating situations where oil trains are passing through some states and provinces regularly without producing economic benefits that are experienced through refining activities or transmodal transfer points.

Advantages of Rail

Increased flexibility for producers and refiners; infrastructural benefits – With an existing infrastructure that supports greater access to new production areas and more refining locations, rail provides a wider range of geographic options combined with faster travel times than via pipeline, allowing producers to make rapid changes amongst delivery locations as market demand shifts, as well as transport the oil much faster.[41] For example, a trip from the Bakken shale play to the Gulf Coast can take 40 days via pipeline versus five to seven days by rail.[42] Rapid delivery to market may be of particular importance to shale oil producers that are incentivized to sell large quantities quickly, as shale formations have high rates of production decline, creating the need to drill more wells to maintain the same volume of extraction.[43]

Despite costing an estimated $5 to $10 more per barrel to transport crude oil by rail than by pipeline, rail can still be cost-effective for producers: the cost of transport per barrel to markets with better prices is generally lower than the revenue that would be lost if they did not move the oil and had to sell it more cheaply.[44] The premium cost of transporting crude oil by rail provides other advantages, as well: producers and refiners can enter into shorter contracts with rail carriers, 1-2 years long versus 10- to 15-year terms typically required for pipelines, allowing for more flexibility in the face of changing market conditions; and heated tank cars improve viscosity of oil sands crude, requiring less diluent to be added for its transport.[45] All of these factors have a positive impact on profitability for oil producers and refiners, which can impart benefits to the public through increases in government revenues from royalties and taxes.

Disadvantages of Rail

Crowding out rail network access by other industries – Increases in crude-by-rail transport can produce congestion on rail routes, crowding out capacity utilized by trains carrying other commodities, such as grains and agricultural industry products, as well as those carrying passengers. These effects have the potential to be compounded by lower oil train speed limits and other regulatory safety measures.

The U.S. and Canadian federal governments have begun to address rail network congestion in both nations. In March 2014, citing rail capacity bottlenecks in delivering Canadian crops to ports, Transport Canada and Agriculture and Agri-Food Canada issued an Order in Council to rail corporations Canadian Pacific Railway Company (CP) and Canadian National Railway Company (CN) that required them to increase capacity to transport grains, report on

quantity transported daily, and face fines for non-compliance.[46] They also introduced legislation in the Canadian parliament to address rail capacity bottlenecks impacting the ability of Canadian farmers to transport their grain.[47]

The U.S. Department of Transportation's Surface Transportation Board held a hearing in April 2014, where representatives from the agriculture industry; the National Railroad Passenger Corporation (Amtrak); railroad corporations such as Burlington Northern Santa Fe Corporation (BNSF), CP and CN; the Federal Railroad Administration (FRA); and others convened to discuss current service limitations to the Midwest, rail industry executive plans to address capacity shortages and options for improvement.[48] As crude-by-rail traffic endures, particularly if constraints on transportation by pipeline persist, crowding out effects will continue to have an impact on rail network access by other industries.

Immature regulatory infrastructure constrains appropriate local preparation for incidents – The rapid increase in the volume of crude oil transported by rail has created challenges to develop new federal regulatory programs in the U.S. and Canada, placing the initial burden on states, provinces, and local governments tasked with preparation and response.[49] This is compounded by limitations in the United Nations classification system for hazardous materials, which groups both Bakken crude and oil sands crude together into one category despite very different physical characteristics that can necessitate special response strategies.[50,51]

Shippers of crude oil have not been historically required to report on routes, modes of transportation, volumes or particular characteristics of the crude oil being transported.[52] Due to the current lack of a comprehensive system identifying the specific content of individual trains carrying unconventional crude oil of varying types, local, state, and provincial governments may incur costs associated with multiple types of infrastructure development in preparation to fulfill their obligation as first responders.[53,54] In particular, the lack of classification specificity regarding crude oil cargo poses resource allocation challenges, as the equipment, response strategies, and human resources required for response can vary based on the type of crude oil spilled.[55,56,57]

Following the Lac-Mégantic accident that killed 47 people in July 2013 in Québec, where improper labeling of the train's cargo led response teams to underestimate its volatility,[58] both the U.S. and Canadian governments have turned more attention to cargo reporting and specialized response capacity issues. In May 2014, the Department of Transportation issued an Emergency Order to rail carriers of crude oil requiring that those carriers of over 1 million gallons or more of crude sourced from the Bakken shale formation provide the State Emergency Response Commission in each state with information on the expected transportation of said oil. Such notifications identify the specific areas in states through which the trains will operate, as well as when they are expected to pass through.[59] Further, pursuant to suggestions from the Department of Transportation dated February 1, 2014, Class I rail carriers agreed to provide $5 million to cover training and tuition expenses for 1,500 emergency responders to attend specialized crude oil spill response trainings by the end of the year, which will help increase first responder capacity.[60] These are key steps toward minimizing the disadvantages associated with under-regulation of crude-by-rail and reporting of specific crude oil cargo, and continual transparency will be necessary to minimize the cost and capacity burdens placed on local governments.

Common carrier responsibility and complex ownership impacts accountability/liability – Rail carriers hold a common carrier obligation in the U.S., meaning that they cannot refuse to transport hazardous goods if inconvenient or not profitable.[61] Railroad carriers responsible for the tracks are joined by sales and transport contractors, producers and/or refiners, who lease or own tank cars carrying crude on railways – thus, responsibility for any given oil train may fall to several parties.[62] This myriad of ownership configurations can make pinpointing liability for regulatory mistakes or accountability for future compensation for expenses borne by governments difficult.

Functionality and safety can be impeded by adverse weather – Transport via rail can be negatively impacted by adverse weather or regular seasonal weather fluctuation, which can compromise infrastructural integrity. For example, railroad tracks can expand out of shape in extreme heat, or they can contract and break in extreme cold, with both being potential causes for derailments.[63] Floods, wildfires, tornadoes and other events can also impact functionality directly through damage or by impeding travel.[64]

Pipeline

Liquid pipeline is the favored mode of oil transportation in North America, and it represents a significant means by which crude oil is transported into and throughout the Midwest. Approximately 70 percent of oil sands crude produced in Alberta is shipped to Midwest refineries via pipeline.[65] As of 2009, of the 26 refining facilities that can process the oil sands crude, 12 are located in states bordering the Great Lakes.[66] Increasing production in Alberta will continue to drive industry movement toward pipeline construction to support transit of oil sands crude into the U.S. Midwest for refining. This has a number of implications for industry, government and private landowners. In particular, despite capacity limitations in the existing pipeline network, investments in domestic crude oil pipelines in the U.S. have increased significantly from $1.6 billion in 2010 to $6.6 billion in 2013.[67] This suggests industry confidence that pipeline projects will provide significant returns on investments.[68] In the meantime, limited capacity in existing pipelines will continue to spur usage of other modes of transportation throughout the Great Lakes-St. Lawrence region, with examples arising of corporations crossing industry sectors to invest in other modes. Facing strong market motivations to move crude oil out of production areas, some pipeline corporations, such as Enbridge, have invested in loading and unloading facilities for rail until pipeline capacity can expand.[69]

Advantages of Pipeline

Cost effective form of transit for producers – Transportation of crude oil via pipeline is, on average, $5 to $10 per barrel cheaper than via rail, presenting producers with an optimally cost effective shipping option when available.[70] However, pipeline infrastructure development has been far outpaced by unconventional crude oil production increases: the location, directionality of flow, and volume capacity of legacy pipelines render the existing network unable to fulfill current supply and demand.

Payment incentives of easement ("right-of-way") agreements for landowners in the United States – Pipeline siting procedures typically involve easement or "right-of-way" agreements where private or public owners retain a legal title to their land, but relinquish certain rights to specific usage of the land to pipeline operators.[71] In said agreements, pipeline operators pay landowners in exchange for limited rights to construct, operate and maintain pipelines on their land. Pipeline easements generate a one-time payment (or a signing bonus and subsequent payments) to private landowners, and this is a source of funds to governments for those pipelines constructed on government land.

Disadvantages of Pipeline

Disruption to agriculture and other land uses from construction and operation – The construction of pipelines can present disadvantages to agricultural landowners holding productive farmland whose field crops, livestock, drainage tiles, etc., may be adversely impacted in the process of installing lines. Pipeline construction can also interfere with timber operations and that of other industries, depending on the siting location.[72] Day-to-day operations of pipelines may also affect the viability of some agricultural operations through affecting ambient soil temperatures, which has the potential to prematurely accelerate seed germination.[73] This is particularly true for pipelines transporting oil sands crude, which is often heated to high temperatures to aid viscosity and ease transport.[74] More generally, pipeline construction and operation may be accompanied by risks to landowner property, including possible contamination of land and water, which may interfere with other resource uses.

Difficulties associated with easement enforcement and land restoration in the United States – Laws differ from state to state regarding the restoration of land following pipeline construction, and the terms and conditions of agreements vary widely across corporations. As easement terms can lack clarity, enforcement of payment for right-of-way access can be challenging.[75] Furthermore, federal regulations treat liquid pipelines and gas pipelines differently: unlike gas pipelines, hazardous liquid pipelines do not require Federal Energy Regulatory Commission certificates for construction to commence, thus, typical redress channels available through FERC are not options for owners along liquid pipeline transmission lines, who are then often wholly dependent on courts to enforce the terms of their easement agreements.[76]

Ship and Barge

Historically, tanker transportation of crude oil to coastal refineries has played an important role in both the U.S. and Canada due to the high volume of crude oil imported from overseas.[77] The increase in domestic production, affordable prices for oil sands crude and the refining capacity in the Midwest for oil sands crude, have combined to create the demand to transport crude oil to inland refineries in the region. A number of these refineries are located in or near the Great Lakes-St. Lawrence basin.[78] As of December 2009, 10 such refineries are located on or near the Great Lakes in the U.S.[79,80] while as of June 2014, at least seven refineries are located on or near the Great Lakes and St. Lawrence Seaway in Canada.[81,82,83] This regional refining capacity has created incentive for industry to explore the viability of vessel transport on the Great Lakes to refineries in the bordering states and provinces, as well as through Chicago to barges that would traverse the Mississippi to reach additional refineries in the Gulf Coast.[84] A report carried out for the American Petroleum Institute (API) forecasts that capital investment in crude oil marine infrastructure will increase by 73 percent between 2014 and 2025.[85]Additionally, a recent proposal to rehabilitate a bulk commodity dock in Superior, Wis., to facilitate transport of oil sands crude on Lake Superior was put on hold, highlighting impending challenges of the market exerting pressure on usage of the Great Lakes as a transportation corridor.

Currently, no crude oil is transported on the Great Lakes. [86,87] However, there has been an increase of crude oil transportation in the larger Great Lakes system, which includes the inland waterways, rivers and canals adjacent to the Great Lakes.[88,89] In 2011, approximately 30,000 short tons of crude oil were carried on the Illinois River between Grafton and Lockport, Ill. [90] This can be compared against the much larger 3.93 million short tons total of petroleum and petroleum products – a broader category that also includes refined oils and other petroleum products – that were transported on the Great Lakes and the inland system.[91] While this transport of petroleum and petroleum products declined to 3.41 million short tons in 2012, in contrast, the amount of crude oil carried through inland waterways, rivers and canals connected to the Great Lakes increased dramatically.[92] In 2012, this included 587,000 short tons transported over the same stretch of the Illinois River, as well as 233,000 short tons carried on the Chicago sanitary and ship canal, in addition to other, much smaller amounts conveyed throughout the Port of Chicago system.[93]

On the St. Lawrence River, in Québec, over 9 million metric tonnes of crude oil were handled in the province's ports in 2011.[94] Most of the crude handled was imported to provide raw material to refineries in Montréal and Lévis. In September 2014, a first shipment of oil sands crude for export left the port of Sorel-Tracy, Québec, to the European market. The oil was sent by train from Alberta to Sorel-Tracy and stocked newly purchased storage tanks since June 2014. The port has the installations to accommodate vessels up to 260 meters in length (with a capacity of over 700,000 barrels) and more than 50 shipments of crude oil could be sent yearly in the future.

Advantages of Ship and Barge

Utilization of existing infrastructure for receiving waterborne shipments at coastal refineries in the Great Lakes-St. Lawrence River region – Due to the traditional prevalence of vessel-based deliveries of imported oil from overseas, some coastal refineries are already outfitted to receive shipments of crude oil via barge where they may not be equipped to receive shipments via rail, so this method of transportation could pose fewer costs to producers.[95] It is also often utilized in combination with rail.[96] Oil is currently being transferred from rail to river barge on the Illinois River at Hennepin, Ill., as well as on the Mississippi River at Wood River, Ill., with the latter of the two operations poised to expand. [97,98]

Disadvantages of Ship and Barge

Uncertainty of how unconventional crude transit via vessel would impact the Great Lakes and St. Lawrence River system – The Great Lakes and St. Lawrence River waterway system is a critical trade and industry corridor, the main source of fresh water for the eight state and two province region, a key feature of regional tourism, a location for a multitude of recreational uses, and a place of significant cultural and social value to the region's residents. As the growth in unconventional crude oil extraction and subsequent increase in transportation to a through the region is a relatively recent phenomenon, scientific knowledge regarding environmental, water quality, and human health impacts of day-to-day vessel operations transporting unconventional crude oils is still being developed. Most of the

current knowledge development has focused on spill effects and response, specifically, not impacts of regular operations. Uncertainty about the potential impacts of the regular operations of crude oil transport by vessels poses a challenge to resource managers and users.[99] While a variety of industries already ship hazardous products on the Great Lakes, the addition of unconventional crude oil to Great Lakes transit will also likely produce management challenges similar to those involved in transit of other industry vessels. These include needing to reconcile industry vessel traffic and port utilization with that of other recreational and commercial activities.[100] On the St. Lawrence River, there has been importation of crude oil for years, but there is now exportation too, and new ports are handling the product. An increase in tankers traffic from the ports of Montréal, Lévis and Sorel-Tracy could result in a gridlock, and new projects like the planned port in Cacouna could contribute to this increase.

Functionality and safety would be impeded by adverse weather; ice cover would narrow shipping window – Transit of crude oil over the Great Lakes-St. Lawrence would be negatively impacted or impeded by both regular seasonal weather patterns and adverse weather events. The onset of ice cover on the lakes for a portion of each year is a delimiter on when transport can occur, and heavy ice can delay the shipping season.[101] In 2014, unusually frigid conditions and the longevity of ice cover on the lakes delayed transport of commercial goods such as grain, iron and steel,[102] and such circumstances would have similar effects on movement of crude oil via vessel.

Truck

Tank trucks commonly act as connections between different modes of transport and, in particular, play a significant role in transporting oil from production areas to pipelines and rail terminals.[103]

Advantages of Truck

Ideal for short distances, but can (in some instances) be economically viable for long hauls – While tank trucks are most logistically advantageous over short road distances, some companies in Canada have initiated utilization of tank trucks for long hauls of oil to markets in the United States. For example, Gibson Energy, Inc. has begun to shift product through its storage facilities in Edmonton and Hardisty, Alberta, or truck it to third-party terminals, pipelines or loading locations for rail in both countries.[104] Impacts of long-haul truck transport of crude oil, specifically, have been relatively unexplored, though forecasts suggest that industry carriers in all modes are committing more investments to "common" infrastructure, such as road, to enable more flexibility in transporting crude oil across multiple modes.[105] Between 2011 and 2012, delivery receipts to refineries demonstrated a 38 percent increase in the use of trucks to deliver crude oil, suggesting that this is an area that requires further exploration.[106]

Disadvantages of Truck

Road traffic congestion and infrastructure damage – Information from shale oil production at the Eagle Ford play in Texas, which relies heavily on tank truck to transport oil between extraction and refining points in close proximity, suggests that heavy usage of tank trucks on roads can lead to traffic congestion and infrastructural damage to the roads themselves.[107] This has resulted in public funding being allocated to lowering speed limits and conversion of paved roads to gravel in rural oil-producing counties in the state, which can have negative effects on other industries and the public residents of that area also using the roads.[108] If tank trucks became a more common feature of oil transport throughout the Great Lakes-St. Lawrence region, accelerated wear and tear on public infrastructure would likely be one outcome of that shift.

Risks Associated with Crude Oil Transportation Accidents

This Issue Brief focuses on the advantages and disadvantages associated with crude oil transportation, but its scope does not address the significant social, economic, health, and other risks and impacts that arise when accidents occur in any of the aforementioned modes of transportation. These risks and impacts can include property damage, environmental harms, adverse impacts on human health, costs associated with oil spill removal, and more. For

details on these effects of oil transportation and their impact for the region, please refer to *Issue Brief 3: Risks and Impacts*.

Discussion

The increase of crude oil transportation throughout the Great Lakes-St. Lawrence River region raises many items that necessitate consideration. This analysis has found that oil production is important to the national economies and Great Lakes-St. Lawrence River regional economy of both the United States and Canada. Two main contributions include substantial revenue to governments via income taxes and royalties and industry job growth exceeding national averages for all industries in the United States and some sectors in Canada. However, the data demonstrates that some states and provinces in the region reap more benefits from oil production than others, and this is also true of the transportation of crude oil through the region.

Producers have strong incentives to transport their oil despite capacity bottlenecks in the pipeline network: the industry earns less profit on landlocked crude oil than on crude transported to better markets where there is higher demand. In considering the individual modes of transport, each presents specific advantages for their use, known disadvantages, and areas where the impacts are not yet well understood. In general, in spite of being costlier, transportation by rail provides greater flexibility than by pipeline or vessel, also offering the advantage of faster delivery in many instances. However, disadvantages arise with the increased use of rail transport, including that an immature federal crude-by-rail regulatory framework imposes significant financial burdens on local governments tasked with accident response and that increased competition for rail cars tends to crowd out agricultural users and other industries and sectors. Similarly, pipeline transportation provides cost effectiveness and construction generates income for private and government landowners through easement agreements. However, construction can interfere with other industries, and less intensive permitting and easement enforcement present significant disadvantages. Though not currently occurring, transport by water on the Great Lakes proper would capitalize both on existing coastal refinery infrastructure and the efficiencies inherent in transporting any/all heavy bulk goods by water. However, the ecological, economic, and human health impacts and risks of day-to-day transit of crude oil on the Great Lakes are unknown and necessitate close scrutiny given the sensitivity of the freshwater environment.

As the Great Lakes-St. Lawrence region continues to be a cornerstone of oil transportation and refining, further investigation into this area will be key in the months and years to come. In particular, as trends forecast future increases in production in both nations, this region will face continual investments from industry to facilitate the movement of crude oil. These anticipated increases underscore the many gaps in available information on the socioeconomic impacts of oil transportation modes separate from those of production or localized risks associated with spills. This highlights a need for future studies examining transportation modes, and their socioeconomic implications for the region, including effects on employment, on other industries, on public resources, and on government revenue in areas with low production and refining activity. Understanding the impacts of changes will help mitigate the associated disadvantages of increased usage for the region as much as possible.

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[1] "Unconventional" in this Issue Brief refers to those crude oil sources extracted via means not meeting the criteria for conventional oil well production, as well as to the methods of extraction, themselves. For more information, please refer to the U.S. Energy Information Administration Glossary at http://www.eia.gov/tools/glossary/

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[5] U.S. Energy Information Administration. Canada Overview Data. 2014. http://www.eia.gov/countries/country-data.cfm?fips=CA&trk=m#pet

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8 Most recent reported tax year data available as of June, 2014.

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