HARTENERGY

Evaluation of Potential Pathways for Tar Sands to the U.S. Northeast

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I. Executive Summary

The Natural Resources Defense Council (NRDC) has requested Hart Energy's assistance in analyzing current and future potential pathways for tar sands crude to make their way to the U.S. Northeast refined product market.[1] The analysis examines the outlook for short-term, medium-term and longer-term trends in refined products from tar sands sold in the U.S. Northeast market. The analysis also examines alternative scenarios for movement of Western Canadian crude to the Northeast and Gulf Coast and provides insight into specific questions raised by NRDC.

Section II of this report summarizes current tar sands crude and product flows to the U.S. Northeast market and Section III provides forecasts of flows in the medium-term and longer term: 2015, 2020 and 2025. Section IV discusses alternate logistic scenarios and responds to specific NRDC questions.

The major findings of the analysis are summarized below:

- Very little tar sands crude was processed in U.S. Northeast refineries as of 2012 (<1%).
- Eastern Canadian refineries supplying product to the Northeast likewise are not largely reliant on tar sands crude.
- In 2012, tar sands contributed only 0.8% of the Northeast product market.
- In the business-as-usual (BAU) scenario, tar sands crude processing in east Canadian and Northeast refineries will provide small contributions to the Northeast product market in the medium and long terms.
- Tar sands will account for 5.2% of the Northeast product market in 2015, 14.2% in 2020 and 14.6% in 2025.
- Product shipments from the Gulf Coast will account for most of the tar sands contribution to the Northeast product market (over 75% by 2020).
- West-to-east pipeline projects or reversals have potential for significant impact on the tar sands contribution to Northeast product if Irving Oil reconfigures their refinery for processing diluted bitumen. Under this scenario, the contribution of tar sands crude to Northeast product in 2020 will increase from 14.2% in the BAU to 15.7%. In a scenario where Irving Oil makes the conversion investment and additional logistics allow for more synthetic crude to reach eastern Canada, the contribution of tar sands crude to Northeast product in 2020 will increase to 18.0%.
- Canadian crude processed in the Gulf Coast is and will be the primary driver of tar sands contribution to the Northeast product market. If the Keystone XL pipeline is not completed,

[1] The U.S. Northeast market analyzed for this report includes the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont and Washington, DC.

the contribution of tar sands crude to Northeast product in 2020 will decrease from 14.2% in the BAU to 11.5%.

II. Current Tar Sands Product to the U.S. Northeast

A. Current (2012) Refining Overview

There are 10 operating refineries in the U.S. Northeast (see **Table 1**) with a total crude distillation capacity of 1.295 million barrels per day (b/d). Six of these refineries are coastal facilities that have traditionally imported crude from offshore. One refinery, Hess Oil in New Jersey, uses unfinished intermediate feed and does not process crude oil. Two refineries are small inland lubricant refineries utilizing domestic crude. Finally, one refinery, United Refining in Warren, Pennsylvania, is an inland refinery processing predominantly crude oil imported from Canada, along with a small volume of domestic crude.

Over the past two years, the refining industry in the area has undergone dramatic changes related to competitive pressures facing the industry. Four refineries changed ownership, with two of the four shutting down temporarily during the sales process. Ownership activity is indicated in Table 1. One other refinery, Sunoco in Marcus Hook, Pennsylvania, has also shut down and a restart does not appear likely. In 2013, the Hess refinery in New Jersey also shut down.

Until recently, the prospects for the shuttered refineries now under new ownership were not promising in terms of economic viability. However, declining U.S. natural gas prices, the shutdown of the HOVENSA refinery in the Virgin Islands and the possibility of access to competitively priced new sources of domestic and Canadian crude have created a more favorable climate. Capacity in the area will stabilize in the near term. Longer term, there will likely be pressure for further rationalization.

Table 1: U.S. Northeast Refineries and Crude Distillation Capacity

Refiner	Location	Crude Capacity Kb/d	Bitumen Capacity[1] Kb/d	Comments
PBF Energy	Delaware City, DE	190	25	Restarted by new owner, formerly Valero
ConocoPhillips	Bayway, NJ	238		
Hess Oil	Pt. Reading, NJ	[2]		
Nustar	Paulsboro, NJ	70	40	
PBF Energy	Paulsboro, NJ	185	10	Restarted by new owner, formerly Valero
American Refining Group	Bradford, PA	10		
Monroe Energy	Trainer, PA	185		Restarted, formerly ConocoPhillips
Philadelphia Energy	Philadelphia, PA	330		New owner, formerly Sunoco
United Refining	Warren, PA	67	5	
Ergon, Inc.	Newell, WV	20		

Note:

[1] Estimated

[2] No crude capacity, downstream only

Source: Hart Energy analysis

The existing refineries have little capability to process tar sands bitumen. Table 1 provides an estimate of the bitumen capacity for those with capacity to process some level of bitumen. The Table 1 bitumen reference and other discussion of bitumen processing in this report refer to the diluted bitumen crude: bitumen with approximately 25 percent light naphtha type diluent. This diluted bitumen dominates the bitumen streams available in the market. There are variations in the bitumen stream composition and quality, but these are not distinguished in this report, nor could they be because of data limitations.

Four of the 10 refineries have some bitumen processing capability. The Nustar asphalt refinery in New Jersey can handle bitumen as a high portion of feed. The others can handle only a relatively small portion of bitumen.

There are seven Canadian refining facilities with access to Northeast refined product markets and a total crude oil distillation capacity of 1.011 million b/d (see **Table 2**). Three of these refineries are located east of Maine and supply a large portion of their refined product output to the U.S. Northeast market. Two are located in Québec with about 10% of output supplying the U.S. The other two are located in eastern Ontario; they supply a small portion of their output to the Buffalo area.

Table 2: Canadian Refineries with Access to U.S. Northeast Market

Refiner	Location	Crude Capacity Kb/d	Bitumen Capacity[1] Kb/d
	East of Maine		
Imperial Oil	Dartmouth, Nova Scotia	85	
Irving Oil	St. John, New Brunswick	250	25
North Atlantic Refining	Come By Chance, Newfoundland	115	
	Québec		
Suncor	Montréal	137	
Valero	Levis	230	
	Ontario		
Imperial Oil	Nanticoke	114	
Nova Chemical	Corunna	80	

Note:
[1] Estimated

Source: Worldwide Refinery Capacity, Oil & Gas Journal and Compiled by Hart Energy

The only eastern Canada refinery capable of processing bitumen is the Irving refinery. Their bitumen processing capability is estimated to be about 25 Kb/d, or about 10% of crude capacity.

The Gulf Coast refineries also have access to the Northeast market via the Colonial and Plantation pipelines. The pipelines can potentially be served by 30+ Gulf Coast refineries with a capacity of about 6.750 million b/d.

B. Current Crude Sources and Tar Sands Crude Processing

More than 93% of the crude oil supply to U.S. Northeast refineries is imported. The estimated crude slate for 2012 is provided in **Table 3**. About 120,000 b/d of low sulfur crude is imported from Canada. Most of this is conventional East Coast offshore production, but a small volume (5,000 b/d) is from Western Canada. An additional 60,000 b/d of high-sulfur Western Canadian crude oil is imported into the United Refining refinery in Pennsylvania. According to statements by United Refining, this consists of conventional heavy crude production as opposed to tar sands derived crude.

Transport or import statistics do not specify whether the imported Canadian crude is conventional, tar sands bitumen or upgraded synthetic crude from tar sands. According to United Refining Co.'s reports, its heavy crude imports are predominately conventional heavy crude[2] – the reported quality would confirm this. However the crude oil delivery system moving Western Canadian crude into the United Refining area also carries bitumen blends, so it is likely that a small portion of United Refinery crude is from tar sands (1% to 2%, or 1,000 b/d). The low-sulfur Western Canadian crude imported to the Northeast coastal region enters the U.S. through the Albany, New York area. On the Canadian side of the border, about one-third of the low-sulfur Western Canadian crude available is estimated to be made up of low-sulfur synthetic crude. Hart Energy therefore estimates that the low-sulfur Western Canadian crude imports are also consistent with this ratio, resulting in about 2,000 b/d tar sands-derived crude. The quality of these imports would support the assumption that a substantial portion is low-sulfur synthetic crude.

The Canadian refineries east of Québec process Eastern Canadian production and imported crude; in the past, no Western Canadian crude was processed. A small volume of Western Canadian crude receipts were reported for the second half of 2012, also reported as being neither synthetic crude nor bitumen.[3] Hart Energy believes this is actually U.S. tight oil shipped through western Canada. Québec refineries process Eastern Canadian and imported crude as well. A small amount of Western Canadian crude (3,000 b/d) has been received in the area. This is assumed to be low sulfur because of the refinery configurations, and based on the low-sulfur mix in Ontario, is estimated to consist of about 1,000 b/d tar sands crude.

Crude oil supplied to Ontario refineries is 85% Western Canadian crude and the rest is imported or from Eastern Canada. According to the Canadian Association of Petroleum Producers (CAPP), Western Canadian crude supplied to Ontario refineries is about 32% tar sands derived. The resulting Ontario crude slate is therefore 27% tar sands-derived.

U.S. Gulf Coast refiners are estimated to have received about 110,000 b/d of Western Canadian crude in 2012. This is thought to be primarily derived from tar sands (according to CAPP). About 30,000 b/d of this is used in a refinery which does not serve the Northeast. Based on the remaining Canadian crude

[2] Letter to Michigan Public Service Commission, from Chris Sparling, United Refining, June 8, 2012.
[3] Supply and Disposition of refined products in Canada-October 2012, Table 3.1, Statistics Canada

and volume of crude processed by refiners with potential access to pipelines to the East Coast (6.750 million b/d), it appears that about 1.2% of the crude mix is tar sands-derived.

Table 3: U.S. Northeast Actual Processed Refinery Crude Slate
(thousand b/d)

Northeast	PBF Energy Delaware	PBF Energy Paulsboro	Nustar	United Refining	L.S. Refineries[1]	Lube Refineries
			Low Sulfur			
Canada	2	1	6		110	
Africa	20	2			400	
CIS					20	
Latin America	11					
Europe	20				8	
Other Imports	3				5	
Domestic -PADD 1				1		25
Domestic Tight Oil	5	5			20	
Subtotal	*61*	*8*	*6*	*1*	*563*	*25*
			High Sulfur			
Canada				64		
Latin America	12	15	26			
Middle East	35	110				
Other Imports	6					
Subtotal	*53*	*125*	*26*	*64*		*0*
Total	**114**	**133**	**32**	**65**	**563**	**25**

[1] Includes ConocoPhillips, Monroe Energy and Philadelphia Energy Solutions

Source: Energy Information Administration and Hart Energy analysis

C. Current Product Supply and Portion from Tar Sands Crude

The current supply of refined product in the U.S. Northeast is sourced from Northeast refineries, including biofuel additions (36%), Canadian product imports (9%), other country imports (14%), and shipments from other U.S. regions (41%). **Table 4** summarizes supply and demand for 2012. The receipts of refined product to the Northeast are, for the most part, shipped from the U.S. Gulf. Northeast refineries ship products to the Midwest via pipeline from the Philadelphia area. There is a small volume of product from the Midwest to the Northeast as well, but the net flow is from the Northeast to the Midwest. Any flow of tar sands product from the Midwest is negligible.

Table 4: U.S. Northeast Petroleum Product Supply and Demand: 2012
(thousand b/d)

2012	Northeast Demand	Northeast Production[1]	East Canada Imports	Québec Imports	Ontario Imports	Other Country Imports	Receipts ex U.S. Gulf
Gasoline	1522	375	109	5	0	375	658
Jet/Kerosene	308	65	0	0	0	21	222
Middle Distillate	653	350	66	7	10	-25	245
Residual Fuel	179	60	30	2	0	30	57
Other	123	146	0	4	9	-8	-28
Total	**2785**	**996**	**205**	**18**	**19**	**393**	**1154**
Percent of Northeast Demand							
Gasoline		25%	7%	5	0	25%	43%
Jet/Kerosene		21%	0	0	0	7%	72%
Middle Distillate		54%	10%	1%	2%	-4%	38%
Residual Fuel		34%	17%	1%	0	17%	32%
Other		119%	0	3%	7%	-7%	-23%
Total		**36%**	**7%**	**1%**	**1%**	**14%**	**41%**

[1] Used in Northeast

Source: Energy Information Administration and Hart Energy analysis

Table 5 provides an estimate of the volume of product produced from tar sands crude and the percentage of the total Northeast product market. The portion of tar sands crude processed in each region from the previous discussion was used as the basis for these product volumes. Tar sands crude currently (2012) accounts for 22,000 b/d or 0.8% of the U.S. Northeast refined product market.

Table 5: Northeast Product from Tar Sands: 2012

Northeast	Northeast	Eastern Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed[1] K b/d	917	410	328	150	6750	N/A	N/A
Tar Sands Derived[2] K b/d	3	0	1	40	80	0	N/A
% Tar Sands	0.3%	0.0%	0.3%	26.7%	1.2%	0.0%	N/A
Product Supplied to Northeast K b/d	996	205	18	19	1154	393	2785
Tar Sands Product to Northeast K b/d	3	0	0	5	14	0	22
% of Northeast Market							0.8%

[1] Crude oil processed in Northeast is less than product supplied (Table 4) because Hess refinery processes unfinished oil versus crude and because ethanol provides additional product supply.

[2] Includes diluted bitumen and synthetic crude

Source: Hart Energy analysis

III. Northeast Import/Export Trends: Tar Sands Crude and Product Flow Through 2025

A. North American Overview: Business as Usual (BAU) Assumptions

Production of North American unconventional tight oil (also referred to as shale oil) and tar sands are growing rapidly. U.S. tight oil production was 640,000 b/d in 2011 and had already risen to 1.700 million b/d by late 2012. Tight oil production is expected to approach 4.0 million b/d by 2020 with some additional tight oil production projected for Canada (about 0.2 million b/d). Canadian tar sands production has increased steadily over the past decade and will experience an even greater rate of growth going forward. In Hart Energy's BAU case, production will increase from 1.880 million b/d in 2012 to 3.600 million b/d in 2020 and 4.44 million b/d by 2025.[4]

These rapid crude oil developments will have major implications for North American markets:

- North America will become petroleum self-sufficient shortly after 2020;
- Crude oil will continue to be imported into East and West Coast markets where refineries do not have economically viable access to North American crude production sources;
- A North American crude surplus will develop requiring crude oil exports prior to 2020. Export requirements will expand rapidly to more than 1.3 million b/d by 2025; and
- Logistics systems will be constrained, resulting in expensive transportation alternatives (crude by rail) and crude oil discounts. Crude oil price structures will create strong incentives to develop all feasible alternatives, including routes to the U.S. Northeast.

The BAU scenario was developed from Hart Energy's global crude and refined product outlook. Major components of Hart Energy's outlook relevant to this analysis are crude oil production, regional refinery utilization, heavy crude oil production, refined product demand and the resulting refined product supply-demand balance (incorporating refined product imports and exports). Key supply, demand and refining assumptions based on the outlook are shown in **Table 6**.

The BAU scenario includes regional balances of U.S. and Canadian crude, including a balance for heavy Canadian bitumen blends. The balances assume processing of diluted bitumen in the East Coast as discussed previously. No diluted bitumen is assumed to be processed on the West Coast. Western Canadian, PADD 2 and PADD 4 refineries are assumed to maintain current processing of diluted bitumen with additional processing assumed in the PADD 2 refineries with heavy crude, bitumen related expansions underway. Current processing of synthetic crude will continue and incremental production will back out imported sweet crude and make up for decline in similar quality conventional crude.

[4] Hart Energy estimates from Heavy Crude Outlook. These are a little different than CAPP estimates based on Hart Energy evaluation of projects.

Table 6: BAU: Supply-Demand Assumptions
(million b/d)

	PADD 1	PADD 2	PADD 3	PADD 4	PADD 5
2012					
Tight Oil Production	0.00	0.67	0.81	0.06	0.00
Conventional Crude	0.02	0.51	3.16	0.36	1.13
Refined Product Demand	5.42	4.79	4.86	0.69	2.80
Net Product Imports	0.88	0.00	-1.67	0.00	-0.18
Refinery Utilization	0.92	3.81	7.60	0.60	2.33
2015					
Tight Oil Production	0.04	1.19	1.91	0.24	0.00
Conventional Crude	0.02	0.44	3.14	0.31	1.02
Refined Product Demand	5.41	4.83	4.79	0.69	2.76
Net Product Imports	0.81	0.00	-1.85	0.00	-0.17
Refinery Utilization	1.00	3.85	7.82	0.60	2.23
2020					
Tight Oil Production	0.06	1.50	2.55	0.32	0.00
Conventional Crude	0.02	0.40	3.07	0.25	1.01
Refined Product Demand	5.28	4.78	4.99	0.68	2.68
Net Product Imports	0.71	0.00	-1.73	0.00	-0.15
Refinery Utilization	1.00	3.74	7.76	0.58	2.13
2025					
Tight Oil Production	0.06	1.64	2.56	0.34	0.00
Conventional Crude	0.02	0.38	2.71	0.20	0.93
Refined Product Demand	5.07	4.68	4.99	0.67	2.59
Net Product Imports	0.61	0.00	-1.66	0.00	-0.14
Refinery Utilization	0.94	3.57	7.65	0.65	2.05

Critical to this analysis is the volume of tar sands crude processed in the U.S. Gulf Coast. The crude balance on the Gulf assumes that as tight oil production and Canadian production grow, crude oil imports will be backed out in favor of tight oil, other U.S. conventional crude production (no U.S. exports other than that to eastern Canada), Canadian synthetic crude and diluted bitumen. Based on the BAU balances, non-Canadian imports will be backed out by 2020.

Finally, the BAU case assumes that sufficient logistic capacity will exist to move Western Canadian production out of Canada. The BAU also assumes that pipeline/rail capacity is sufficient to move the volume of Canadian crude calculated to be processed in the Gulf Coast. This assumes availability of the Pegasus pipeline, the Enbridge Flanagan, the Enbridge ETP and the Keystone XL. Additional capacity will be required beyond this to move additional Canadian crude to the export market. However that is not

considered in the BAU scenario because it would not directly impact tar sand crude processing in the U.S. and tar sands derived product on the East Coast.

B. Tar Sands Crude Flow to U.S. Northeast Refineries and Other Refining Centers Supplying the Northeast

Hart Energy's BAU forecast calls for an increased shipment of crude oil from Western Canada and the U.S. Midwest of 160,000 b/d by 2015 and an additional 20,000 b/d between 2015 and 2020. Shipments are projected to remain at this volume beyond 2020. The incremental shipments will be rail movements of tight oil and western Canadian crude (primarily bitumen blends).

Four Northeast refineries – United Refining, Nustar, PBF Paulsboro and PBF Delaware City – can process tar sands crude in varying shares of their total crude mix. The United refinery will continue to have access to Western Canadian crude shipped via the Enbridge 6B line to its terminal in West Seneca, NY. The refinery does not have the capability to shift overall crude quality significantly, but can increase imports of tar sands crude by incorporating blends of heavier bitumen and light synthetic or conventional crude. The trend in tar sands use will likely track changes in tar sands crude flowing into the Ontario area (32% in 2012 to 35% by 2020). The Hart Energy forecast increases the tar sands crude processed at United Refining from 1.5% to 4.5%.

Rail capability to Delaware City, DE is projected to increase[5] to 150,000 b/d by 2015 (about 80,000 b/d heavy oil). Some of this volume can in turn be barged to Paulsboro, NJ. Crude discounts will favor bitumen blends, but there will be some limitation on processing capability. These three refineries are projected to process about 80,000 b/d of tar sands bitumen; the remaining rail shipments will be tight oil.

The Philadelphia refineries and ConocoPhillips in New Jersey cannot process tar sands bitumen. They can process low-sulfur tar sands synthetic crude, but tight oil crude is likely to be more desired and economical for these facilities. The Midwest and Gulf Coast will be long on the very light tight oil and the East Coast refineries will provide a suitable outlet.

Hart Energy's BAU projects no change in crude sources for Canadian Atlantic refineries; these facilities will not process Western Canadian crude. One of the Atlantic refineries, Imperial Dartmouth, is expected to shut down prior to 2015. In the absence of new rail connections, new pipelines or a pipeline reversal, the Québec refineries will continue to have limited access to Western Canadian crude. However, with price discounts, there will be an incentive to move some Western Canadian or tight oil crude to these refineries. In 2011, 16,000 b/d of Western Canadian crude was shipped to Québec during both June and July.[6] For the forecast, it is assumed that this monthly rate is achieved throughout the year from 2015 to 2025.

[5] PBF News release, 2/4/2013
[6] Supply and Disposition of Refined products in Canada-October 2012, Statistics Canada

The Ontario refineries are projected to increase tar sands crude slightly, consistent with the changing mix of tar sands crude in Canada's heavy crude mix and anticipated synthetic crude shipped to the region, according to CAPP. Tar sands crude is forecast to increase to 35% of Western Canadian crude in Ontario. In addition, Western Canadian crude is projected to back out crude imports. The portion of Western Canadian crude will increase to 90% of the mix in Ontario and 32% of the resulting overall crude mix will be tar sands-derived.[7]

The U.S. Gulf Coast will receive increasing volumes of Canadian crude over time. Western Canadian and U.S. Midcontinent crude production will exceed local refining capabilities and refined product demand, and transportation capacity will be expanded accordingly. Additional crude will be moved east and west, but these volumes will be limited, as discussed previously.

Figure 1 shows the volume of tar sands crude processed in Eastern Canadian and U.S. Northeast refineries, and the tar sands portion of the total refinery crude mix for 2015 through 2025. **Figure 2** shows the same data for U.S. Gulf Coast refineries that have access to the Northeast product market. Tar sands crude is projected to grow to 8.2% of crude processed in eastern refineries and to 23.7% of crude processed in Gulf Coast refineries.

C. Refined Product Supply to the U.S. Northeast Refineries and Portion from Tar Sands Crude

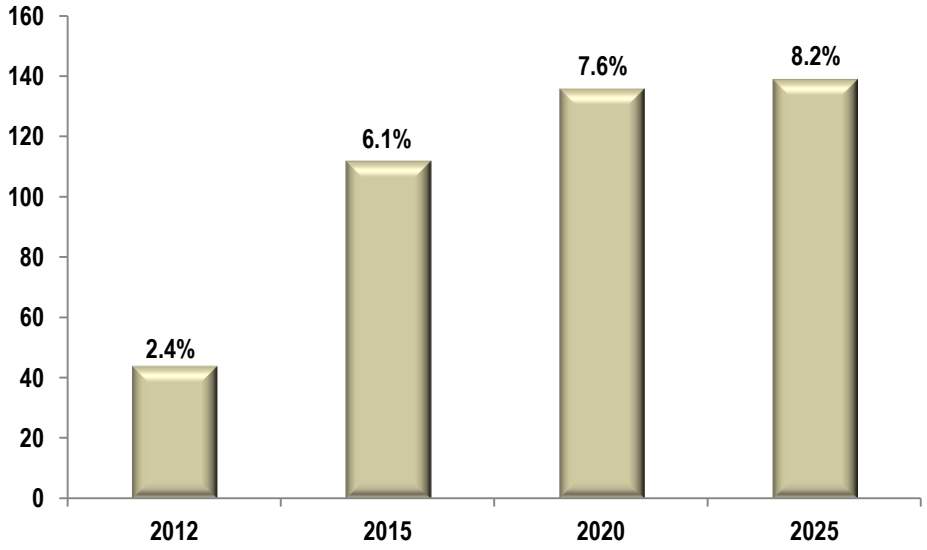
Table 7 summarizes U.S. Northeast refined product supply and demand for 2015, 2020 and 2025. The receipts of refined product to the Northeast will continue, for the most part, to be shipped from the U.S. Gulf. The Northeast refineries will continue to ship products to the Midwest via pipeline from the Philadelphia area, but volumes will decline slightly. There will be a small volume of product moving from the Midwest to the Northeast as well, but the flow from the Midwest associated with tar sands will be negligible.

The supply-demand pattern will not deviate significantly from the current balance – product shipments from the Gulf Coast will make up the largest share of supply, followed by local Northeast refinery production. Together, Gulf Coast and Northeast refineries will account for over 80% of supply. The Gulf Coast market share will increase a little over time (5.1% between 2012 and 2025) and the Northeast refinery share will increase by 1.6%. The portion of the market supplied by Canadian and other imports will decline.

[7] Hart estimates. There is limited capability for these refineries to process heavy crude. They are well suited to light Tight Oil

Figure 1: Tar Sands Crude[1] Processed in East Canadian and U.S. Northeast Refineries

(thousand b/d)

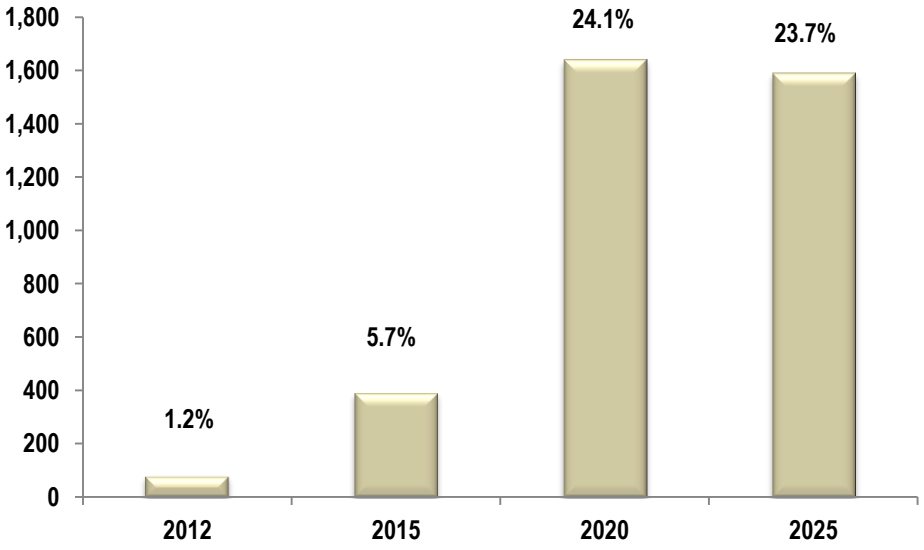


[1]Includes diluted bitumen and synthetic crude.

Source: Hart Energy analysis

Figure 2: Tar Sands Crude[1] Processed in Gulf Coast Refineries

(thousand b/d)



[1] Includes diluted bitumen and synthetic crude

Source: Hart Energy analysis

Table 7: U.S. Northeast Petroleum Product Supply and Demand: 2015-2025
(thousand b/d)

2015	Northeast Demand	Northeast Production	East Canada Imports	Quebec Imports	Ontario Imports	Other Country Imports	Receipts ex U.S. Gulf
Gasoline	1504	398	90	5	0	335	676
Jet/Kerosene	315	107	0	0	0	0	208
Middle Distillate	698	376	28	7	10	-15	292
Residual Fuel	134	69	16	2	0	0	47
Other	124	144	0	4	9	-2	-31
Total	**2775**	**1094**	**134**	**18**	**19**	**318**	**1192**
% of Northeast Demand		**39%**	**5%**	**1%**	**1%**	**11%**	**43%**
2020	**Northeast Demand**	**Northeast Production**	**East Canada Imports**	**Quebec Imports**	**Ontario Imports**	**Other Country Imports**	**Receipts ex U.S. Gulf**
Gasoline	1419	350	90	5	0	300	674
Jet/Kerosene	317	110	0	0	0	0	207
Middle Distillate	705	370	25	6	9	0	295
Residual Fuel	134	65	14	2	0	0	53
Other	125	138	0	4	9	0	-26
Total	**2700**	**1033**	**129**	**17**	**18**	**300**	**1203**
% of Northeast Demand		**38%**	**5%**	**1%**	**1%**	**11%**	**45%**
2025	**Northeast Demand**	**Northeast Production**	**Eastern Canada Imports**	**Québec Imports**	**Ontario Imports**	**Other Country Imports**	**Receipts ex U.S. Gulf**
Gasoline	1304	300	82	4	0	252	666
Jet/Kerosene	323	116	0	0	0	0	207
Middle Distillate	717	355	41	6	8	-4	311
Residual Fuel	134	65	14	2	0	0	53
Other	128	138	0	4	9	0	-23
Total	**2606**	**974**	**137**	**16**	**17**	**248**	**1214**
% of Northeast Demand		**37%**	**5%**	**1%**	**1%**	**10%**	**47%**

Source: Hart Energy analysis

Table 8 provides an estimate of the resulting volume of product produced from tar sands crude and the percentage of the total Northeast product market. The portion of tar sands crude processed in each region from the previous discussion was used as the basis for these product volumes. Northeast refined product derived from tar sands crude will increase from 22,000 b/d or 0.8% of the U.S. Northeast refined product market in 2012, to 384,000 b/d or 14.2% by 2020. Most significant in terms of the Northeast market reliance on tar sands is the role of Gulf Coast shipments. Gulf Coast refineries will

process a much higher percentage of tar sands crude than either Eastern Canadian or Northeast refineries. Even if additional crude logistics systems are expanded to move more Western Canadian crude eastward, the tar sands contribution to Northeast markets will be driven by Gulf Coast refineries.

Table 8: Northeast Product from Tar Sands: 2015-2025

2015	Northeast	East Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed K b/d	1005	340	328	155	6850	N/A	N/A
Tar Sands Derived K b/d	64	0	5	43	392	0	N/A
% Tar Sands	6.4%	0.0%	1.5%	27.7%	5.7%	0.0%	N/A
Product Supplied to Northeast K b/d	1094	134	18	19	1192	318	2775
Tar Sands Product to Northeast K b/d	70	0	0	5	68	0	143
% of Northeast Market							5.2%

2020	Northeast	East Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed K b/d	1000	330	320	150	6800	N/A	N/A
Tar Sands Derived K b/d	85	0	5	46	1640	0	N/A
% Tar Sands	8.5%	0.0%	1.6%	30.7%	24.1%	0.0%	N/A
Product Supplied to Northeast K b/d	1033	129	17	18	1203	300	2700
Tar Sands Product to Northeast K b/d	88	0	0	6	290	0	384
% of Northeast Market							14.2%

2025	Northeast	East Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed K b/d	945	310	298	140	6710	N/A	N/A
Tar Sands Derived K b/d	85	0	5	49	1590	0	N/A
% Tar Sands	9.0%	0.0%	1.7%	35.0%	23.7%	0.0%	N/A
Product Supplied to Northeast K b/d	974	137	16	17	1214	248	2606
Tar Sands Product to Northeast K b/d	88	0	0	6	288	0	381
% of Northeast Market							14.6%

Source: Hart Energy Analysis

IV. Alternate Crude Logistic Scenarios and Response to NRDC Questions

A. Additional Pipeline Reversal Scenarios

The growing surplus of crude in the North American midcontinent will continue to create strong incentives to find additional outlets for Western Canadian crude as well as tight oil crude from the Bakken play and other tight oil (shale) plays. This will include links to markets in Eastern Canada and the U.S. Northeast refining centers.

A proposal under consideration involves the reversal of Enbridge's "Line 9," which currently moves conventional oil (primarily imported) from Montréal to refineries in Sarnia. With this reversal, Western Canadian crude can reach eastern Canadian refineries. If carried further the plan could involve reversal of the Portland pipeline and create an export outlet for Canadian crude.

Another issue, not yet resolved is the status of the Keystone XL pipeline. Without this pipeline or alternative which will provide capacity to move crude to Gulf Coast refiners, the Gulf Coast tar sands crude assumptions in the BAU cannot be achieved.

To illustrate the impact of the alternate pipeline capacity outcomes, three scenarios (compared to the BAU scenario) have been examined for 2020:

- Additional diluted bitumen processed by Irving Oil and additional synthetic crude to refineries in Québec.
- Additional diluted bitumen processed by Irving Oil and additional synthetic crude to refineries in Québec along with Atlantic refineries and U.S. Northeast refineries.
- BAU supply in the east and Keystone XL not approved.

The first assumes reversal of Line 9, providing additional Western Canadian crude to the Montréal area and east as far as the Irving Oil refinery. For this scenario it is further assumed that with access to Western Canadian crude and potential discounts for bitumen, Irving Oil would elect to invest in capacity to increase capability to process bitumen blends.[8] Hart Energy has assumed that the investments would allow Irving to process 90,000 b/d of diluted bitumen.[9] The Québec refineries are not able to process bitumen blends, so in this scenario, the Western Canadian crude shipments would have to be low-sulfur (synthetic crude and/or low-sulfur conventional). Low-sulfur crudes currently moving into Ontario consist of a mix of conventional and synthetic crudes. For this scenario, Hart Energy assumes the same

[8] Conversations between T. Higgins of Hart Energy and Irving Oil executives indicated that this option would be considered under attractive pricing scenarios.

[9] This is the average bitumen processing capacity increase of three recent/proposed Midwest heavy bitumen expansions (Cenovus, Marathon and Husky). The BP expansion was considered too large and atypical of what might be expected elsewhere.

mix would move on to Québec. (The assumed level of synthetic crude is probably high because, based on the type of crude currently processed, the optimal replacement will be Bakken crude or other light tight oil plays.) **Table 9** summarizes the resulting Northeast tar sands product from this scenario. The tar sands contribution to 2020 Northeast product in this case would increase to 15.7% (versus 14.2% in the BAU).

Table 9: Northeast Production from Tar Sands: Additional Bitumen Processed by Irving Oil

2020	Northeast	East Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed K b/d	1000	330	320	150	6800	N/A	N/A
Tar Sands Derived K b/d	85	90	106	46	1640	0	N/A
% Tar Sands	8.5%	27.3%	33.1%	30.7%	24.1%	0.0%	N/A
Product Supplied to Northeast K b/d	1033	129	17	18	1203	300	2700
Tar Sands Product to Northeast K b/d	88	35	6	6	290	0	424
% of Northeast Market							15.7%

Source: Hart Energy analysis

For the second scenario, the Portland pipeline is also assumed to be reversed. In this case synthetic crude could also be used in the Atlantic refineries (assume additional 25,000 b/d) and U.S. Northeast refineries (assume additional 50,000 b/d). Under this scenario (see **Table 10**) tar sands contribution to Northeast product increases to 18.0%.

Table 10: Northeast Production from Tar Sands: With Irving Oil Investment and Additional East Coast Links

2020	Northeast	Eastern Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed K b/d	1000	330	320	150	6800	N/A	N/A
Tar Sands Derived K b/d	135	115	106	46	1640	0	N/A
% Tar Sands	13.5%	34.87%	33.1%	30.7%	24.1%	0.0%	N/A
Product Supplied to Northeast K b/d	1033	129	17	18	1203	300	2700
Tar Sands Product to Northeast K b/d	139	45	6	6	290	0	486
% of Northeast Market							18.0%

Source: Hart Energy analysis

The final scenario is presented as a low impact scenario, and assumes the Keystone XL is not approved and Irving Oil does not elect to make bitumen processing investments. The results of this low impact case are provided in **Table 11,** tar sands contribution to Northeast product decreases to 11.5%.

Table 11: Northeast Production from Tar Sands: Without Irving Investment or Keystone XL[10]

2020	Northeast	Eastern Canada	Québec	Ontario	U.S. Gulf Coast	Other Country Imports	Northeast Market Total
Crude Oil Processed K b/d	1000	330	320	150	6800	N/A	N/A
Tar Sands Derived K b/d	85	0	106	46	1200	0	N/A
% Tar Sands	8.5%	0%	33.1%	30.7%	17.6%	0.0%	N/A
Product Supplied to Northeast K b/d	1033	129	17	18	1203	300	2700
Tar Sands Product to Northeast K b/d	88	0	6	6	212	0	311
% of Northeast Market							11.5%

B. Response to NRDC Questions

1. How likely is it that the Portland pipeline could be reversed?

Under current Hart Energy production and crude balance forecasts, Canadian producers need an export market outlet for more than 1 million b/d within a decade.[11] This will create strong incentives and place pressure for approval for all alternatives. The Line 9 reversal by itself does not provide much outlet, particularly for heavier blends. Therefore, the Portland reversal will be needed to make west-to-east movements of any substantial volume. Hart Energy believes the Portland pipeline reversal is possible, but recognizes that there will be much debate. The prospect for a sizeable outlet via the West Coast would take pressure off the west-to-east alternative.

The more recent discussion of a pipeline to New Brunswick and use of the Irving port for crude oil exports is also possible, but only one of these options would make sense, Portland pipeline or Irving port – not both.

North American midcontinent crude access to East Coast markets would be very beneficial for the movement of surplus light, tight oil crude. This will build pressure for one of these west-to-east projects.

2. How likely is it that East Coast refineries would invest in the infrastructure necessary to process heavier blends of tar sands?

Hart Energy does not believe there will be widespread investment in Northeast refineries to process heavier blends of tar sands. PBF Energy may consider such an option in Paulsboro or Delaware as part of its overall low-sulfur diesel strategy. United Refining Co. has proposed a coker project (which would increase its bitumen processing capability) but has not gone forward with the project. The disadvantage for that company is in economies of scale. This factor may continue to preclude the investment.

[10] Based on Hart Energy production forecasts and crude balances, Hart estimates that loss of the Keystone XL will reduce 2020 tar sands crude runs by about 440,000 b/d even though the XL pipeline is greater.
[11] While this is based on Hart Energy forecasts, other production forecasts (CAPP) are not much different and would likely yield a similar conclusion.

Hart Energy does not believe that other Northeast refineries will make the investment, particularly in view of the surplus light, tight oil crude that could also be available.

On the Canadian side, Irving Oil would be a likely candidate for an upgrade to handle additional heavy oil blends, but other Canadian refiners would not be expected to do so.

3. Could pipeline connections allow a wider range of upgraded tar sands (synthetic crude) to be processed on the East Coast?

Pipeline expansions could provide potential for upgraded crude to the East Coast, but Hart Energy does not believe that any significant movement of this crude to Northeast refineries is likely. Northeast refineries are well-suited to handle the light, tight oil crudes that will be long in supply in the Midwest and Gulf Coast.