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ECON 366: Energy Economics

Topic 2.5: Oil and Gas Transportation Infrastructure

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Oil and gas transportation

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At the end of this section, you should feel comfortable answering all of these questions:

- Why are pipelines and other transportation technology important in crude oil and gas markets? What impact does infrastructure have on prices?
- What is Canada's current pipeline infrastructure and how are we positioned to accommodate future growth or contraction in production?
- How and why are pipelines regulated as they are?
  - What does the Canadian Energy Regulator (CER) do?
  - Why does the CER need to be involved in pipeline approvals?
- What is the difference in realized value for oil sands bitumen transported by pipe vs transported by rail and why?

We will leave toll setting for a different set of slides later on, but we'll introduce the basics here.

Oil supply chain

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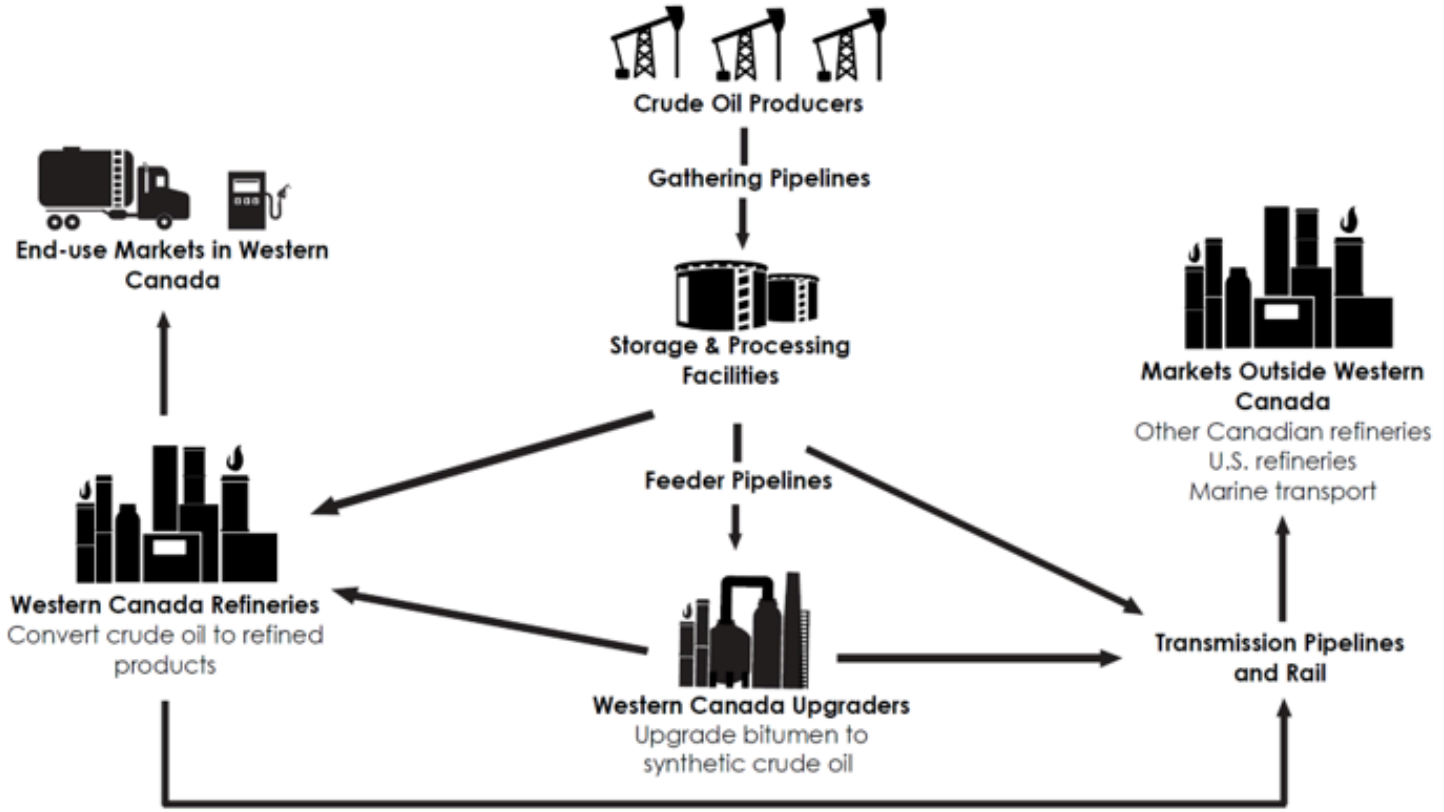
Figure C.1: Western Canada Crude Oil Supply Chain



Source: NEB

Pipelines link our products to markets

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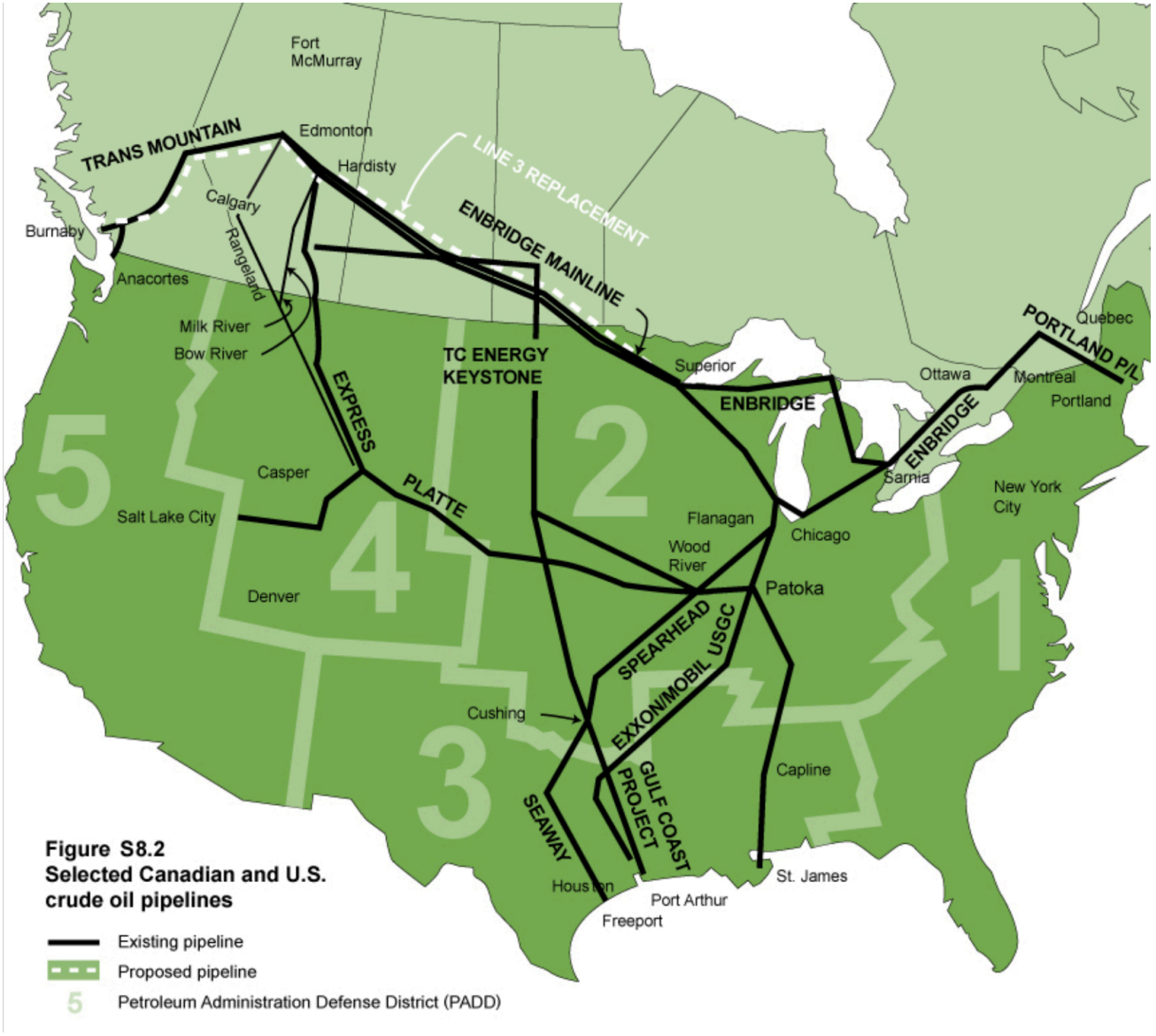
For today's discussion, we're interested in transmission pipelines:

- long distance pipelines which carry oil and natural gas out of Alberta
- oil pipelines you *may* have heard of:
  - Keystone (not the XL one, RIP)
  - TransMountain (and the TransMountain Expansion or TMX)
  - Enbridge Mainline system
- gas pipelines you *may* have heard of:
  - TCPL Mainline
  - Nova Gas Transmission Line (think NIT gas prices)
  - Alliance (NGLs)

The transmission pipeline network is much bigger than you might have thought

Pipelines link our products to markets (Source: AER)



Pipelines link our products to markets (Source: Enbridge)

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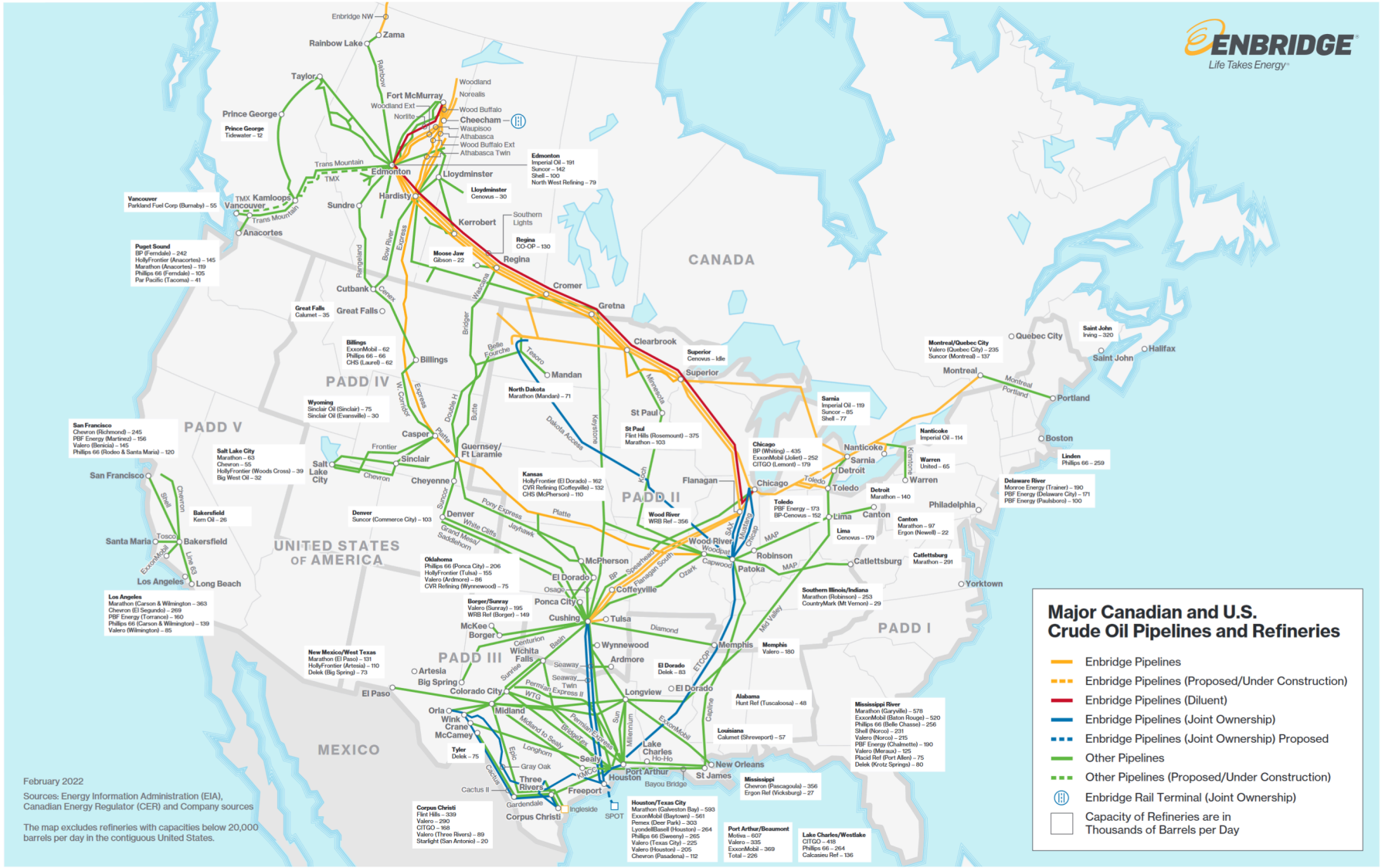

Enbridge Mainline

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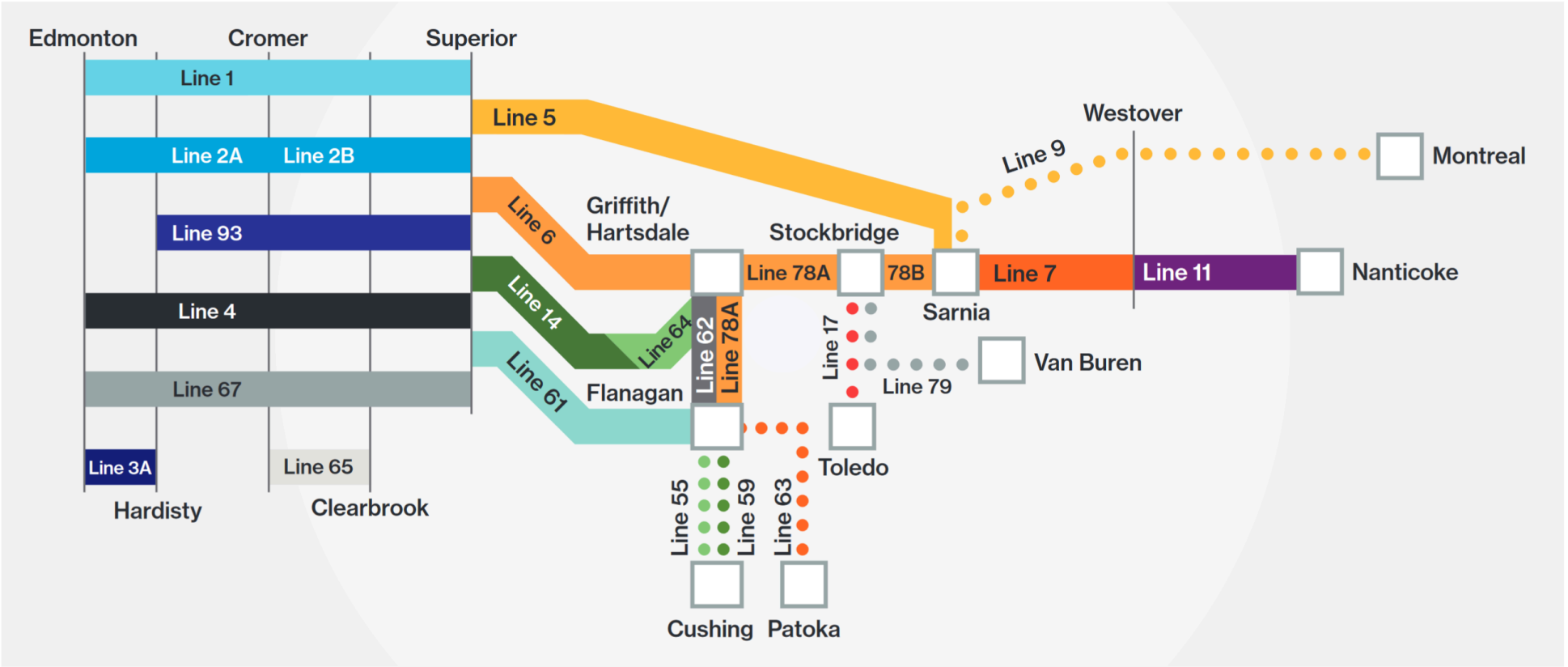
Pipeline System Configuration

Q1, 2022

ENBRIDGE
Life Takes Energy



Canadian Production

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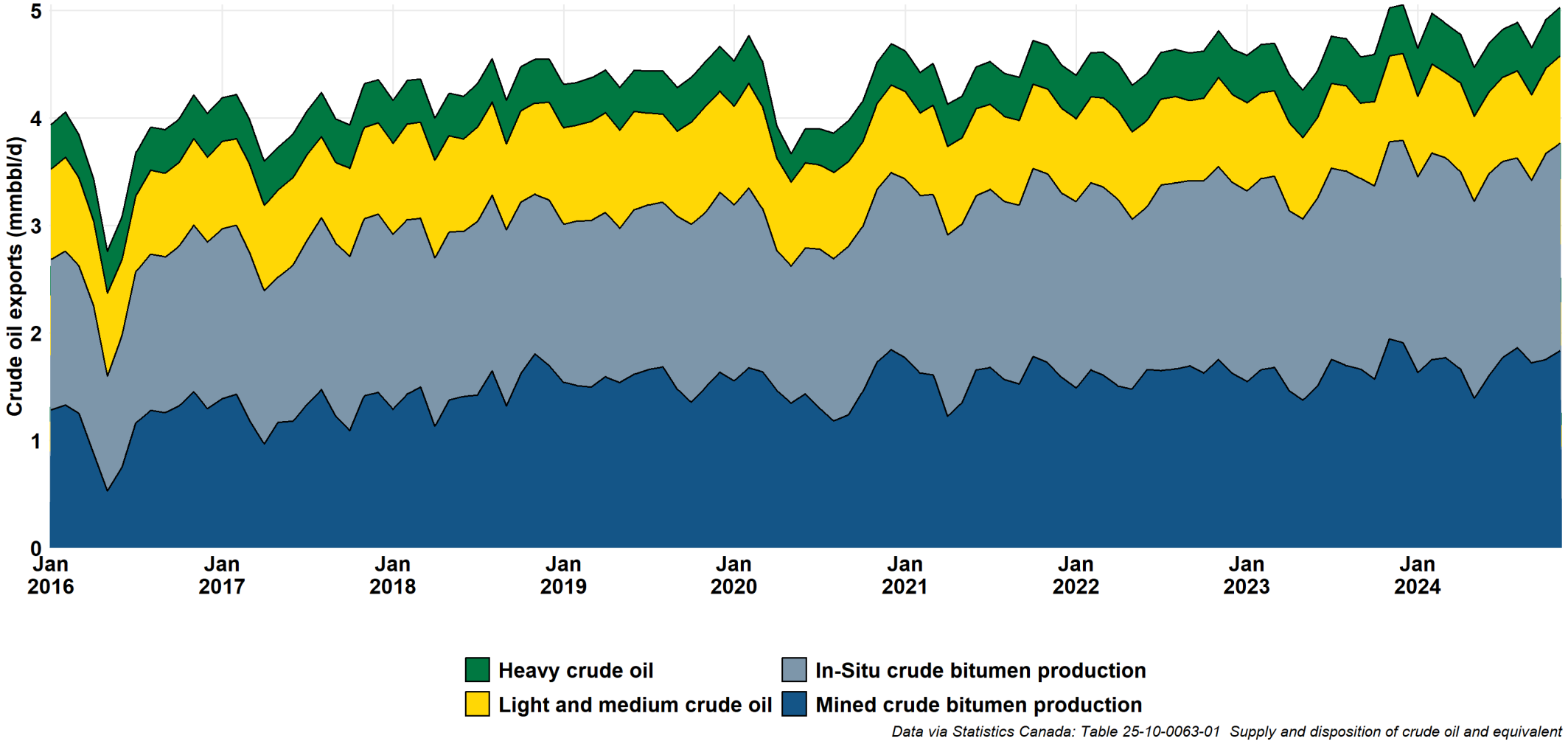

Data via Statistics Canada: Table 25-10-0063-01 Supply and disposition of crude oil and equivalent

Imports

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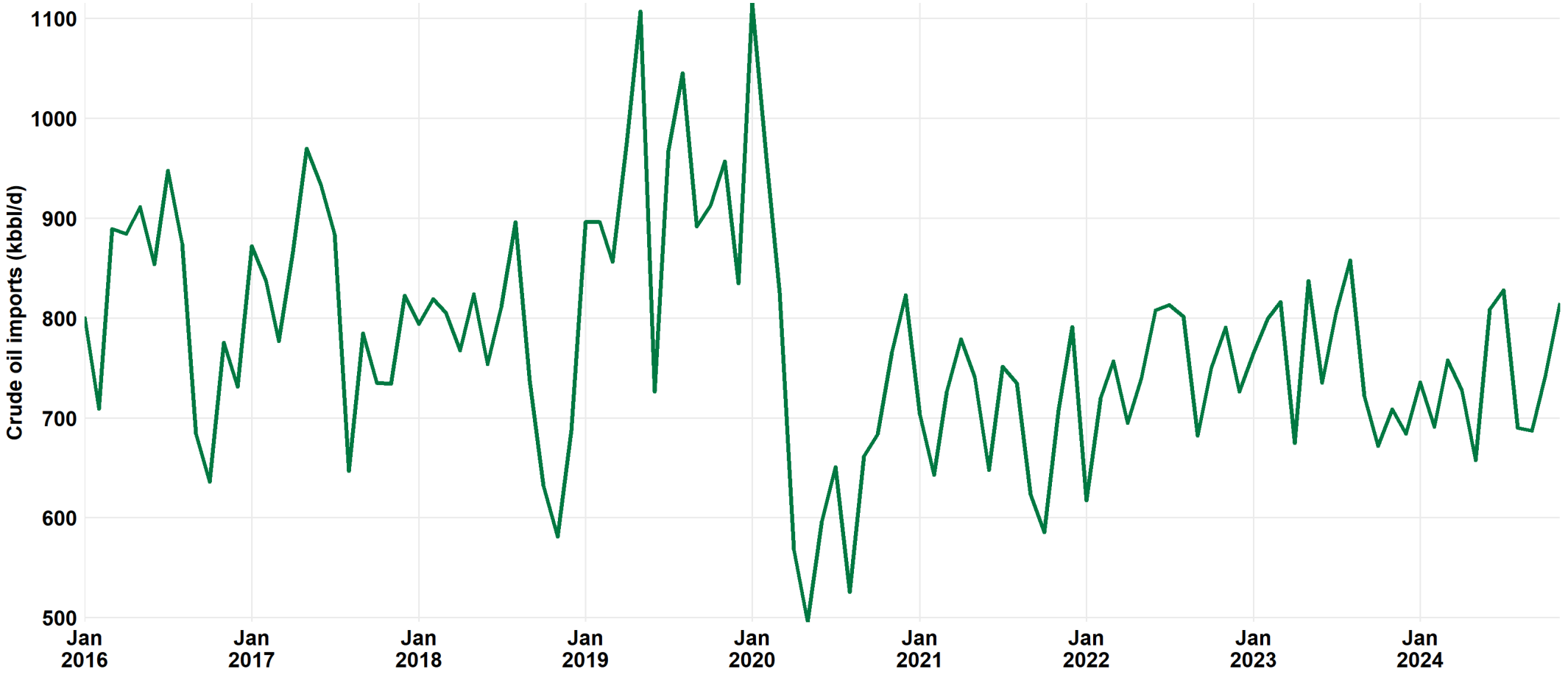

Data via Statistics Canada: Table 25-10-0063-01 Supply and disposition of crude oil and equivalent

Exports

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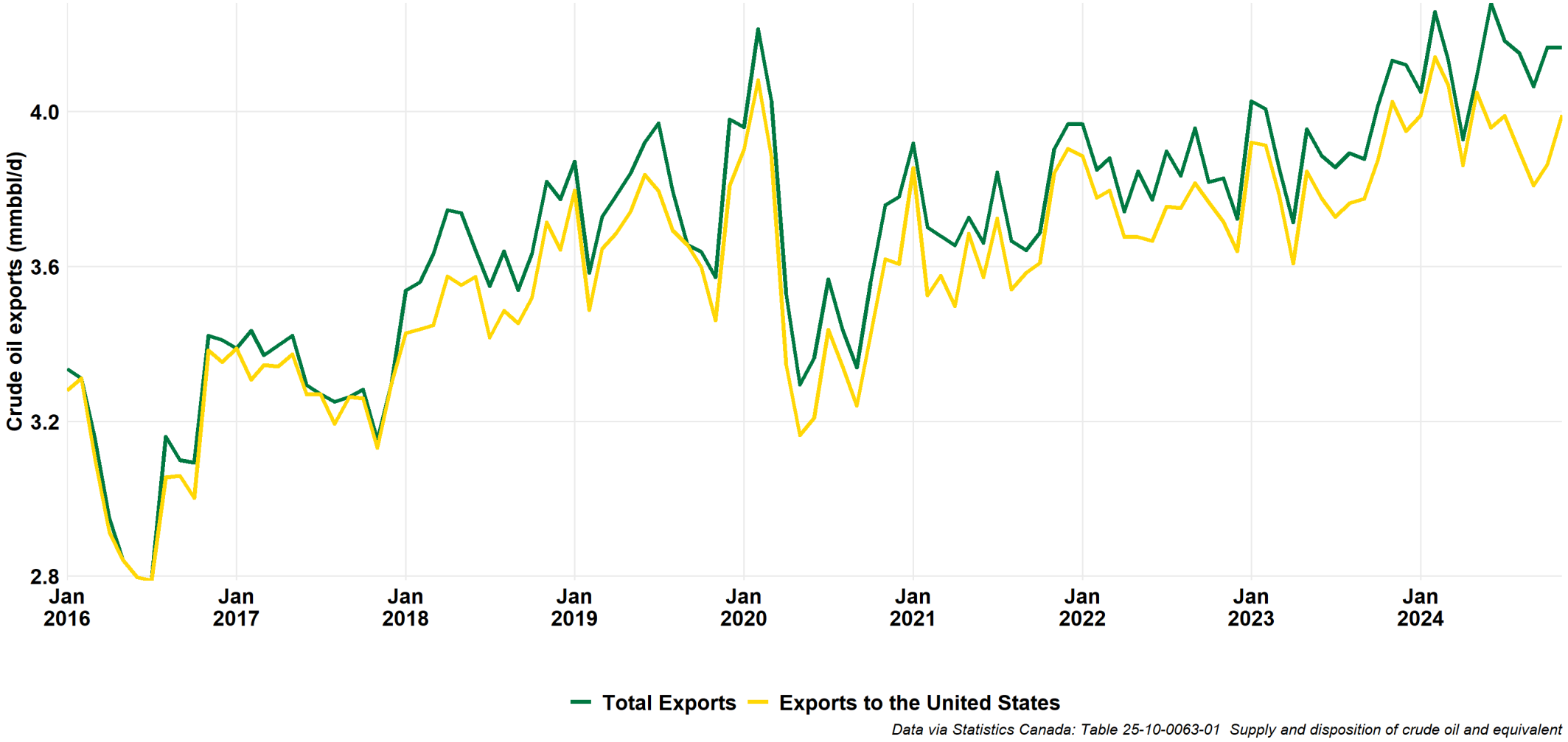

Data via Statistics Canada: Table 25-10-0063-01 Supply and disposition of crude oil and equivalent

Canadian Major Pipeline Exports by Line

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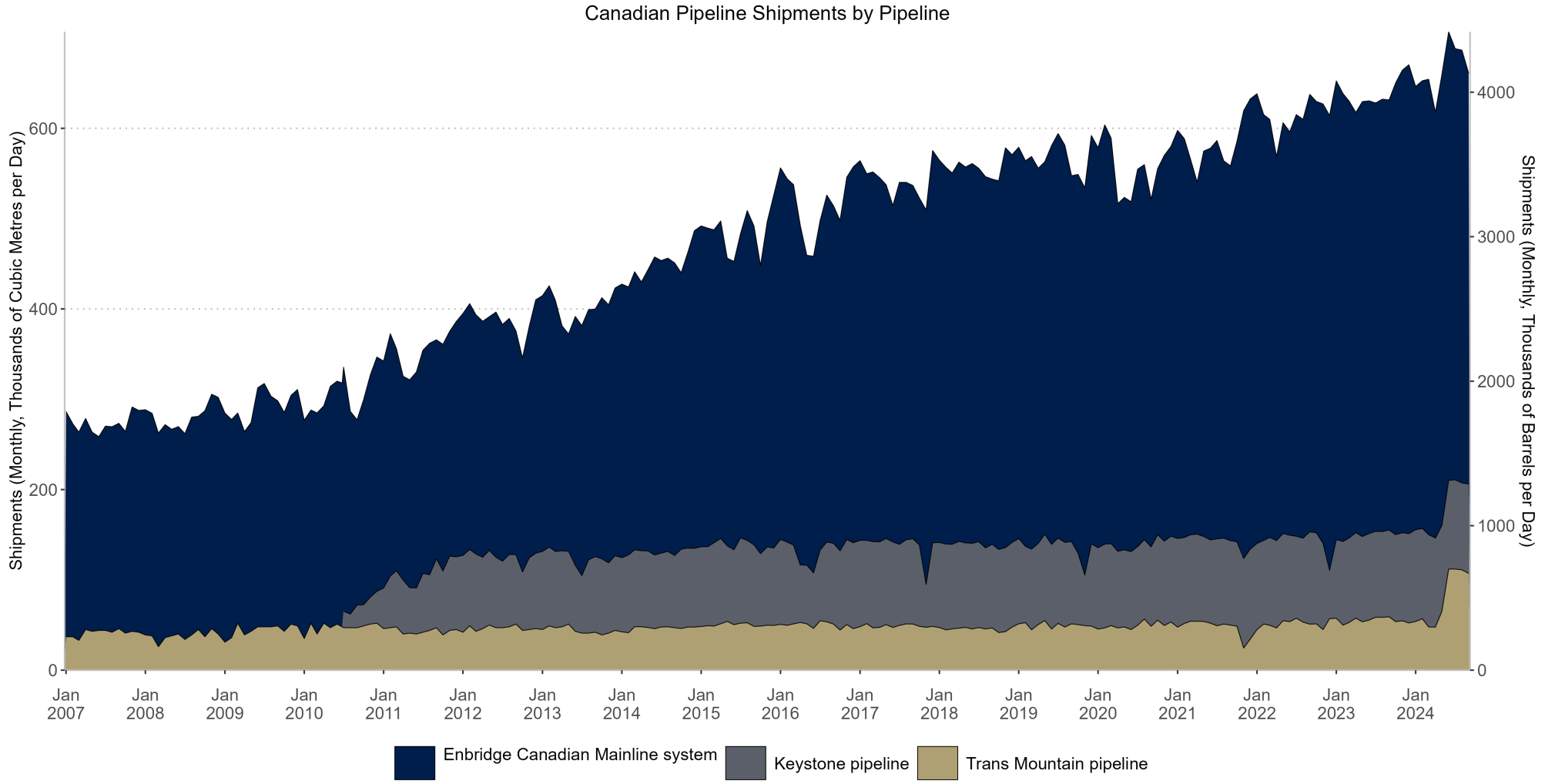

Source: CER Data for Enbridge Mainline (ex-Gretna), Keystone (MB border), and TransMountain (all delivery points), graph by Andrew Leach.

Canadian Major Pipeline Exports by Grade

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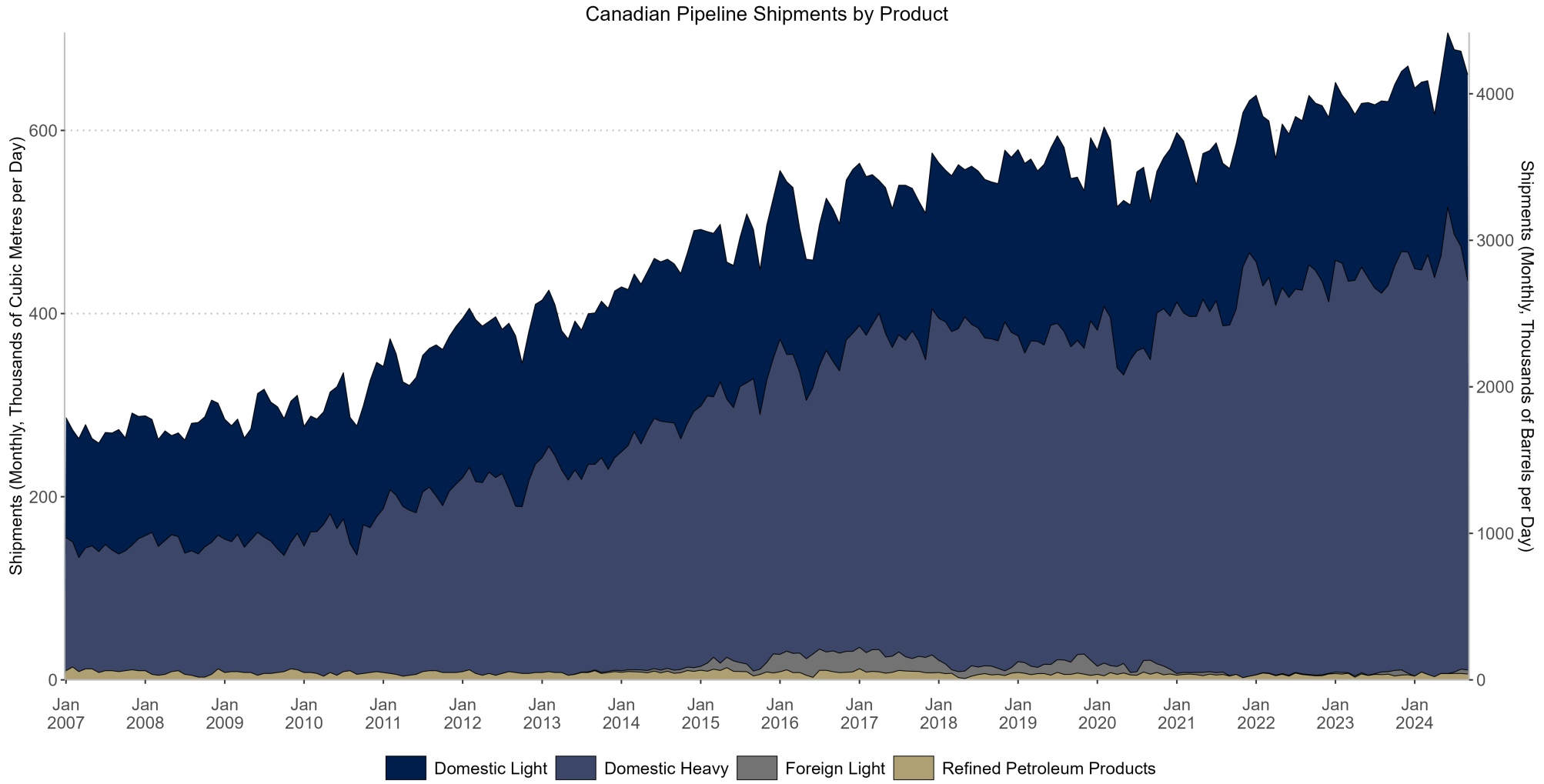

Source: CER Data for Enbridge Mainline (ex-Gretna), Keystone (MB border), and TransMountain (all delivery points), graph by Andrew Leach.

Canadian Major Pipeline Exports by Grade and Line

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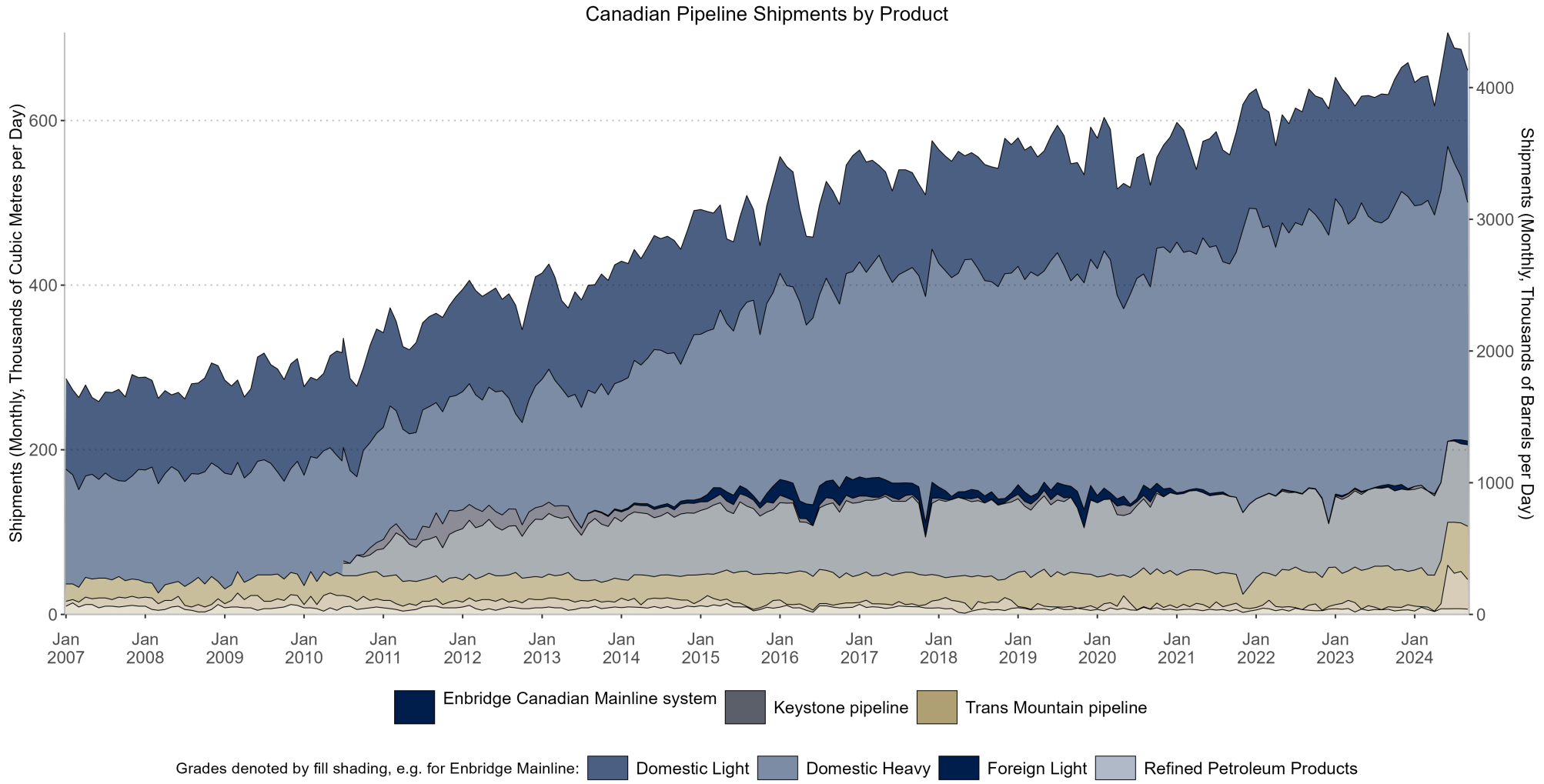

Source: CER Data for Enbridge Mainline (ex-Gretna), Keystone (MB border), and TransMountain (all deliveries), graph by Andrew Leach.

Enbridge Mainline Movements into Sarnia

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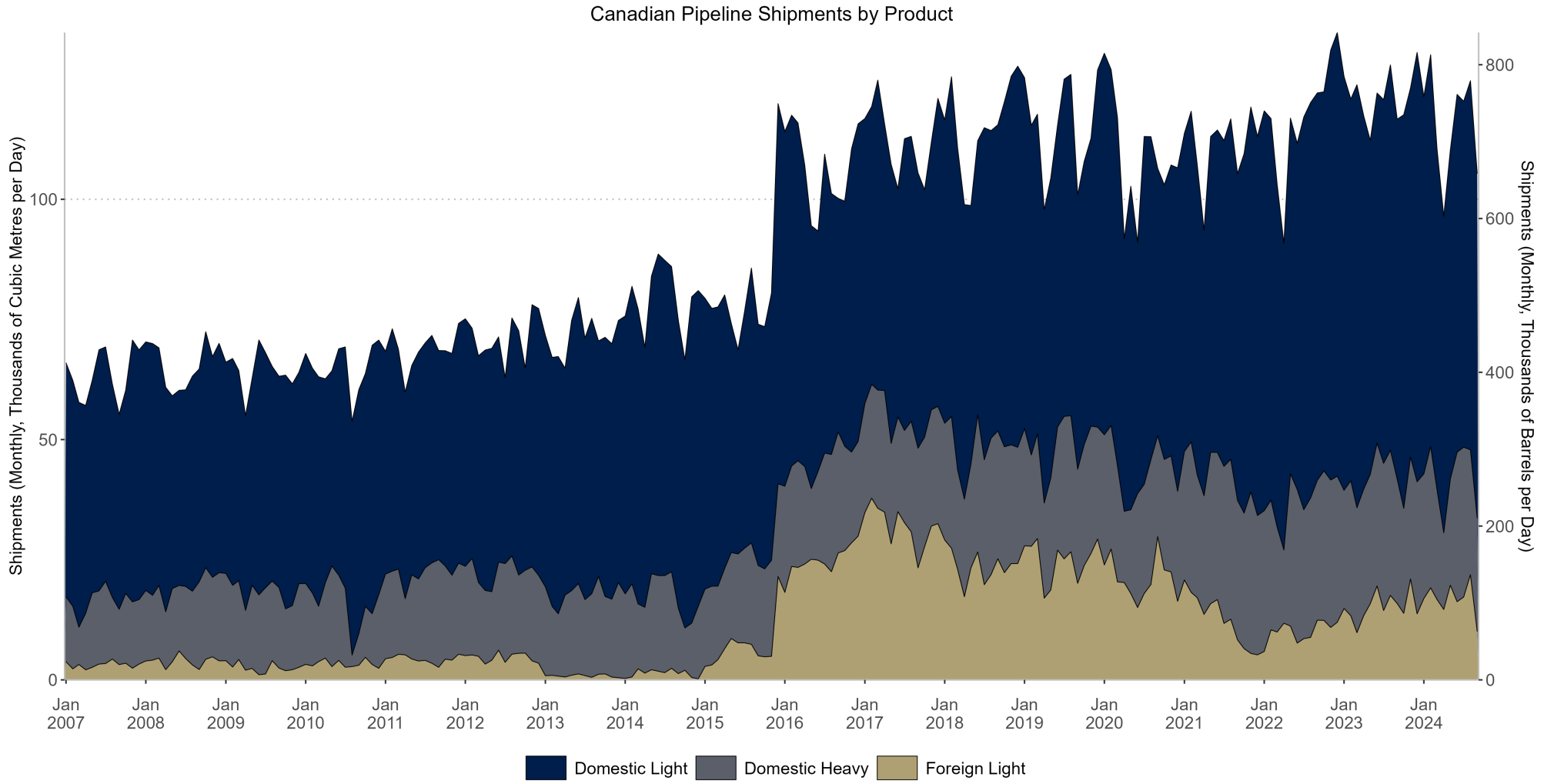

Source: CER Data for Enbridge Mainline (into-Sarnia), graph by Andrew Leach.

TransMountain

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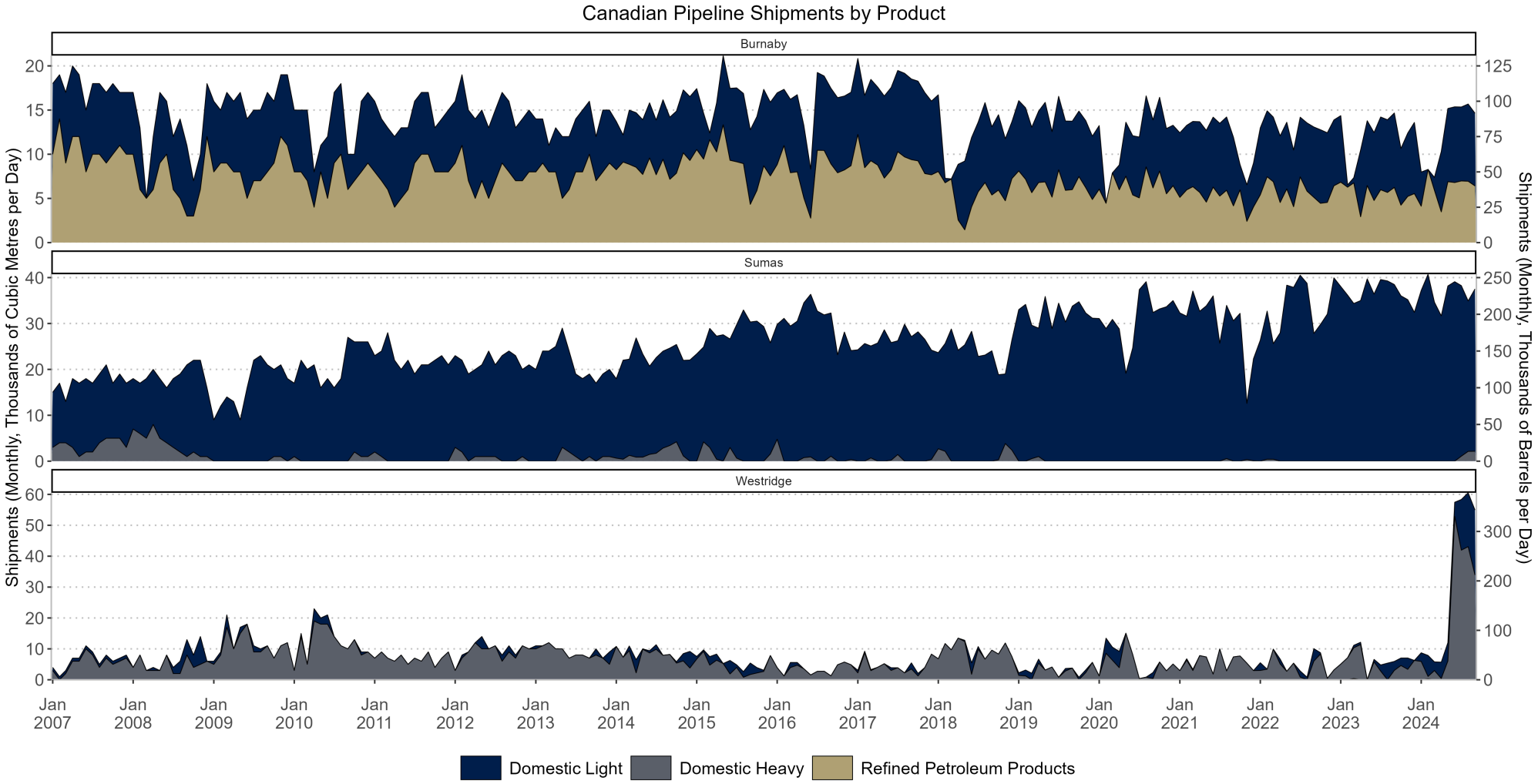

Source: CER Data for TransMountain (all deliveries), graph by Andrew Leach.

Canadian Crude Trade in the US

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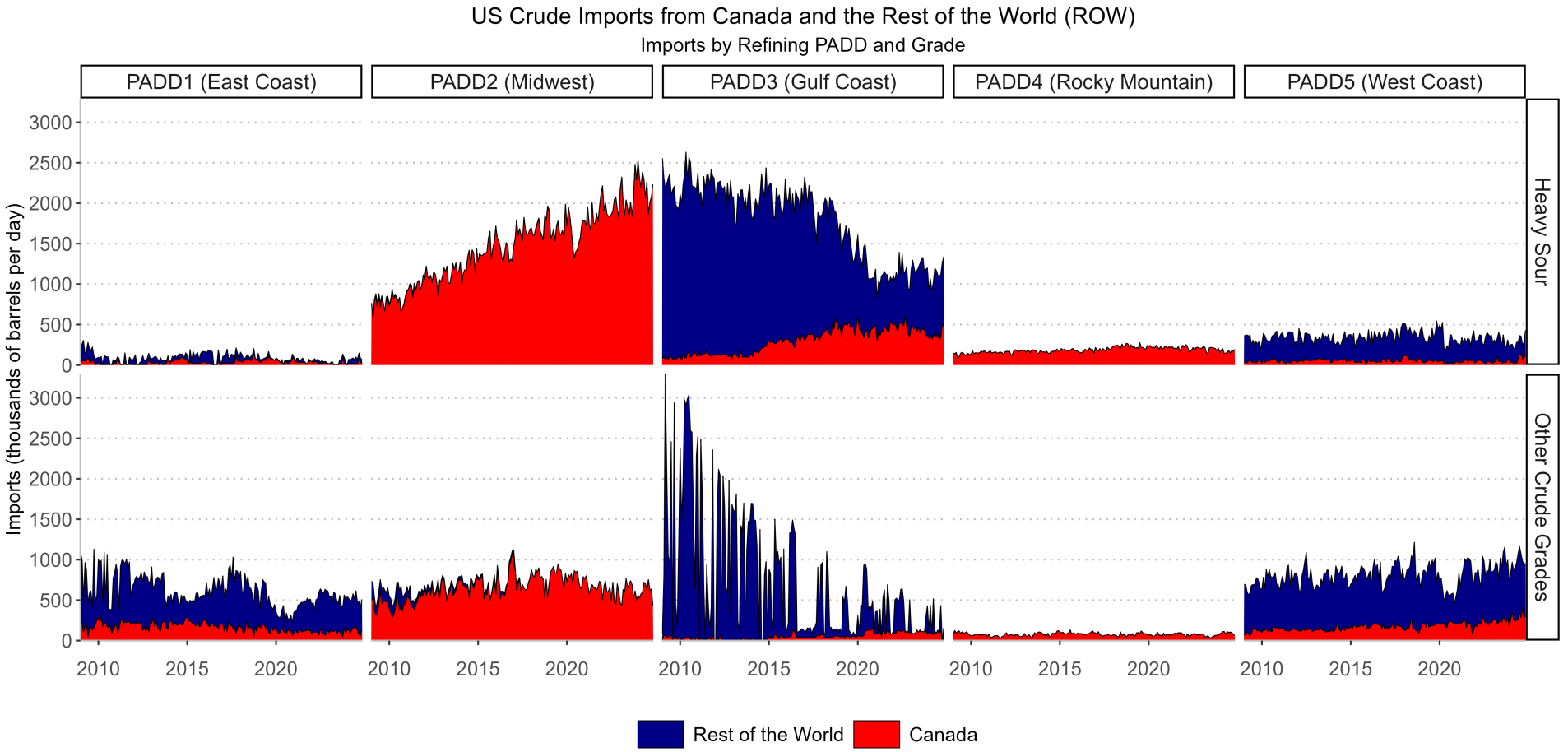

Data via US Energy Information Administration, current to November 2024. Graph by Andrew Leach.

Crude by Rail

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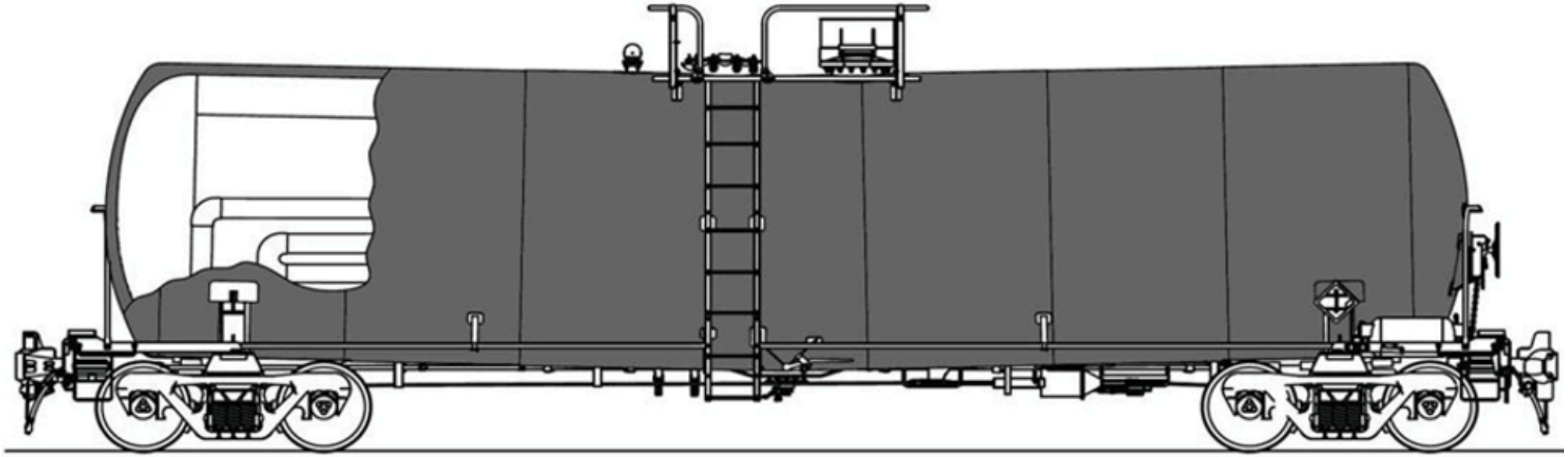

Rail Network and Loading

Source: RBN Energy

Domestic Loadings: Crude by Rail

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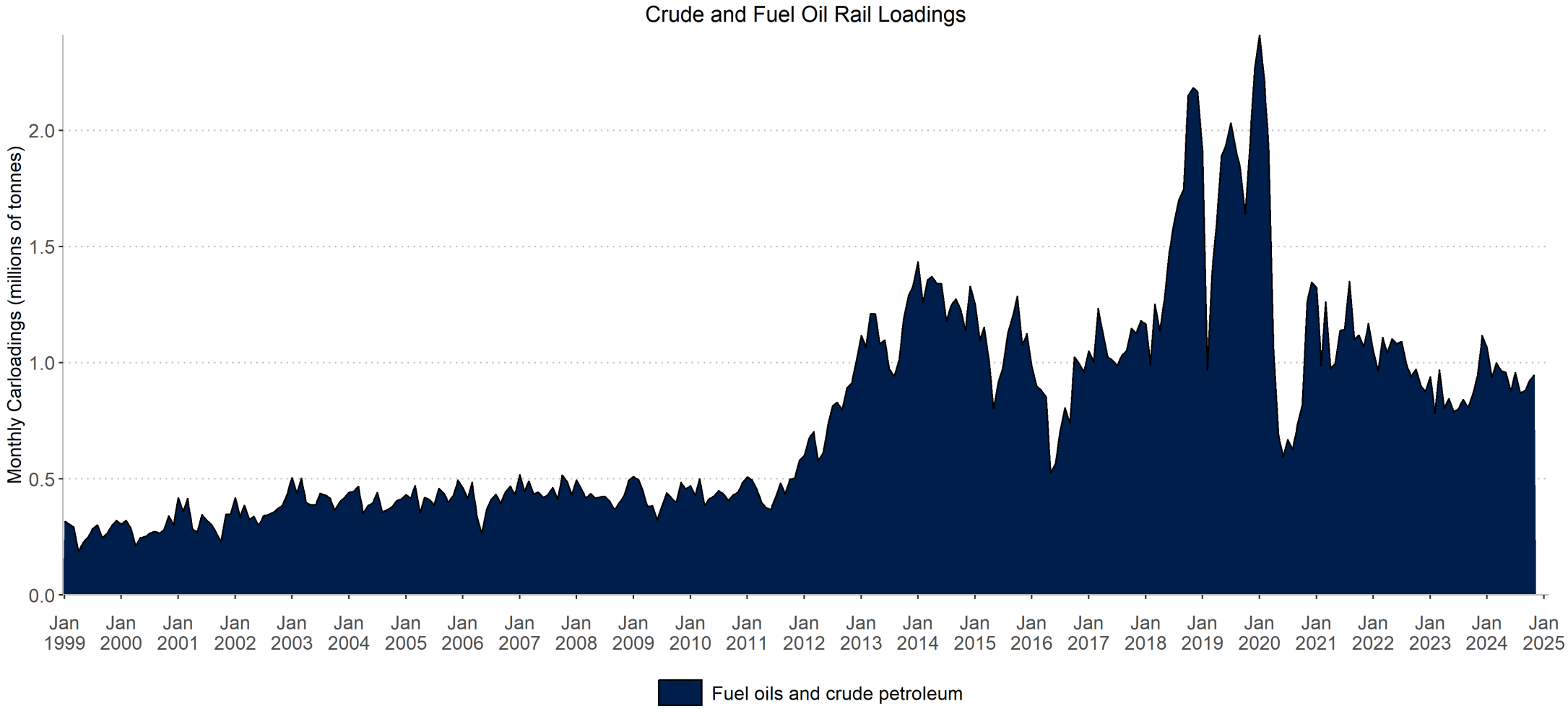

Source: Statistics Canada CANSIM table 404-0002 accessed February 23, 2025. Graph by Andrew Leach.

Domestic Loadings: Crude by Rail

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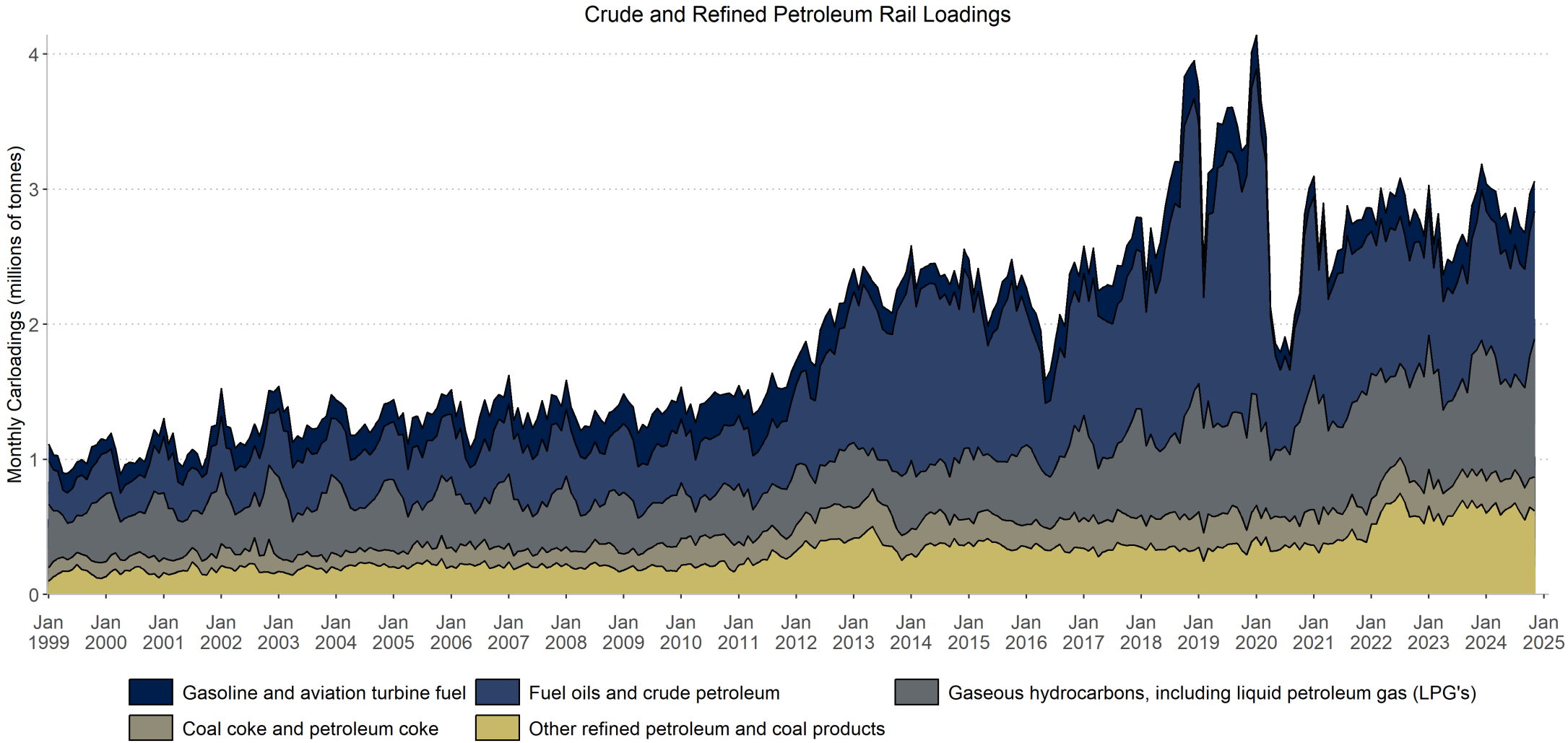

Source: Statistics Canada CANSIM table 404-0002 accessed February 23, 2025. Graph by Andrew Leach.

Domestic Loadings: Crude by Rail

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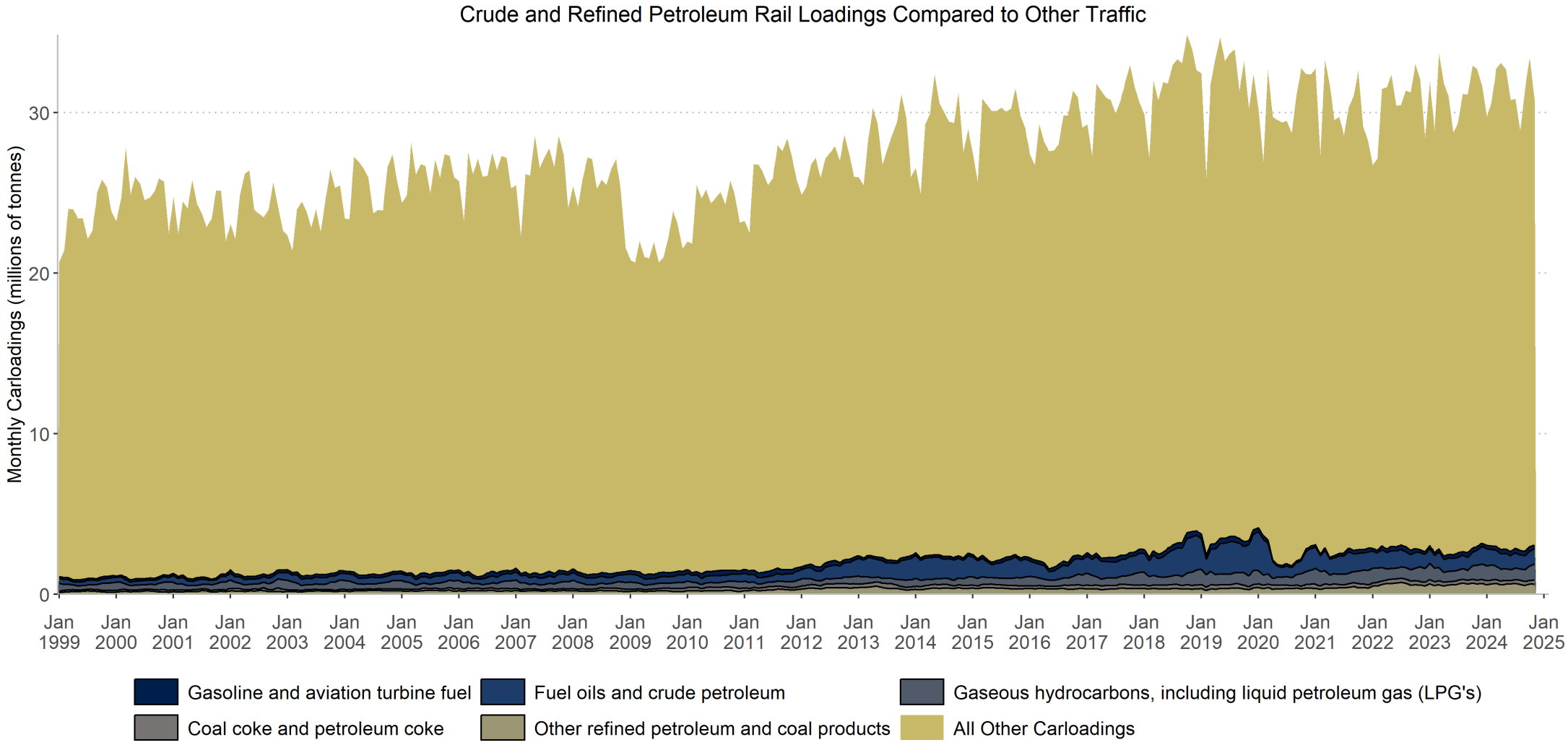

Source: Statistics Canada CANSIM table 404-0002 accessed February 23, 2025. Graph by Andrew Leach.

Exports by Rail

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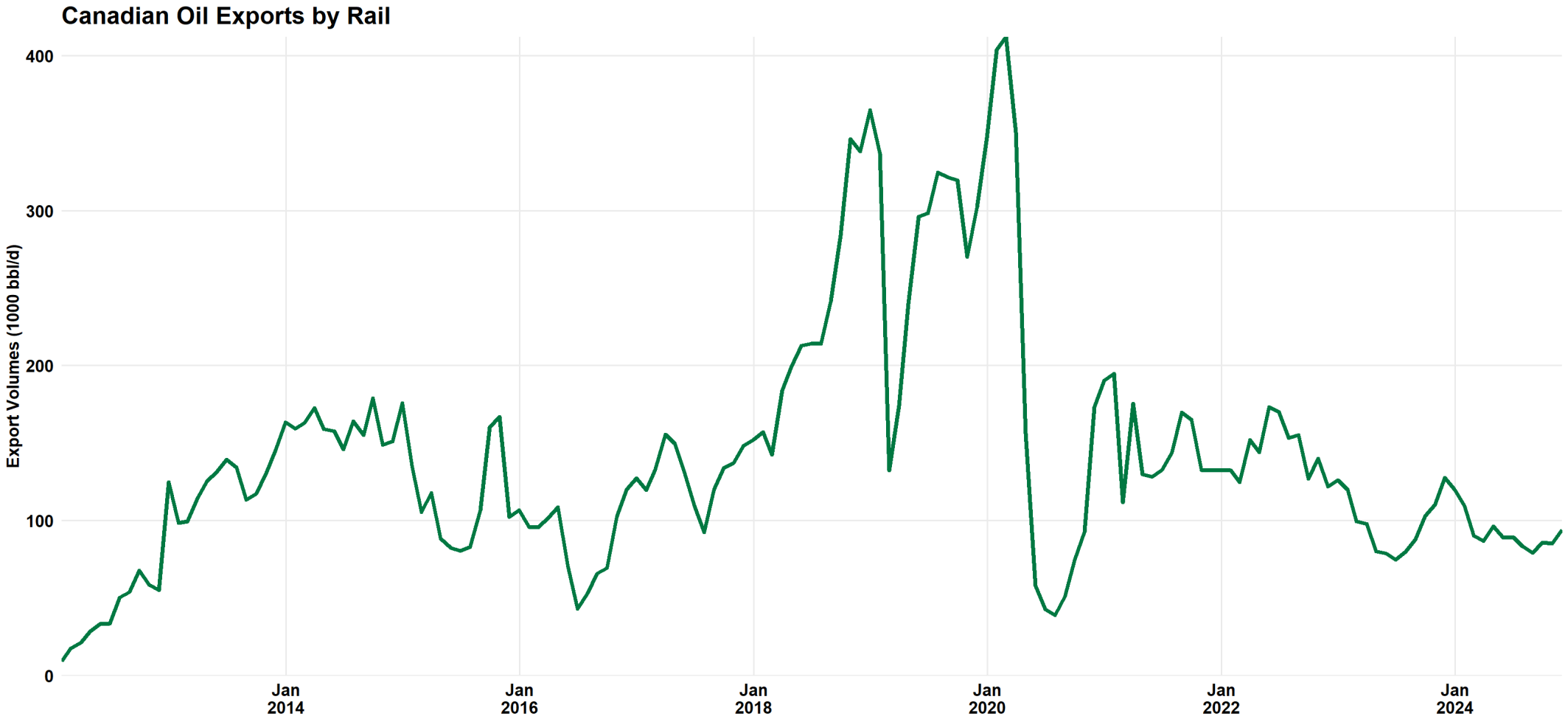
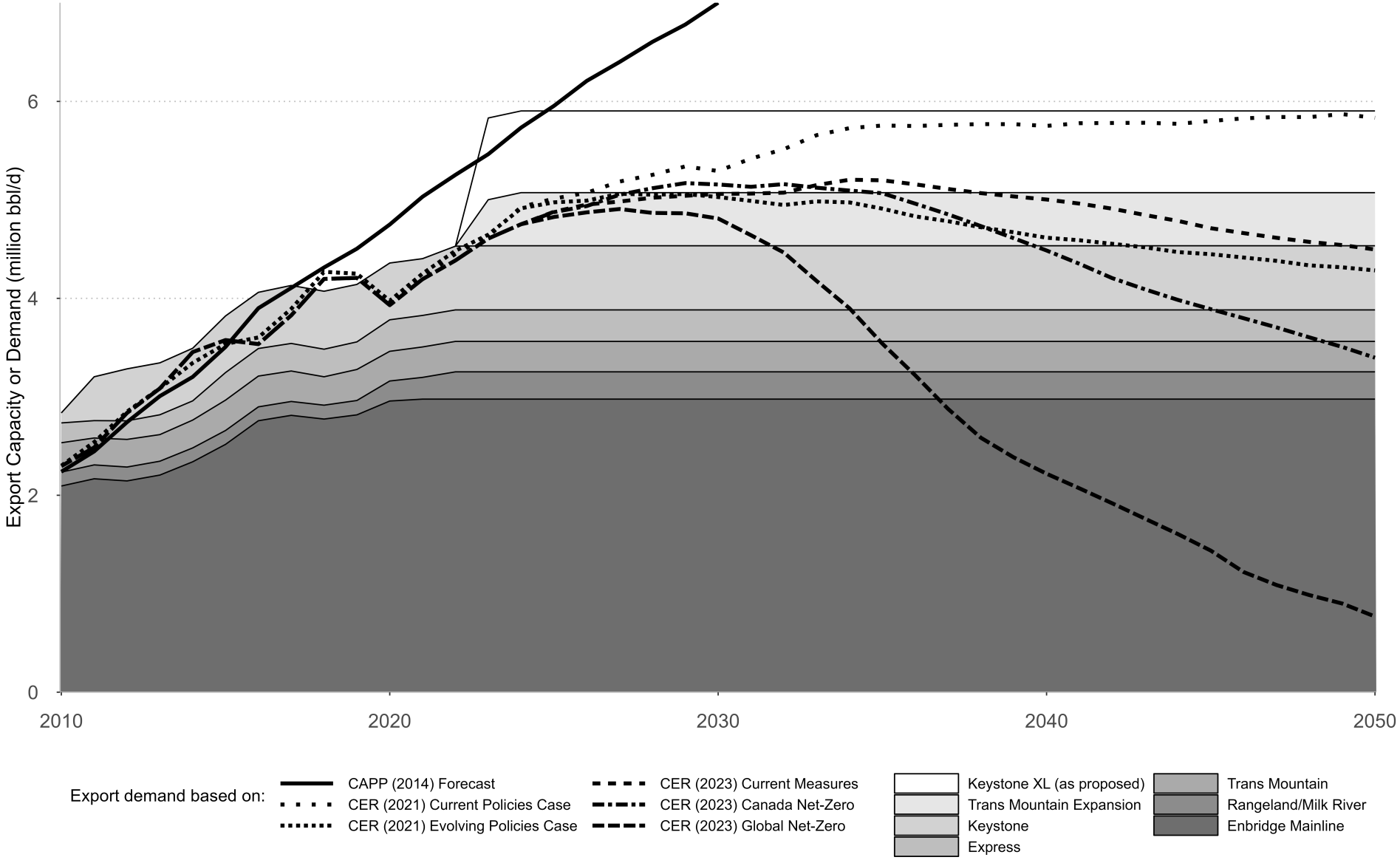


Source: Canadian Energy Regulator.

Current pipeline capacity situation



Gas supply chain

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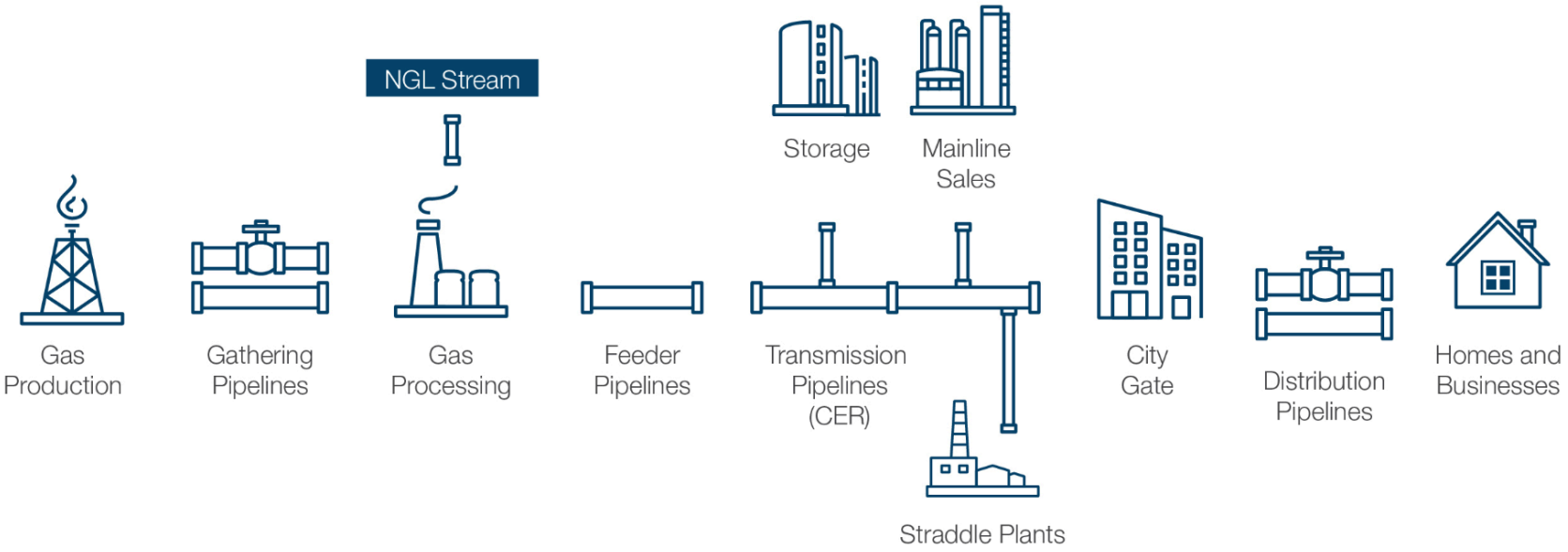
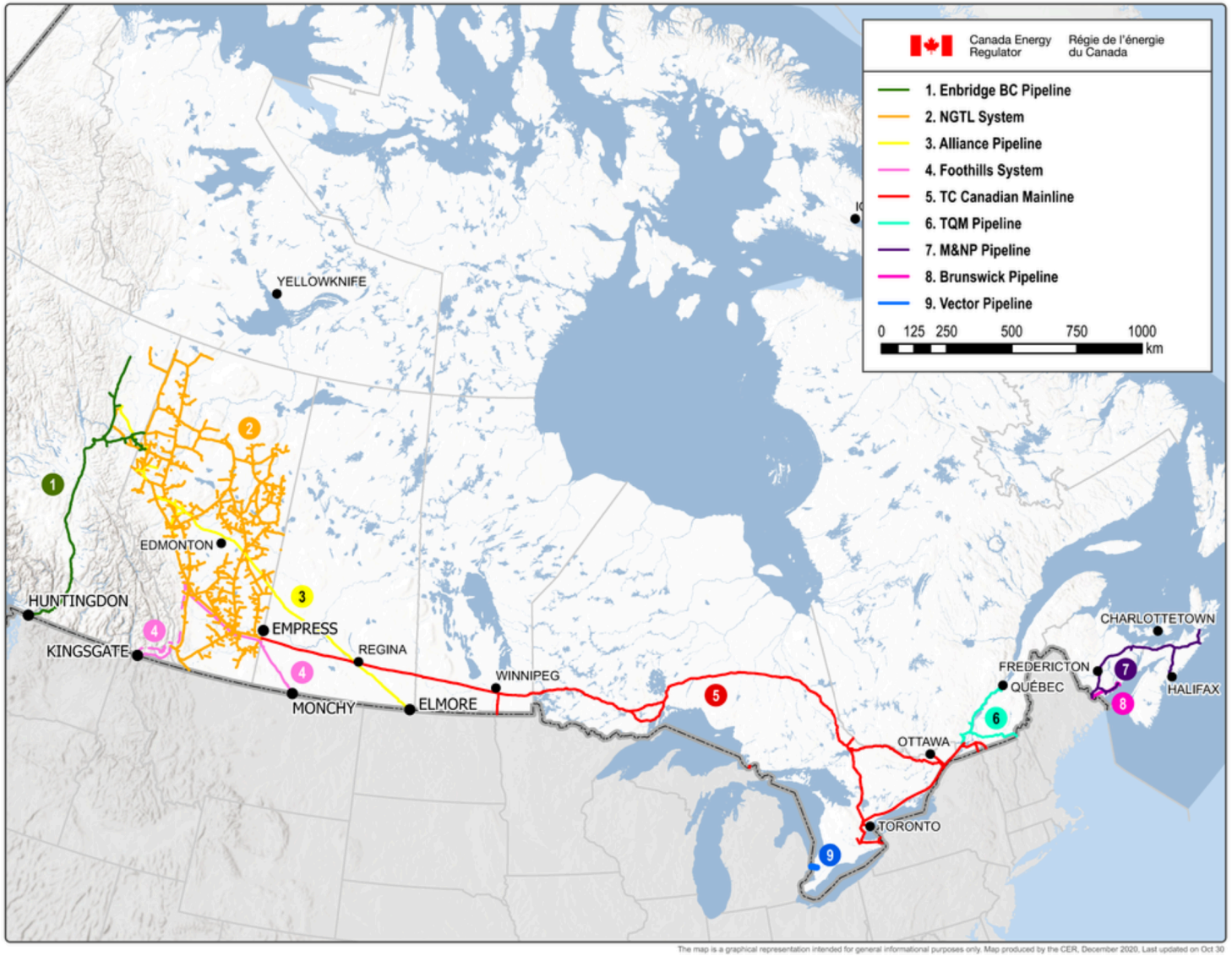
Figure 14. Gas Pipeline System Overview



Source: CER

Our gas pipeline infrastructure



Source: CER

TCPL Mainline

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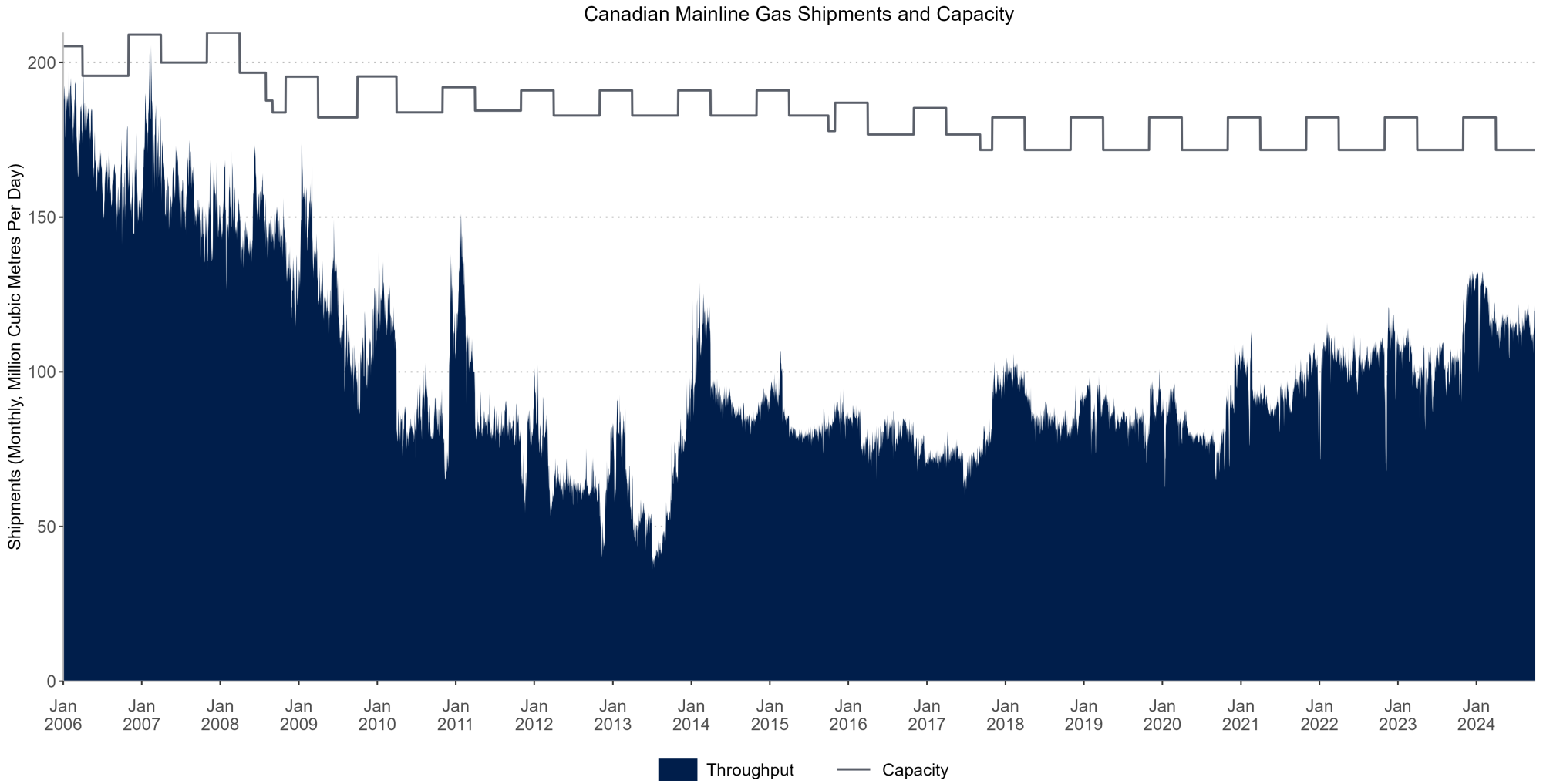
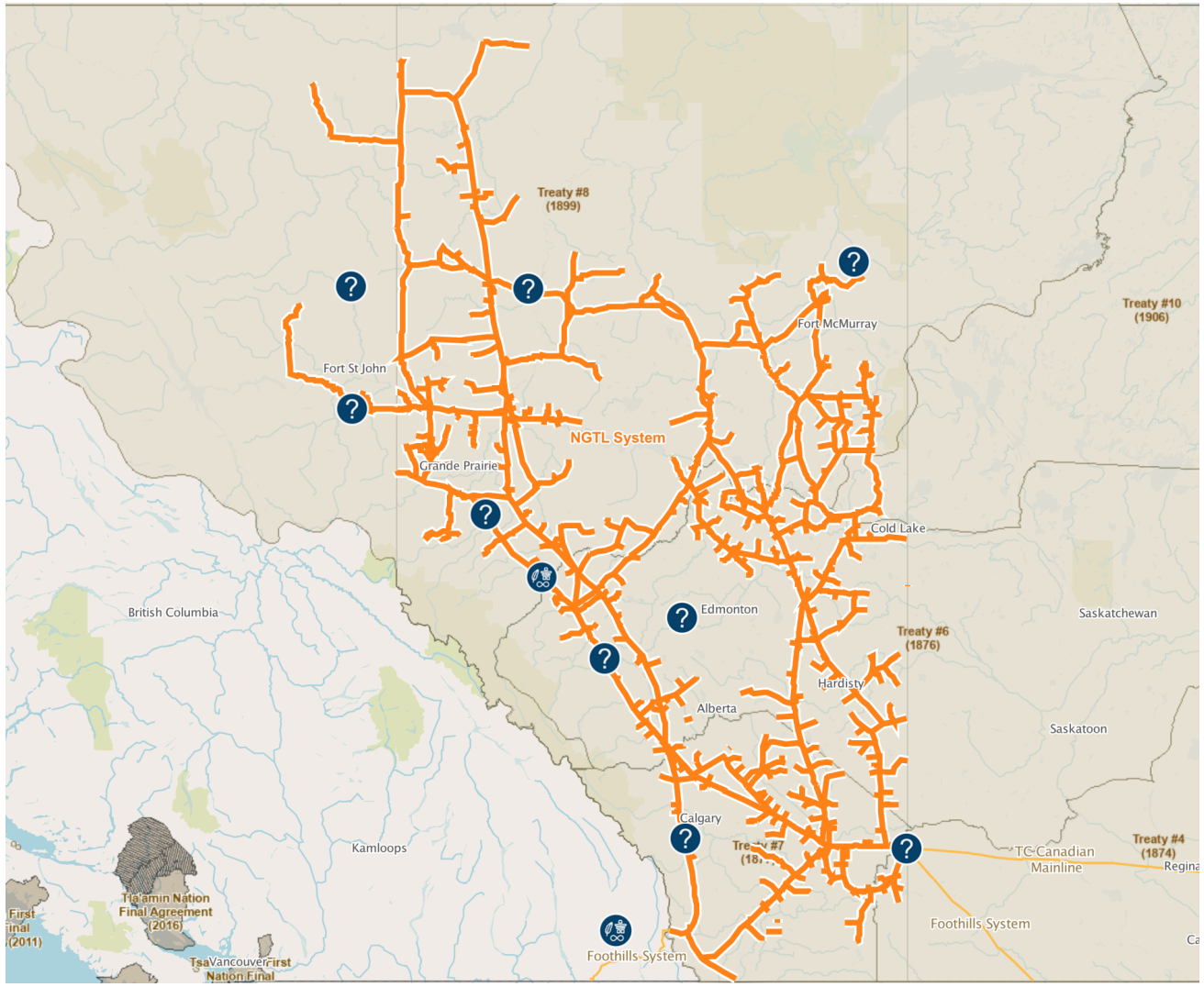


Source: CER Data for TCPL Mainline (Prairies), graph by Andrew Leach.

NGTL System James River (NE)



NGTL System James River Gate

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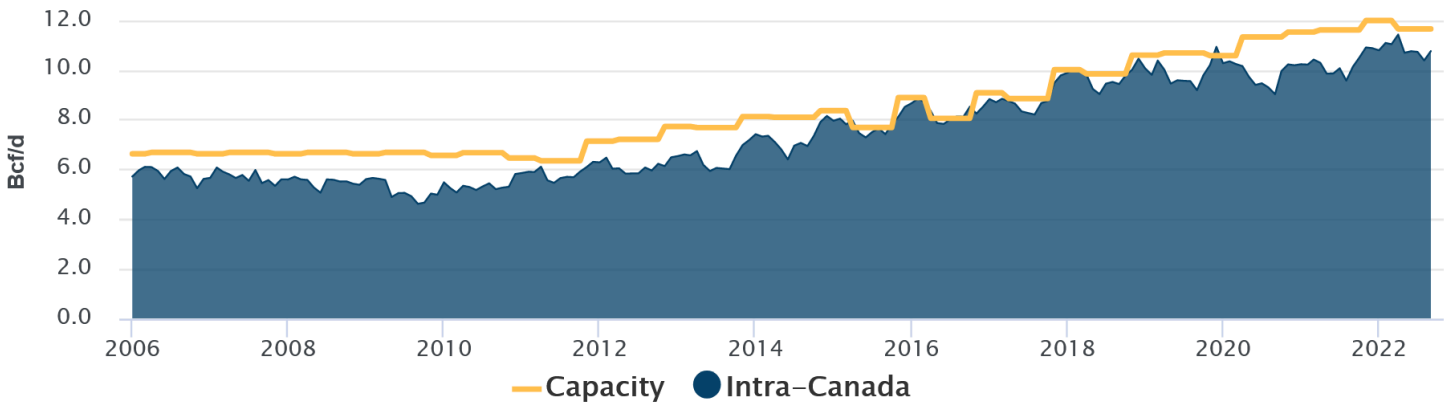
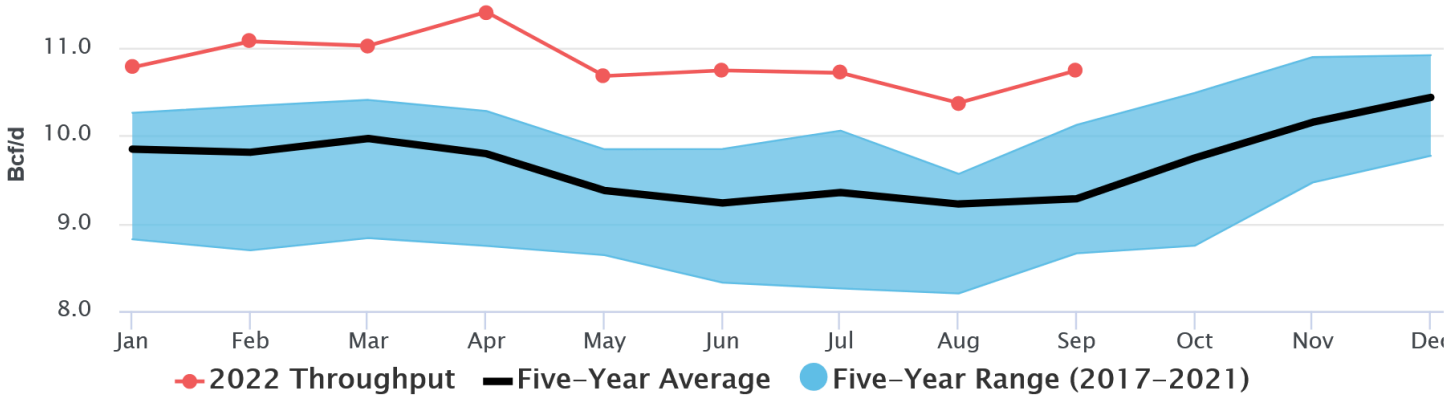
Upstream of James River – monthly traffic



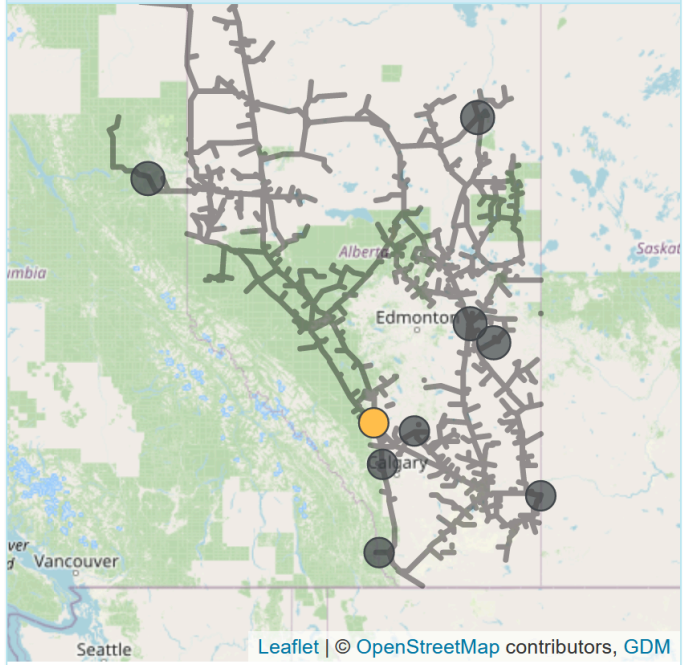
Upstream of James River – five-year average & range



Select units:

(●) Bcf/d ( ) million m3/d

Key Point Map



Zoom In | Zoom Out

NGTL System James River Gate

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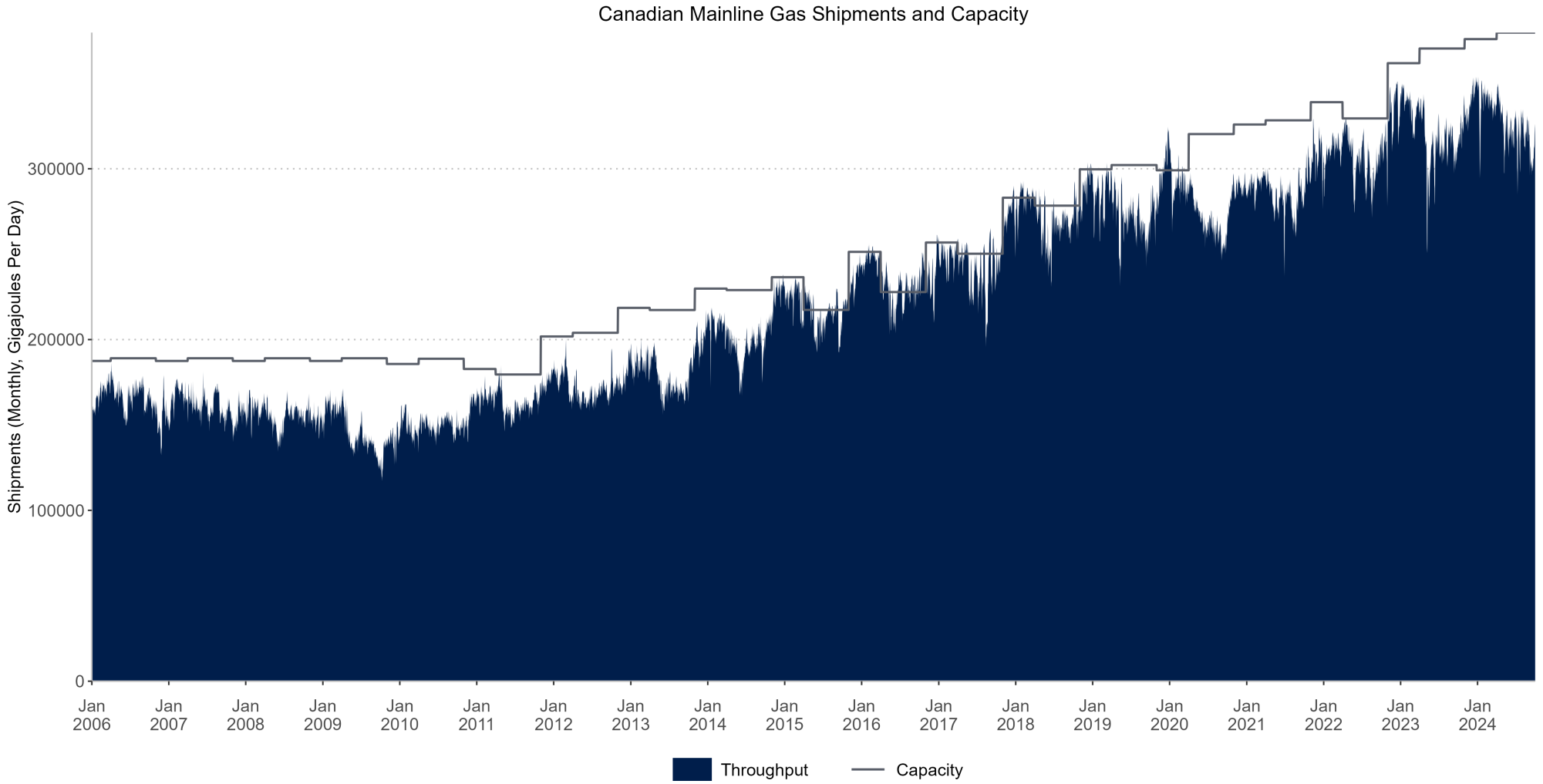

Source: CER Data for NGTL System (Upstream of James River), graph by Andrew Leach.

NGTL System West Gate

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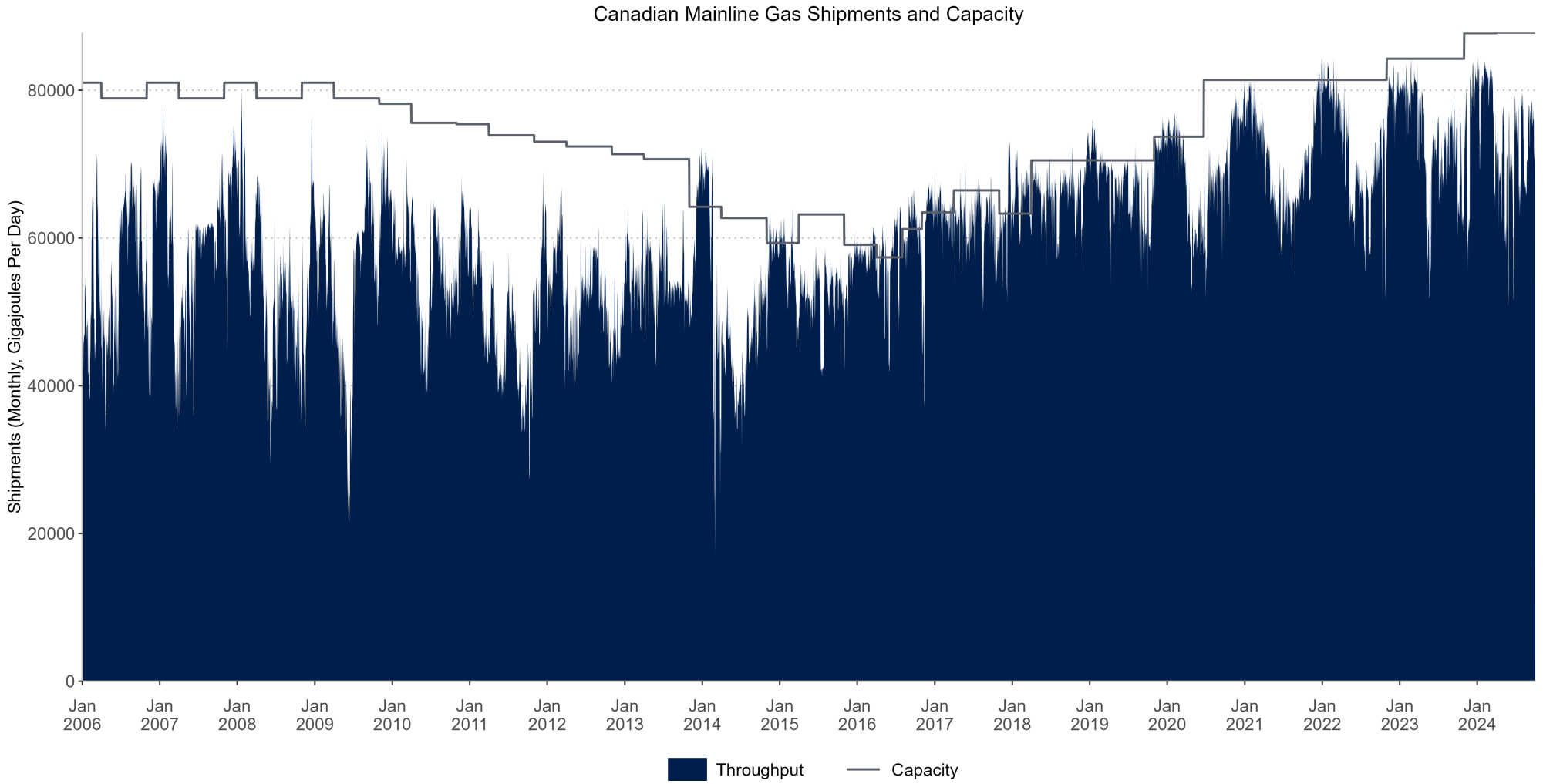

Source: CER Data for NGTL System (West Gate), graph by Andrew Leach.

NGTL System East Gate (access to prairies system)

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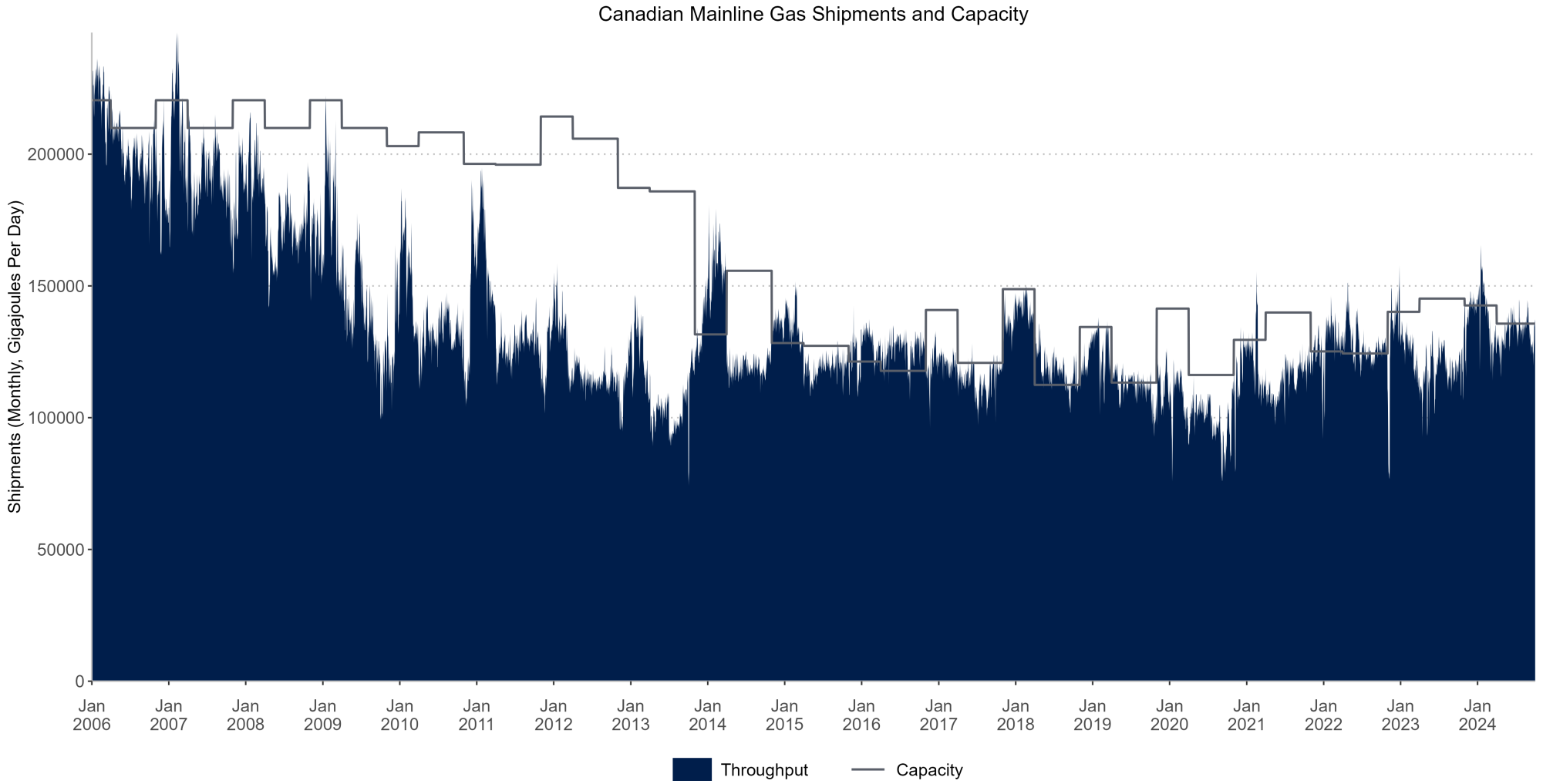

Source: CER Data for NGTL System (East Gate), graph by Andrew Leach.

Pipeline Regulation

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There are multiple steps in the regulation of pipelines. We'll glance at a few of them:

- approval for construction and operation
  - the certificate of public convenience and necessity
    - the Canadian Energy Regulator Act
    - the Impact Assessment Act (for now?)
  - Governor in Council approval
  - US Presidential Permits
  - The duty to consult affected First Nations
- tolls and negotiated settlements on common carrier pipelines
  - more on cost-of-service regulation to come
- open seasons and firm service agreements
- apportionment of common carrier pipeline volumes

Duty to consult

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35 (1) The existing aboriginal and treaty rights of the aboriginal peoples of Canada are hereby recognized and affirmed.

(2) In this Act, “aboriginal peoples of Canada” includes the Indian, Inuit and Métis peoples of Canada.

(3) For greater certainty, in subsection (1) “treaty rights” includes rights that now exist by way of land claims agreements or may be so acquired.

(4) Notwithstanding any other provision of this Act, the aboriginal and treaty rights referred to in subsection (1) are guaranteed equally to male and female persons.

Constitution Act, 1982, s 35

Duty to consult

We have case law from both successful (*Gitxaala Nation v. Canada* and *Tsleil-Waututh Nation v. Canada (Attorney General)*) and unsuccessful (*Bigstone Cree Nation v. v. NOVA Gas Transmission Ltd.*) appeals of project approval decisions

What can we say is required to fulfill the duty to consult? This, via Osler, is a good list:

- early, direct, meaningful engagement between the proponent and Indigenous groups, prior to and in parallel with the regulatory process;
- demonstrated serious consideration of Indigenous rights and concerns;
- addressing Indigenous rights and concerns through proponent commitments, project conditions, further studies and other mitigation measures, where appropriate;
- CER / GiC reasons for decision that consider the adequacy of consultation; and,
- opportunities for future consultation re: fresh concerns throughout the life of the project.

Source: Osler

Duty to consult

We have case law from both successful (*Gitxaala Nation v. Canada* and *Tsleil-Waututh Nation v. Canada (Attorney General)*) and unsuccessful (*Bigstone Cree Nation v. v. NOVA Gas Transmission Ltd.*) appeals of project approval decisions

The Duty to consult is not a veto

The duty "falls along a spectrum ranging from limited to deep consultation, depending upon the strength of the Aboriginal claim, and the seriousness of the potential impact on the right." (Clyde River (Hamlet) v. Petroleum Geo-Services Inc., 2017 SCC 40 at para 20, citing *Haida Nation v. British Columbia (Minister of Forests)*, 2004 SCC 73, at paras. 39 and 43-45).

New case law (*Yahey v British Columbia*, 2021 BCSC 1287), tells us that cumulative effects are germane to consideration of the impingement of First Nations' rights: i.e. you can't subject rights to death by 1000 cuts

Pipeline Regulation: timelines are long

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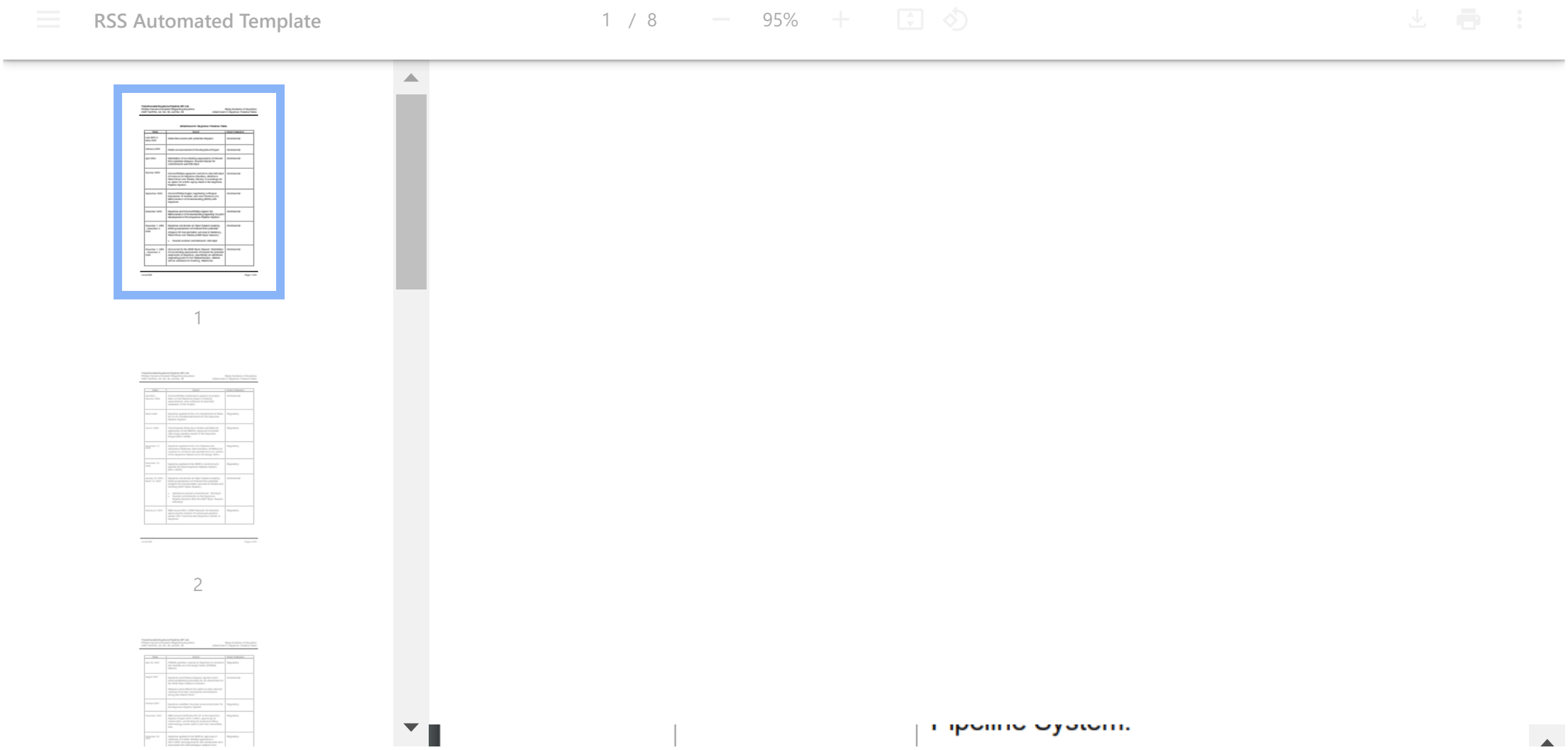

Pipeline tolls

The CER oversees pipeline tolls under the *Canadian Energy Regulator Act*:

> 230 All tolls must be just and reasonable, and must always, under substantially similar circumstances and conditions with respect to all traffic of the same description carried over the same route, be charged equally to all persons at the same rate.
>
> 231 The Commission may determine
>
> > (a) whether traffic is or has been carried under substantially similar circumstances and conditions for the purposes of section 230; (b) whether a company has complied with the provisions of section 230; and (c) whether there has been unjust discrimination for the purposes of section 235.

Source: CER: Pipeline Tolls and Tariffs

Cost-of-service regulation as a backstop

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Companies may only charge tolls specified in a tariff that has been filed with the CER and is in effect or that have been approved by an order of the Commission (*CERA* s. 227)

CER divides companies into two groups for financial regulation purposes:

- Group 1 companies are those with extensive systems under the CER's jurisdiction;
- Others are Group 2.

A Group 1 pipeline company not regulated on a complaint basis (see footnote 16 in Guide R) that has not reached a negotiated settlement with its interested parties is regulated on a cost-of-service basis

Toll regulation of Group 2 companies is normally carried out on a complaint basis. Complaints may lead to cost-of-service regulation.

Cost-of-service regulation

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A toll change in the context of cost-of-service regulation requires that a company file a toll application with the supporting documentation

CER holds a public hearing to allow input from interested parties and issues a decision approving final tolls

Tolls are set so investors can recover costs and earn a reasonable return on their investment.

CER manual states that the rate of return calculation will consider whether:

- the pipeline can attract capital on reasonable terms and conditions
- the allowed return is comparable to the return available to other companies of similar risk
- the financial integrity of the regulated pipeline will be maintained

Negotiated settlements

Beginning in the mid-1990s, the CER began accepting multi-year negotiated settlements.

Settlements can include incentives to reduce costs and provisions to share savings between the pipeline company and its shippers.

CER role is to make sure all interested parties have a fair opportunity to participate in the settlement process and that there is a general acceptance of the outcome.

The existence of a negotiated settlement does not limit the CER's authority:

- CER may accept or reject a settlement package in its entirety;
- An unopposed settlement may be taken to indicate that tolls will be just and reasonable without a public hearing.

Taken with slight modifications from: CER: Guidelines for Negotiated Settlements

Negotiated settlements

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In the case of a contested settlement, CER may choose one of three options:

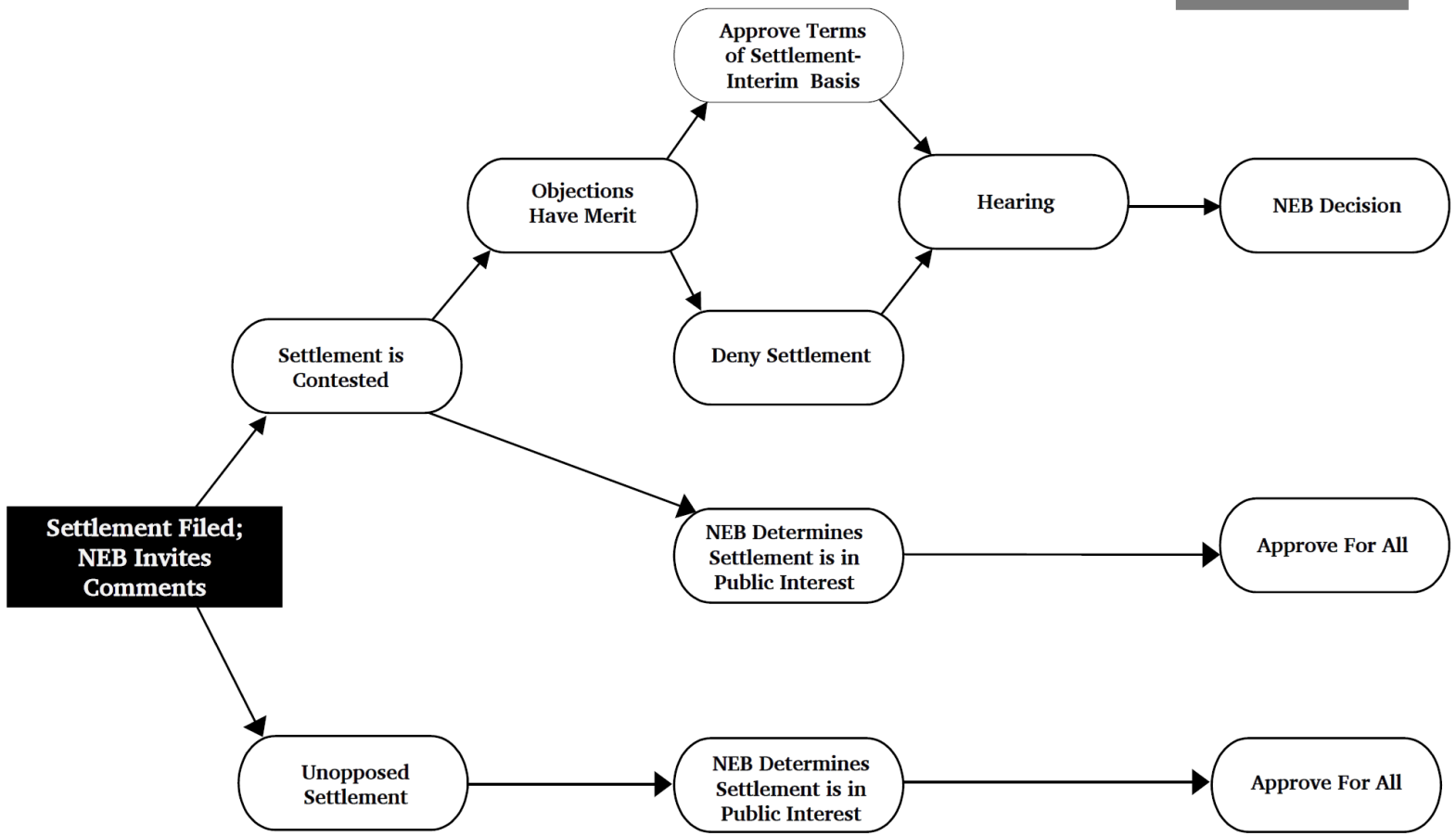
- dismiss the objections and approve the settlement
- deny the settlement and refer the matter for hearing
- approve the terms of the settlement on an interim basis and then hold a hearing to address the issues raised by dissenting parties

Taken with slight modifications from: CER: Guidelines for Negotiated Settlements

Negotiated Settlements

Attachment to Board Letter
dated 12 June 2002
File 4600-A000-3

Negotiated Settlements Process



Toll design

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Toll design is the process of deriving tolls for different services and different distances from the cost of service or revenue requirement and throughput or contracted quantities.

Principles:

- Tolls should generate sufficient revenue to recover approved costs
- Tolls should fairly allocate charges to users in relation to the costs and benefits of different services.

The basic principle is user pay (or cost-causation from Bonbright)

Taken with slight modifications from: CER: Guidelines for Negotiated Settlements

Toll design

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Toll design divides costs between the various functions performed by the pipeline system, such as transmission and metering, and then determines costs and usage of those functions:

- Some costs are common to every unit of throughput.
- Other costs may depend upon variables such as the distance shipped.
- Others may be unique to a particular type or class of shipper.

With additions to an existing pipeline, there may be toll issues about whether expansion costs should be rolled into a single, existing rate base and charged to all shippers equally (rolled-in methodology) or kept separate and charged only to particular shippers (incremental methodology).

Taken with slight modifications from: CER: Guidelines for Negotiated Settlements

Pipeline Tolls

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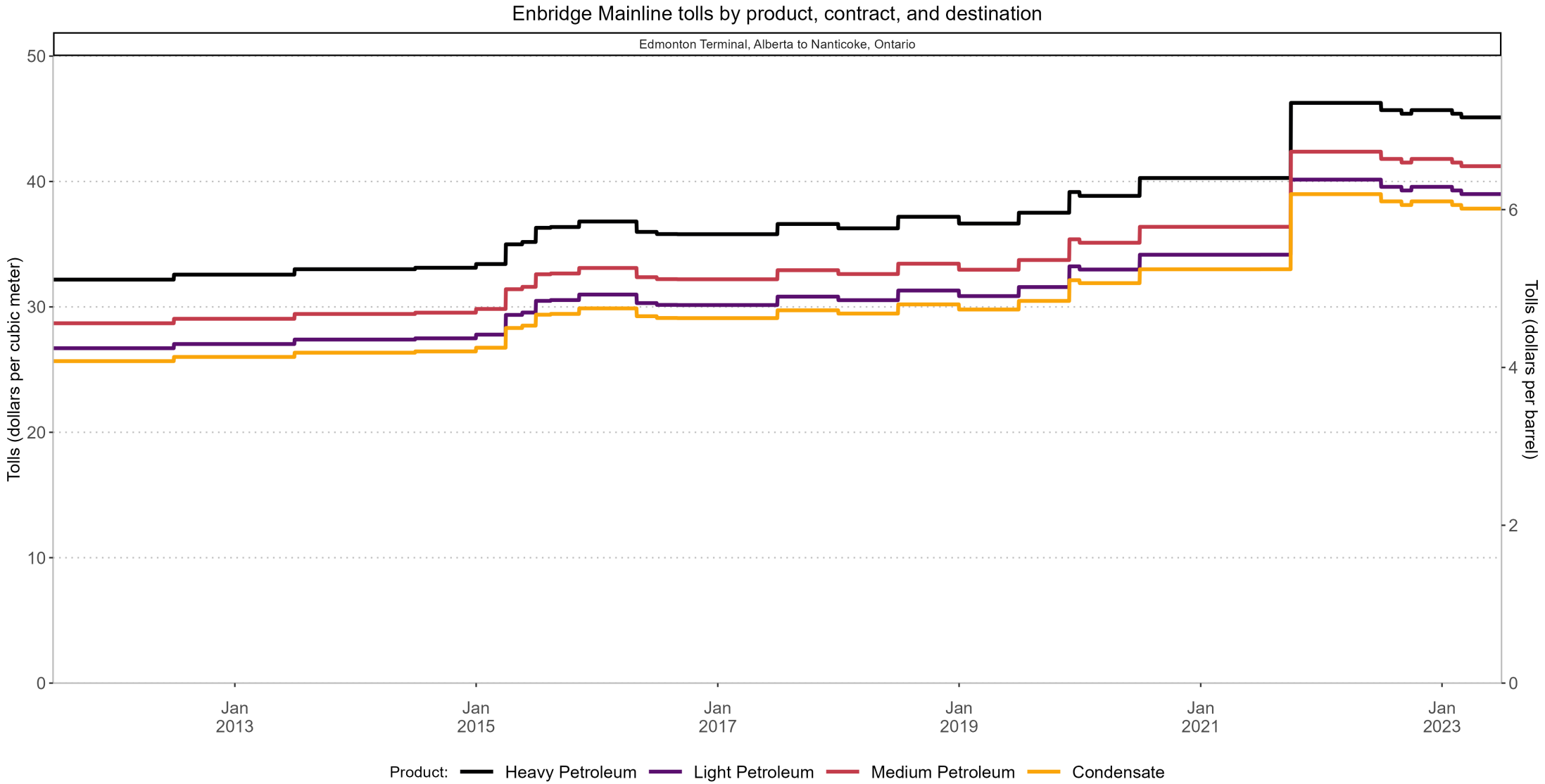

Source: CER Data, graph by Andrew Leach.

Pipeline Tolls

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INTERNATIONAL JOINT TRANSPORTATION RATES FOR ENBRIDGE PIPELINES INC. AND ENBRIDGE ENERGY, LIMITED PARTNERSHIP

INTERNATIONAL JOINT TRANSPORTATION RATES IN US DOLLARS PER CUBIC METER

From	To	Rate				
		NGL	CND	LIGHT	MEDIUM	HEAVY
Edmonton Terminal, Alberta	Clearbrook, Minnesota		19.3484	20.2703	21.3413	23.2176
	Superior, Wisconsin	21.9817	22.8138	23.7429	25.0315	27.2855
	Lockport, Illinois		31.5615	32.5075	34.3284	37.5185
	Mokena, Illinois		31.5615	32.5075	34.3284	37.5185
	Flanagan, Illinois		31.1000	32.0460	33.8669	37.0570
	Griffith, Indiana		31.5615	32.5075	34.3284	37.5185
	Stockbridge, Michigan		34.5622	35.5147	37.5315	41.0654
	Rapid River, Michigan	26.8042				
	Marysville, Michigan		34.5622	35.5147	37.5315	41.0654
	Corunna or Sarnia Terminal, Ontario	33.3041	34.9606	35.9219	37.9493	41.4948
	Westover, Ontario		37.0450	38.1502	40.3210	44.1180
	Nanticoke, Ontario		37.8361	38.9957	41.2210	45.1134

Common Carrier Pipelines

All CER-regulated oil pipelines are common carriers by default, and all must have some uncommitted capacity available each month for shippers without contracted capacity.

Canadian Energy Regulator Act:

> 239 (1) Subject to any regulations that the Commission may prescribe and any exemptions or conditions it may impose, a company operating a pipeline for the transmission of oil must, according to its powers, without delay and with due care and diligence, receive, transport and deliver all oil offered for transmission by means of its pipeline.

The Enbridge Mainline offers 100% of its capacity on an uncommitted basis every month

Source: CER: What is Pipeline Apportionment?

Common Carrier Nomination Process

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Customers **nominate** the volume they would like to ship on a monthly basis

If total nominations exceed uncommitted capacity, capacity is **apportioned** on a pro-rata basis based on nominated volumes

Issues have arisen with respect to shippers over-nominating *air barrels*

Curtailment may be applied to contracted volumes if the pipeline cannot carry its committed capacity.

Source: CER: What is Pipeline Apportionment?

Pipeline Apportionment

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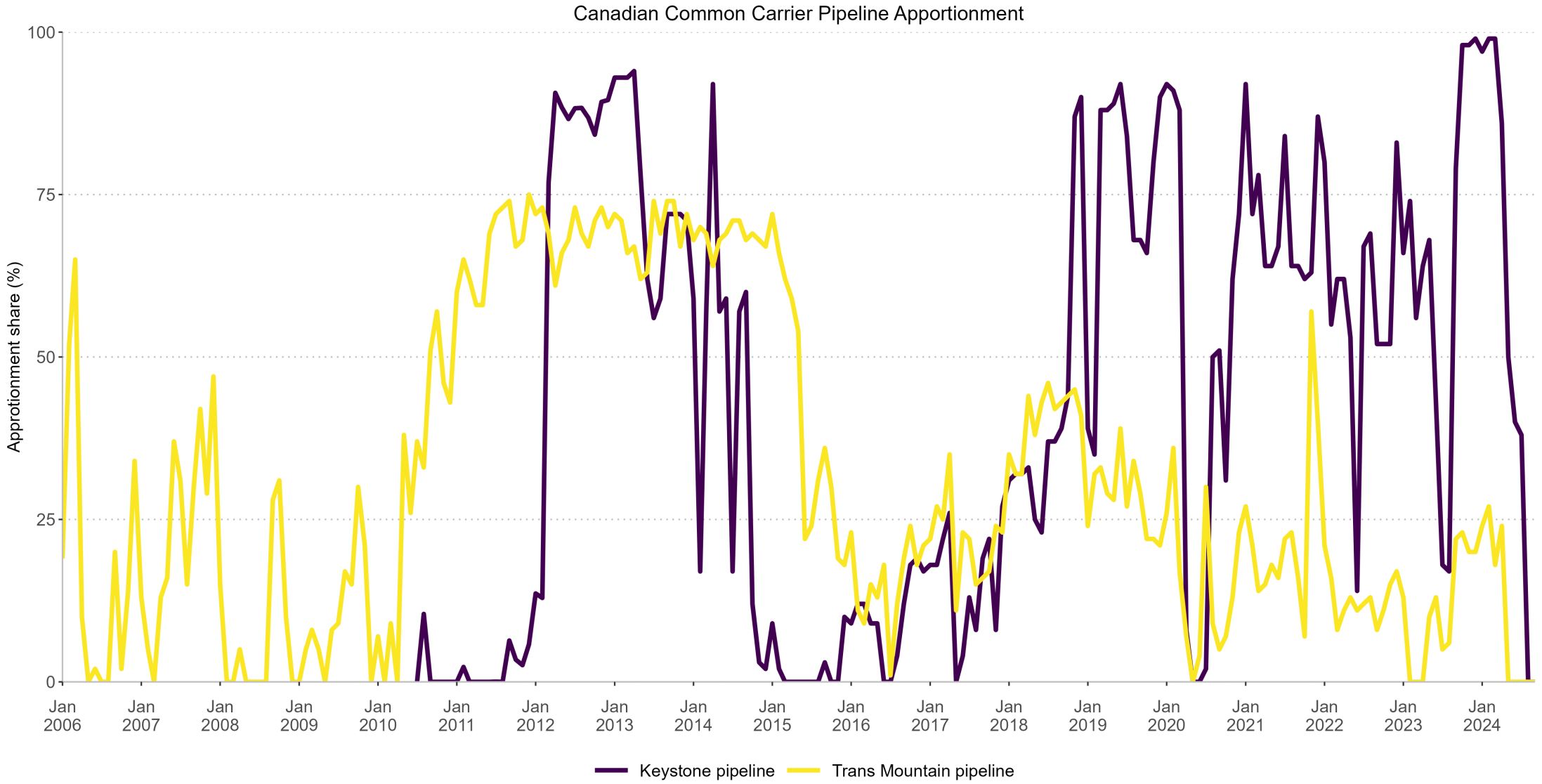
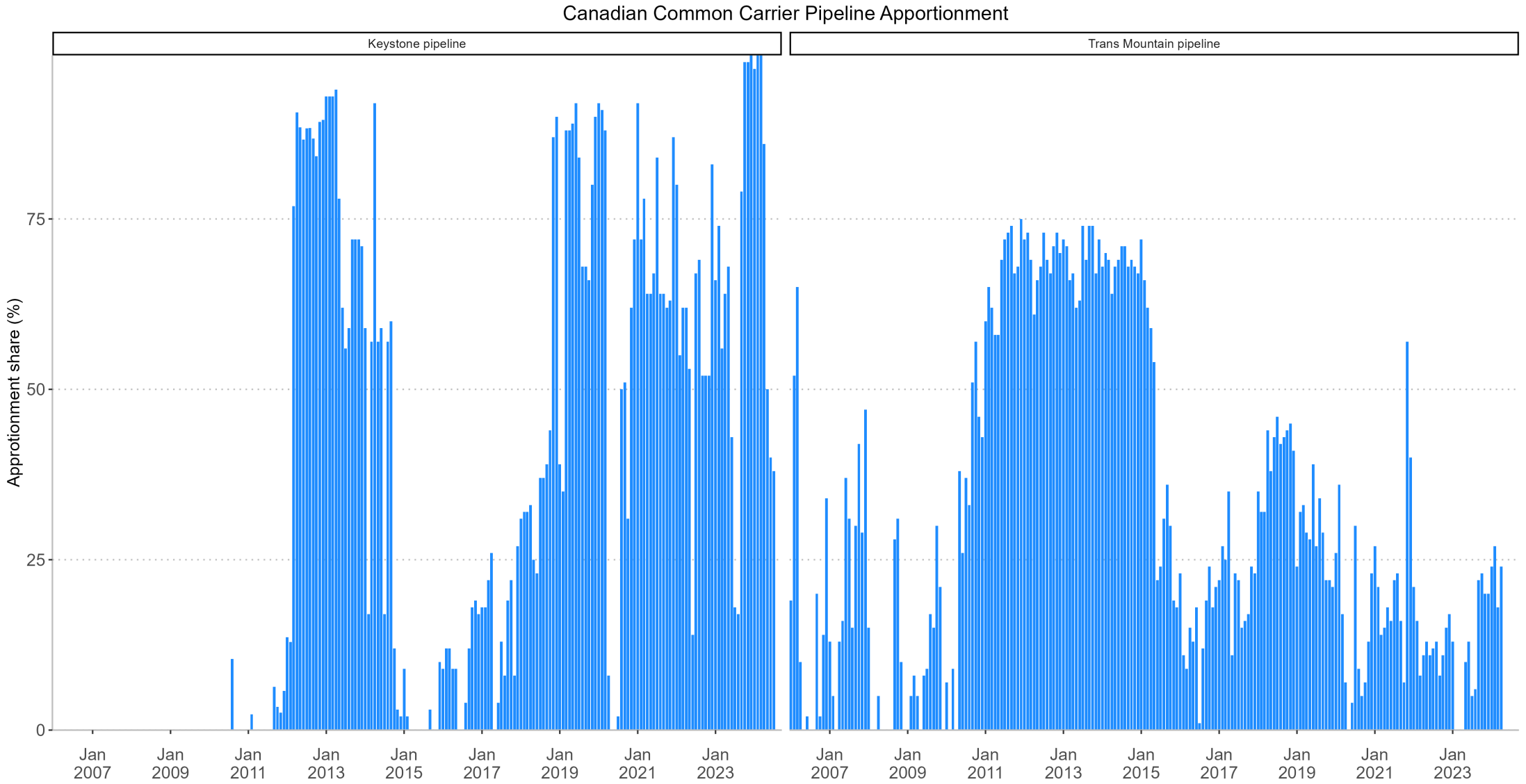


Source: NEB Data, graph by Andrew Leach.

Pipeline Apportionment



Source: CER Data, graph by Andrew Leach.

Contracted Volumes

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Table 1. Canadian Oil Pipelines [13] – Capacity, Contract Capacity and Uncommitted Capacity (June 2021)

Pipelines	Total Current Capacity	Contracted Capacity	Uncommitted Capacity
Enbridge Canadian Mainline [14]	2 890 Mb/d 459.5 $10^3m^3/d$	0 0	2 890 Mb/d 459.5 $10^3m^3/d$
Express Pipeline [15]	310 Mb/d 49.3 $10^3m^3/d$	290 Mb/d 46.1 $10^3m^3/d$	20 Mb/d 3.2 $10^3m^3/d$
Milk River Pipeline [16] Aurora Pipeline [17] Wascana Pipeline [18]	97.9 Mb/d 15.6 $10^3m^3/d$ 45 Mb/d 7.2 $10^3m^3/d$ 40 Mb/d 6.4 $10^3m^3/d$	0 0	183 Mb/d 25.4 $10^3m^3/d$
Keystone Pipeline [19]	591 Mb/d 94.0 $10^3m^3/d$	555 Mb/d 88.2 $10^3m^3/d$	36 Mb/d 5.7 $10^3m^3/d$
Trans Mountain Pipeline [20]	300 Mb/d 47.7 $10^3m^3/d$	54 Mb/d 8.6 $10^3m^3/d$	246 Mb/d 39.1 $10^3m^3/d$

Source: CER

Pipeline Tolls - Firm Service Agreements

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- New pipelines (Keystone, TMX) have not been built as exclusively common carrier pipelines
- Keystone and TMX negotiated *committed* tolls with shippers through open seasons
- Shippers on these pipelines hold long-term contracts (subsciptions, commitments to pay) for most of each pipeline's capacity
- Both lines have uncommitted rates for small shares of their capacity
  - e.g. Keystone has 36k bbl/d
- Enbridge proposed to shift 90% of Mainline volumed to contracted service, but that application was rejected by the Canadian Energy Regulator

Pipeline Tolls - Firm Service Agreements

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Details of Committed Service Offerings

ENBRIDGE
Life Takes Energy

Common Contract Terms

- Commencement Date July 1, 2021, subject to L3R in service
- Contract term of 8 to 20 years (96 to 240 months)
- 90% of Canadian Mainline capacity set aside for contracted volumes
- Ramp-up provides ability to increase commitment
- Volume renewal rights at 50% of initial contract term
- Ensures same or better terms for contract shippers should Enbridge offer additional Mainline contracts in future
- Term, Volume, Throughput, and other discounts provided
- Tolls escalated annually by 65% of Canadian GDPP Index
- Contract tolls subject to toll adjustments from regulatory changes but not from future expansions
- Volume, power, integrity costs included in toll
- Subject to Deficiency and Failure to Tender charges

Requirements Contracts

- Producers can commit up to 90% of production capacity/ Refiners can commit lesser of 90% of refining capacity or recent historical movements
- Relief from deficiency payments if unable to process crude or under certain legislative changes
- 3 month make up rights
- Credit requirement is 3 months of contract volume

Take or Pay Contracts

- Maximum commitment of 300 kbpd for Crude Petroleum, 68.2 kbpd for NGL and for Refined Petroleum Products
- Ability to temporarily reduce contract twice every five years
- 12 month make-up rights
- Credit requirement is 12 months of contracted volume

Flex Term Option (All Contract Types)

- 8 – 20 year term, cancellable any time on three years' notice
- Receives secondary allocation in Open Season, after regular 8 – 20 year contracts
- Toll set at a small premium to uncommitted toll
- No Term, Volume, Throughput or other discounts provided

Source: Enbridge Mainline Contracting Application, Appendix 42

Pipeline Tolls - Firm Service Agreements

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Summary of Committed (Firm) Service Tolls

ENBRIDGE
Life Takes Energy

Include:

- Transmission and Terminalling tolls
- Line 5 Tunnel Costs
- Line 3 Replacement
- Future Mainline Expansions

Charged Separately:

- Receipt and Delivery Tankage Tolls
- Terminalling Transfer tolls
- CER Abandonment Surcharges

Subject to Future Adjustments:

- 65% of Canadian GDPP Index
- MPUC Decommissioning Surcharge
- Changes to Applicable Laws

Source: Enbridge Mainline Contracting Application, Appendix 42

Pipeline Tolls - Firm Service Agreements

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Summary of Uncommitted (Spot) Tolls

ENBRIDGE
Life Takes Energy

Include:

- Transmission and Terminalling tolls
- Line 3 Replacement

Charged Separately:

- Receipt and Delivery Tankage Tolls
- Terminalling Transfer tolls
- CER Abandonment Surcharges

Subject to Future Adjustments:

- 65% of Canadian GDPP Index
- MPUC Decommissioning Surcharge
- Changes to Applicable Laws
- Line 5 Tunnel Costs
- Future Expansion Surcharges

Source: Enbridge Mainline Contracting Application, Appendix 42

Pipeline Tolls - Firm Service Agreements

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Open Season Procedures Key Terms

ENBRIDGE
Life Takes Energy

- Enbridge negotiated the Open Season Procedures with its shippers and other interested parties
- Prospective contract shippers will submit binding requests for service including supporting information as necessary (e.g. production or facility designation in the case of RCs)
- Enbridge will return a fully executed TSA to each shipper that is allocated committed volumes
- Minimum volume for contracting is 2,200 bpd (1 batch per month)

Source: Enbridge Mainline Contracting Application, Appendix 42

Pipeline Tolls - Firm Service Agreements

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Open Season Procedures Capacity Allocation

ENBRIDGE Life Takes Energy

- Capacity in a given Service Haul will be allocated in the following order until no contractible capacity remains:
  - Step 1 – Committed Volumes other than Flex Service requests including Ramp Up Committed Volumes prior to January 1, 2022
  - Step 2 – Flex Service requests
  - Step 3 – Committed Volumes with a Ramp Up after January 1, 2022 and no later than December 31, 2025
- Capacity in each of Steps 1 & 2 will be allocated on a pro-rata basis if oversubscribed
- If contractible capacity remains after Steps 1 & 2, then Step 3 will be allocated in order of subscribed Ramp Up date

Source: Enbridge Mainline Contracting Application, Appendix 42

Pipeline Tolls - Firm Service Agreements

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Committed Rates[2] *

(Rates in United States dollars per Cubic Meter)

				Fixed	Variable[11]		Total	
Origin	**Destination**	**Contract Term**		**Light and Heavy Crude**	**Light Crude**	**Heavy Crude**	**Light Crude**	**Heavy Crude**
International Boundary at or near Haskett, Manitoba	Wood River, Illinois	20 yr	A[3a]	[U]12.835	[U]7.388 [5][9]	[U]10.554 [5][9]	[U]20.223	[U]23.389
			B[3b]	[U]13.464			[U]20.852	[U] 24.018
	Patoka, Illinois	20 yr	A[3a]	[U]12.835	[U]7.791 [5][9]	[U]11.130 [5][9]	[U]20.626	[U]23.965
			B[3b]	[U]13.464			[U]21.255	[U]24.594
	Cushing, Oklahoma	10 yr		[U]19.275[5]	[U]6.742 [9]	[U]9.632 [9]	[U]26.017	[U]28.907
	Cushing, Oklahoma	20 yr		[U]17.147[5]	[U]6.742 [9]	[U]9.632 [9]	[U]23.889 [3][4][6][7]	[U]26.779[3][4][6][7]
	Port Arthur, Texas[10]	20 yr	A	[U]57.1652[9]	[U]10.234	[U]14.620	[U]67.3992	[U]71.7852
			B	[U]28.172[9]	[U]10.234	[U]14.620	[U]38.406	[U]42.792
	Houston, Texas	20 yr	A	[U]57.1652[9]	[U]10.229	[U]14.613	[U]67.3942	[U]71.7782
			B	[U]28.172[9]	[U]10.229	[U]14.613	[U]38.401	[U]42.785

[2] Committed Rates are applicable to a Term Shipper and are charged in accordance with Term Shipper's Contract. Fixed Rate referenced in the above table means the Term Shipper Commitment Rate as set forth in Term Shipper's Contract.

Pipeline Tolls - Firm Service Agreements

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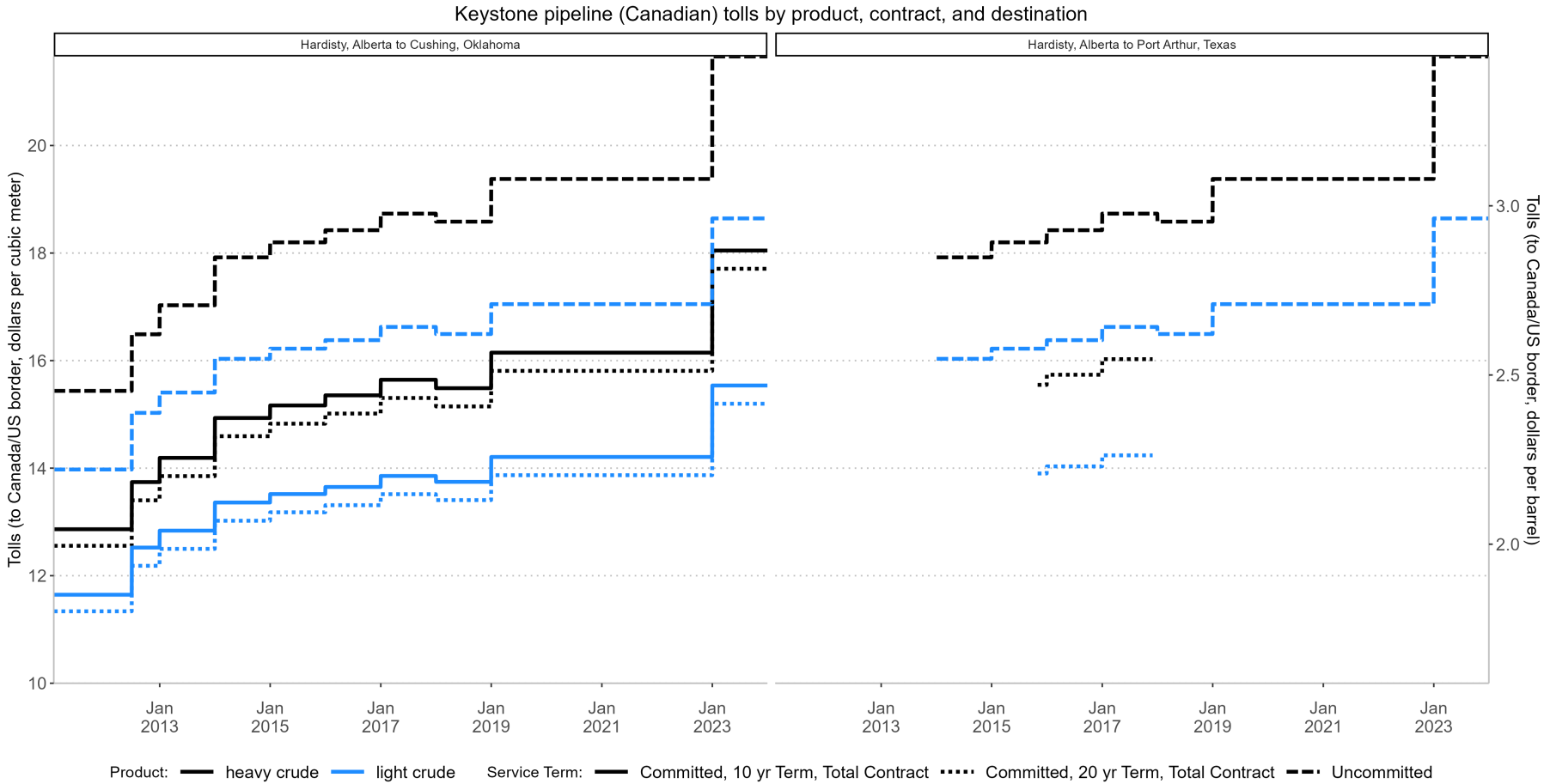

Source: CER Data, graph by Andrew Leach.

LNG - the process

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The LNG Process: How to Liquefy Natural Gas

There are three primary steps involved in creating LNG:

STEP 1: LIQUEFACTION

When raw natural gas arrives at the liquefaction plant, impurities are removed leaving a product that is primarily methane. The natural gas is cooled to about -161°C so it becomes liquid. The volume of natural gas in its liquid state is about 600 times smaller than its volume in its gaseous state. The LNG is stored in insulated tanks to keep it cold until ready to ship.

Source: CAPP

LNG - the process

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STEP 2: LNG TRANSPORTATION

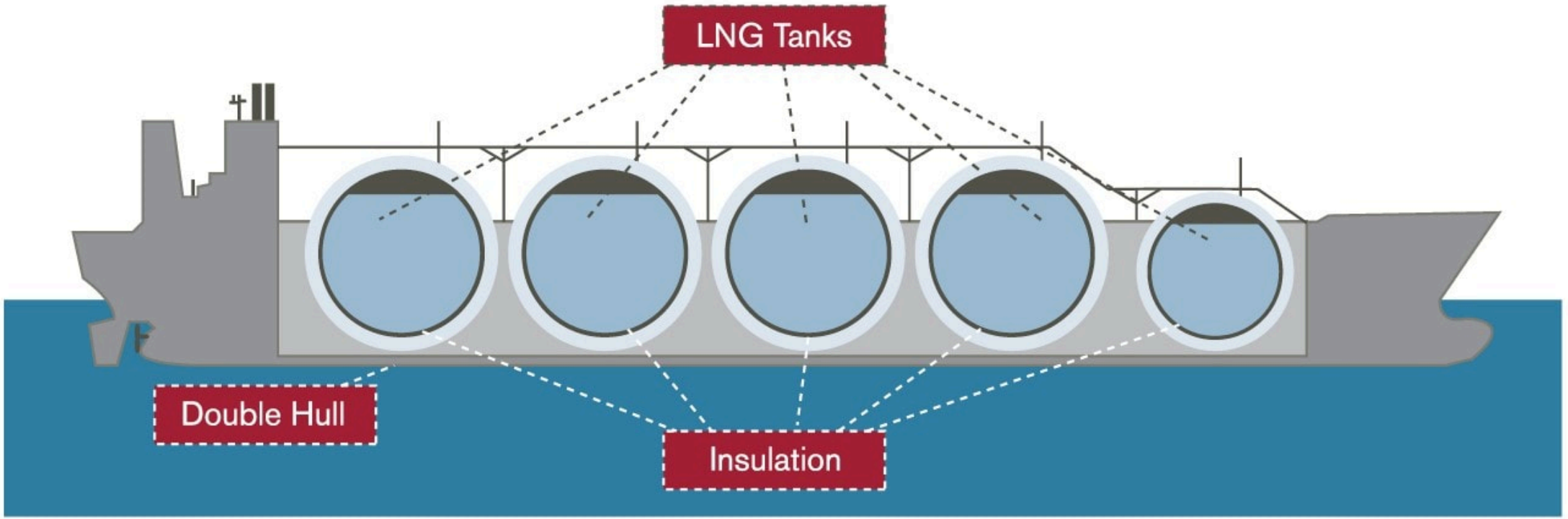
LNG is pumped into double-hulled LNG carriers designed to keep the LNG cold and minimize evaporation. LNG carriers can hold up to 9.4 million cubic feet of LNG, equivalent to 5.6 billion cubic feet of natural gas in its natural gaseous state.

STEP 3: RE-GASIFICATION

When the LNG carrier arrives at its destination, the LNG is offloaded and stored in insulated storage tanks to keep it cold. When needed, the LNG is warmed to convert it back to a gas and then delivered by pipeline to customers.

Source: CAPP

LNG - the ships



Source: CAPP

LNG - the trade

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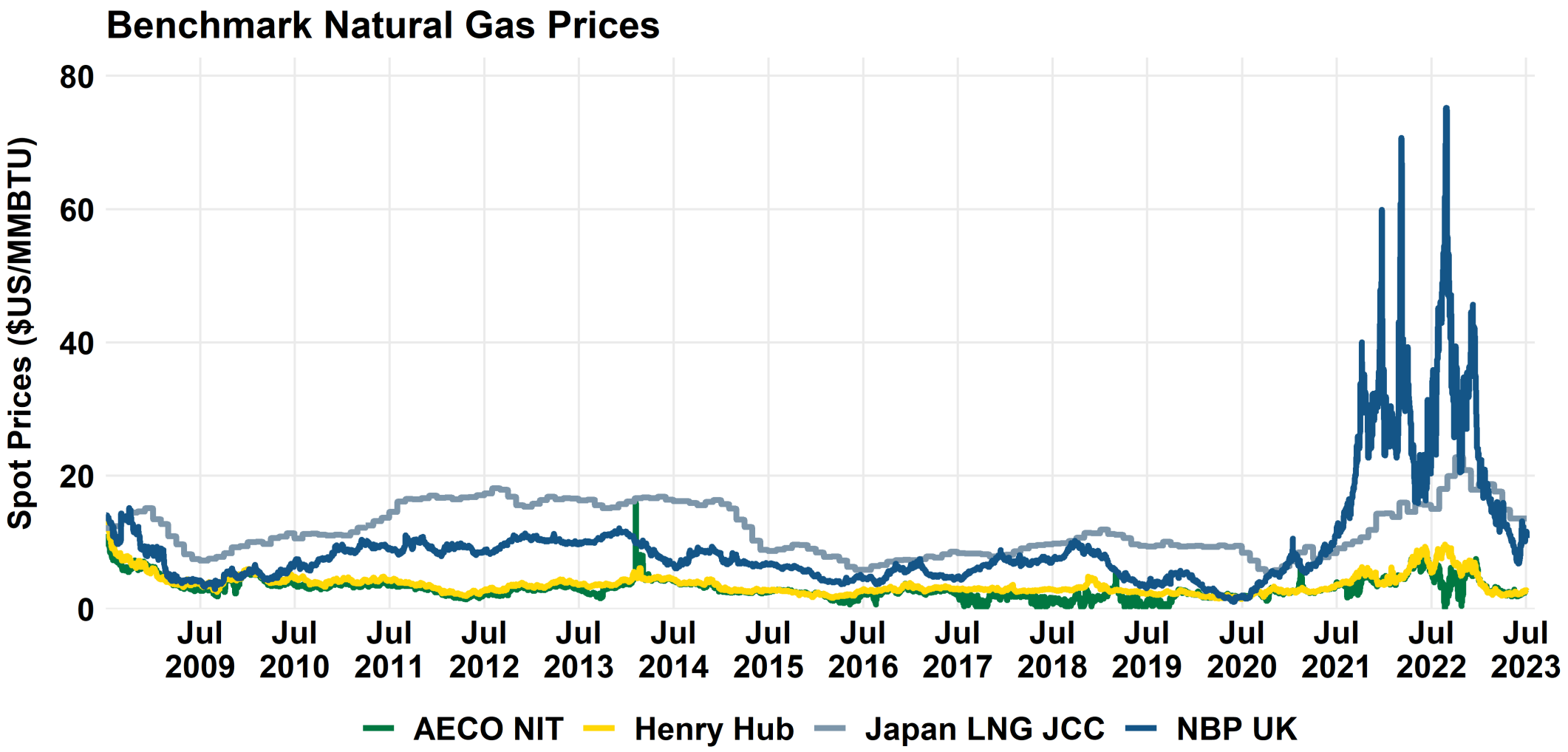

Data via Bloomberg

LNG - the trade

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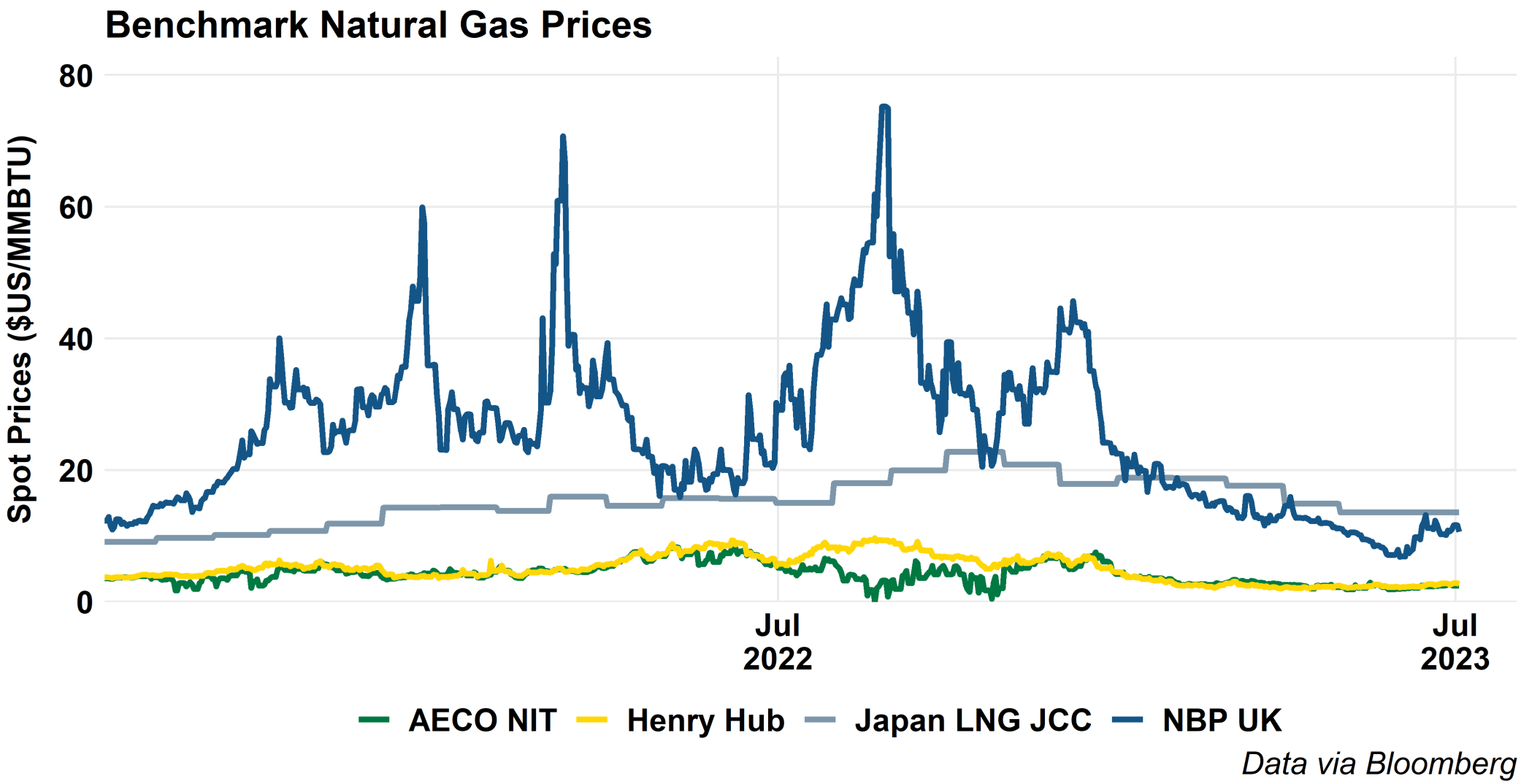

Data via Bloomberg

LNG - the contracts

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LNG Purchase Price	LNG Liquefaction Processing Fee	Marketing and Other Fee	Pipeline Transportation Fee	Netback to Natural Gas Supplier
$13.60 ($90/bbl oil)	**$3.00**	**$0.25**	**$0.75**	**$9.60**
$10.80 ($70/bbl oil)	**$3.00**	**$0.25**	**$0.75**	**$6.80**
$8.00 ($50/bbl oil)	**$3.00**	**$0.25**	**$0.75**	**$4.00**
$5.20 ($30/bbl oil)	**$3.00**	**$0.25**	**$0.75**	**$1.25**

Notes

- Implied LNG Pricing Formula = 14% * WTI Price +$1.00

LNG - the contracts

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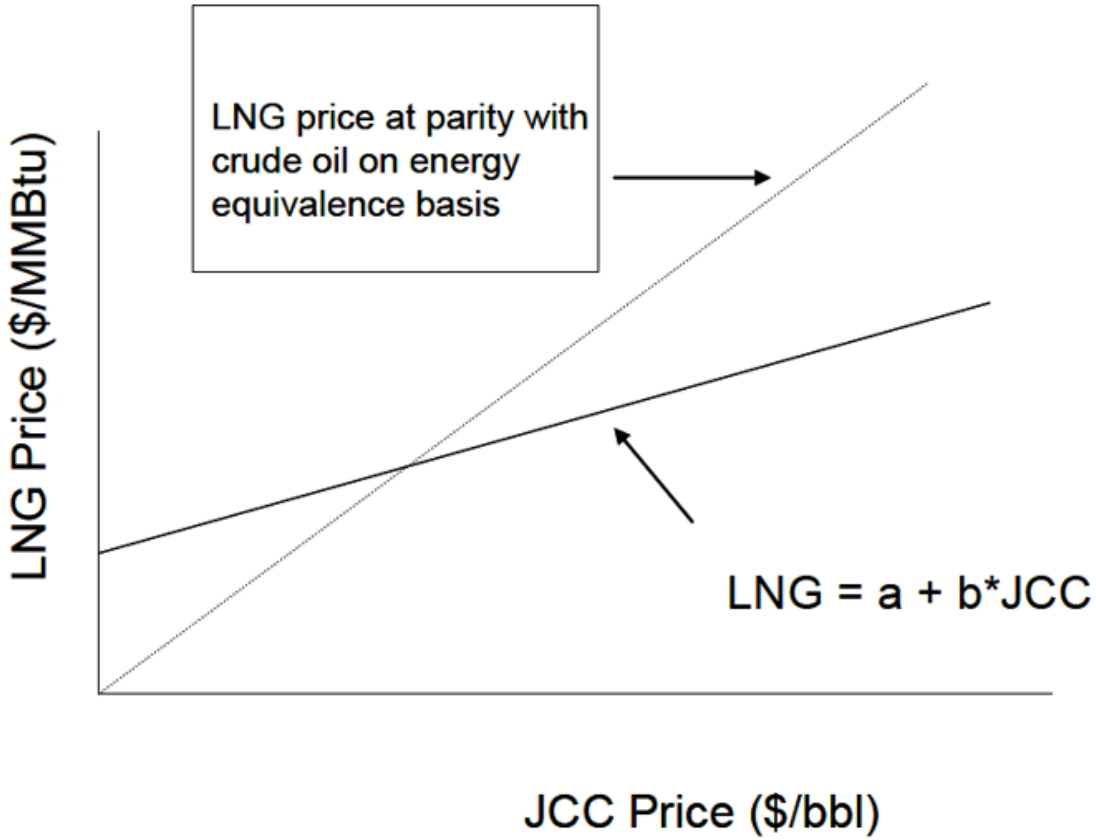
Figure 4 - Typical JCC Structured LNG Pricing Contract



Source: CAPP

LNG - the projects

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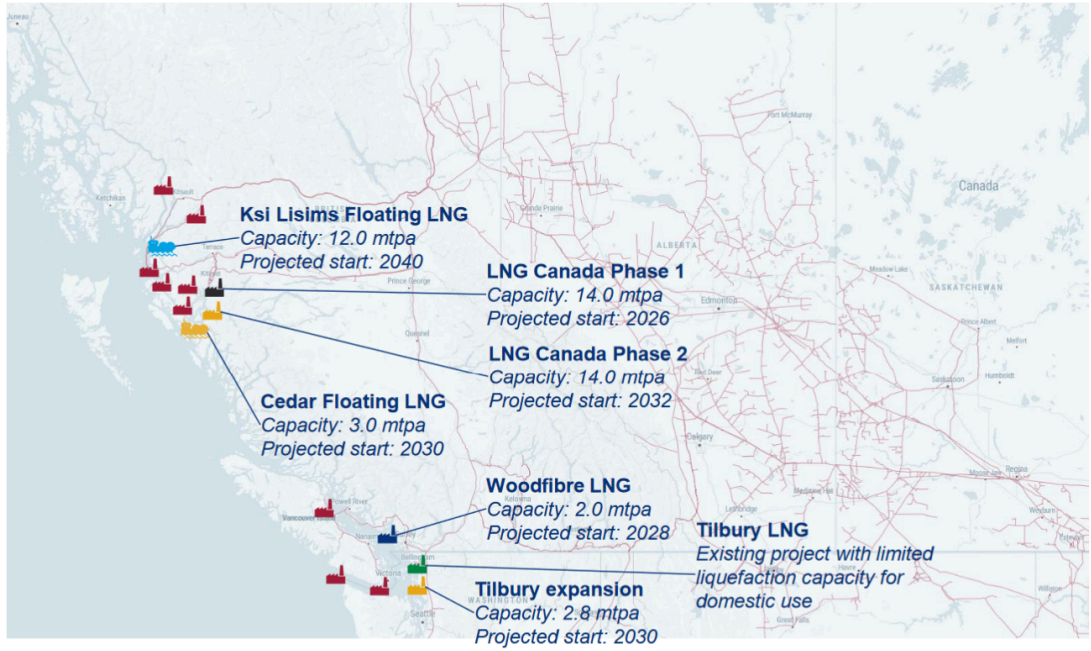
woodmac.com

Pipelines transport natural gas produced in the Western Canadian Basin gas fields to British Columbia's emerging coastal natural gas liquefaction industry

Canada has 23+ proposed conventional and floating LNG liquefaction facilities

Map of West Canada natural gas pipelines and LNG liquefaction facilities



- Natural gas piped from Western Canadian Sedimentary Basin (WCSB) fields becomes LNG on the West Coast
- Tilbury is Canada's only existing liquefaction facility, producing LNG for domestic natural gas customers and marine bunkering
- Cancelled projects may be reconsidered to supply growing East Asian demand for LNG

- Existing
- Under construction[1]
- Probable[1]
- Possible[1]
- Speculative
- Cancelled[2]

1) Included in base case scenario
2) Cancelled projects: **Kitimat LNG, Aurora LNG, WCC LNG**, Douglas Channel LNG, Pacific Northwest LNG, Prince Rupert LNG, Kitsault Energy, Triton LNG, Stewart LNG Phase 1, Stewart LNG Phase 2, Grassy Point LNG, Kwispaa LNG Phase 1, Kitimat LNG Train 3, Malahat LNG, Discovery LNG, Orca LNG, NewTimes LNG among others

Source: Wood Mackenzie

8

Source: CAPP

LNG - the competition

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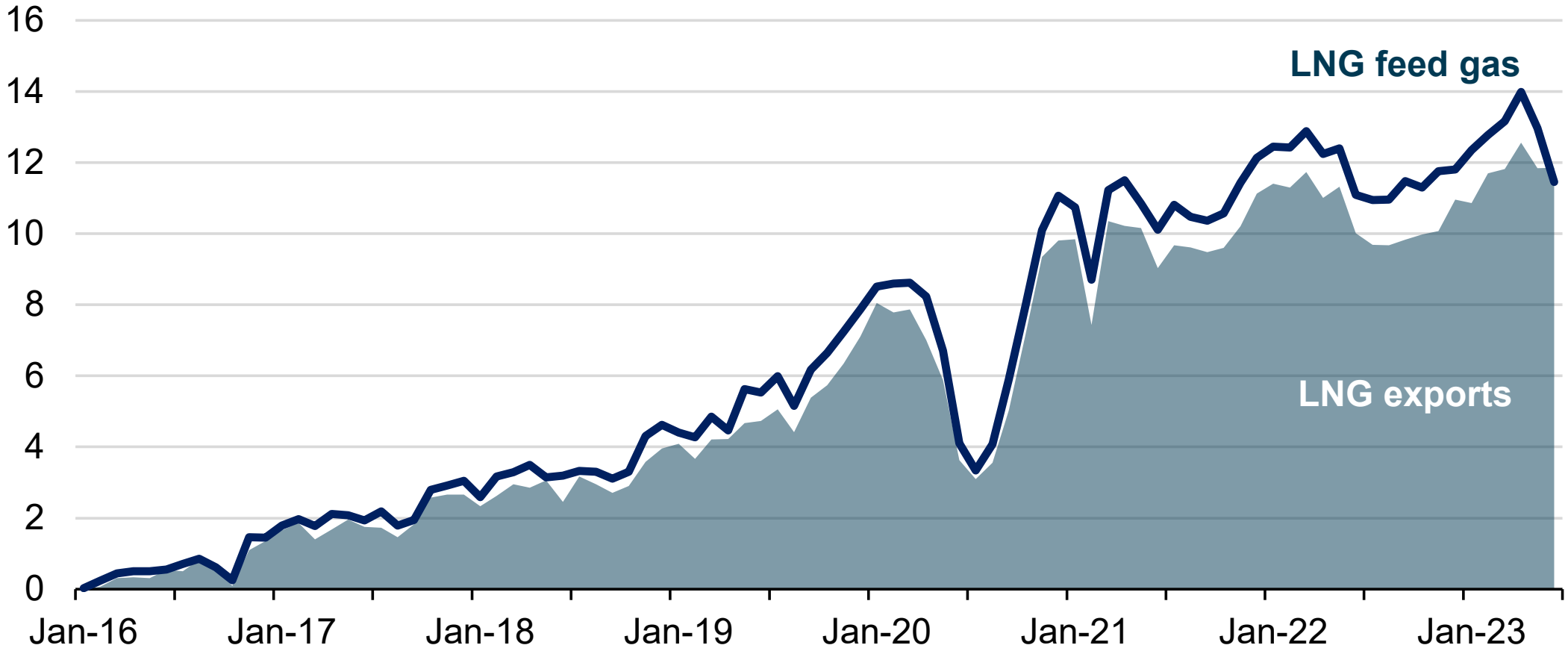
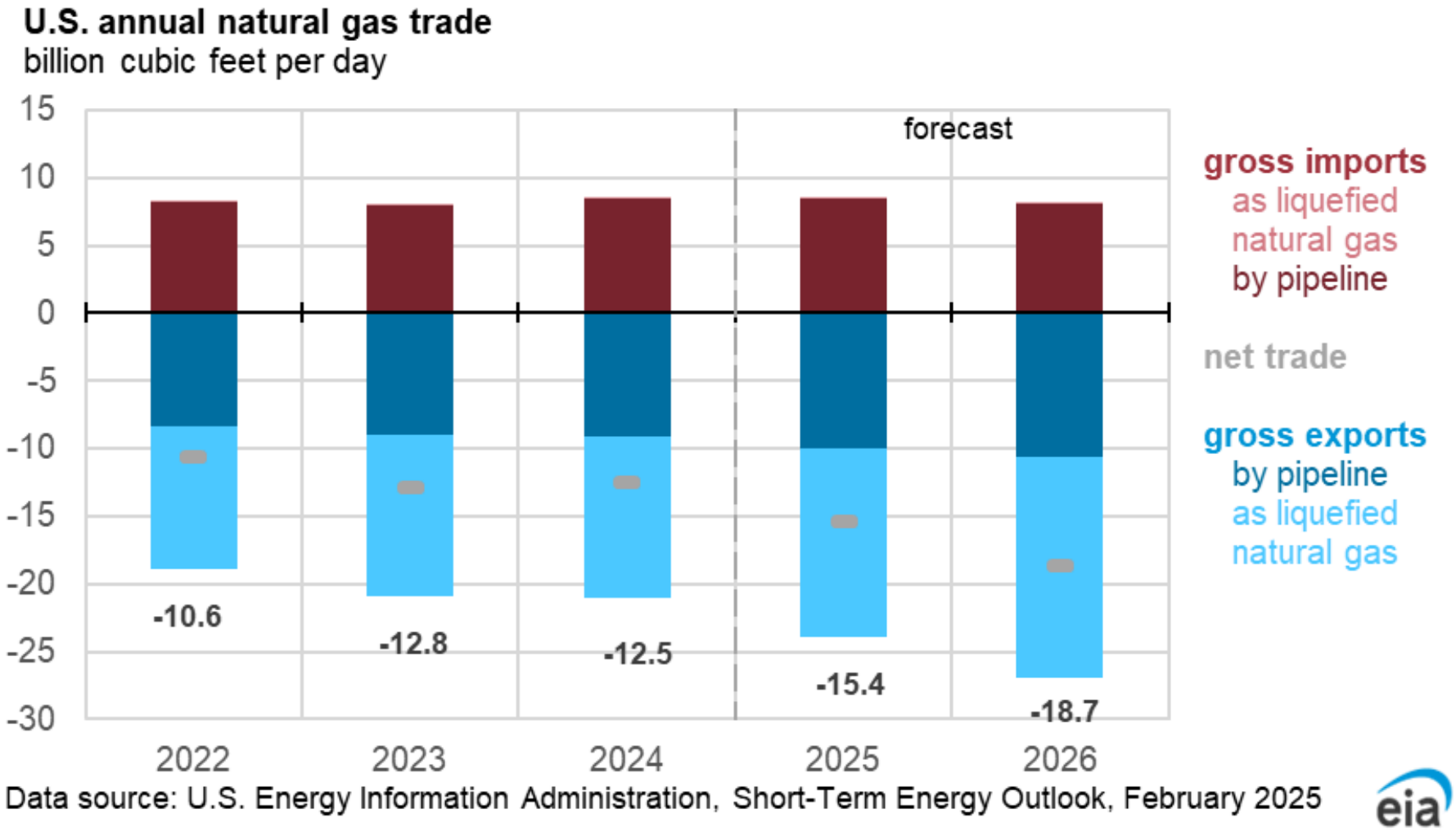
U.S. monthly LNG feed gas and exports (Jan 2016–Jun 2023)
billion cubic feet per day



Source: EIA

LNG - the competition



Source: EIA STEO

LNG - the market (Source: Shell)

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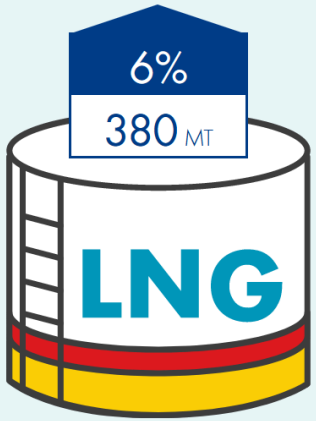
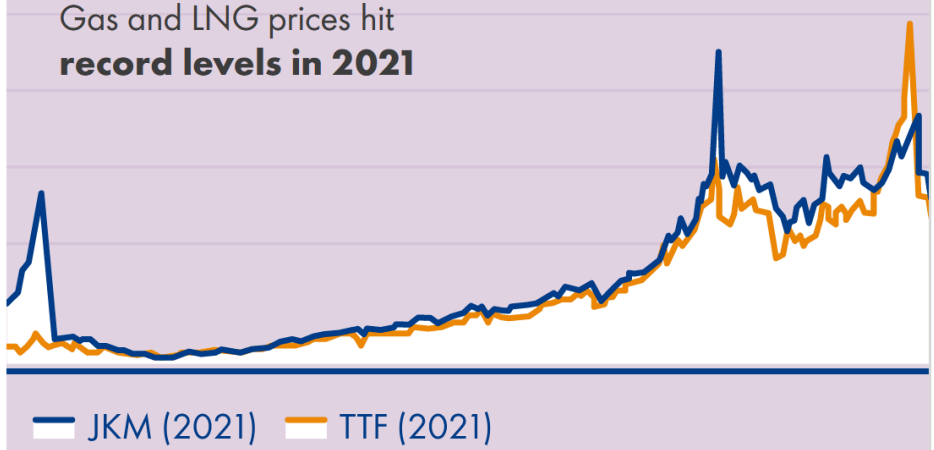
2021 in focus | Longer-term demand | Reaching net-zero

Global trade in **liquefied natural gas rebounds** strongly during **2021**.

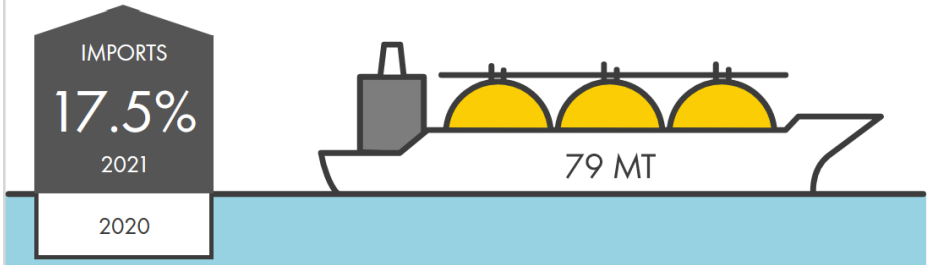
Trade hits 380 million tonnes, an **increase of 21 million tonnes** (or 6.0%) compared to 2020.



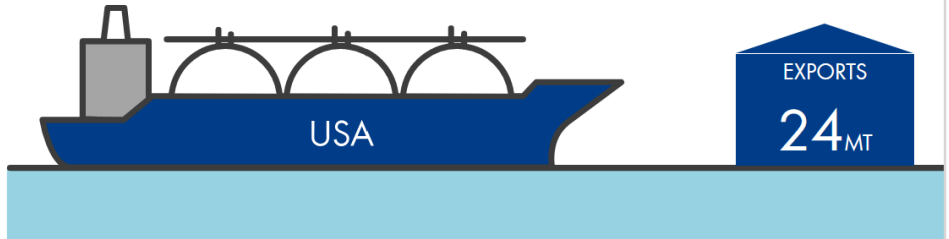
Gas and LNG prices hit **record levels in 2021**



China becomes the **world's largest LNG importer** with LNG imports reaching **79 million tonnes**.



US led **export growth** with an increase of **24 million tonnes**.



LNG - the longer-term market(Source: Shell)

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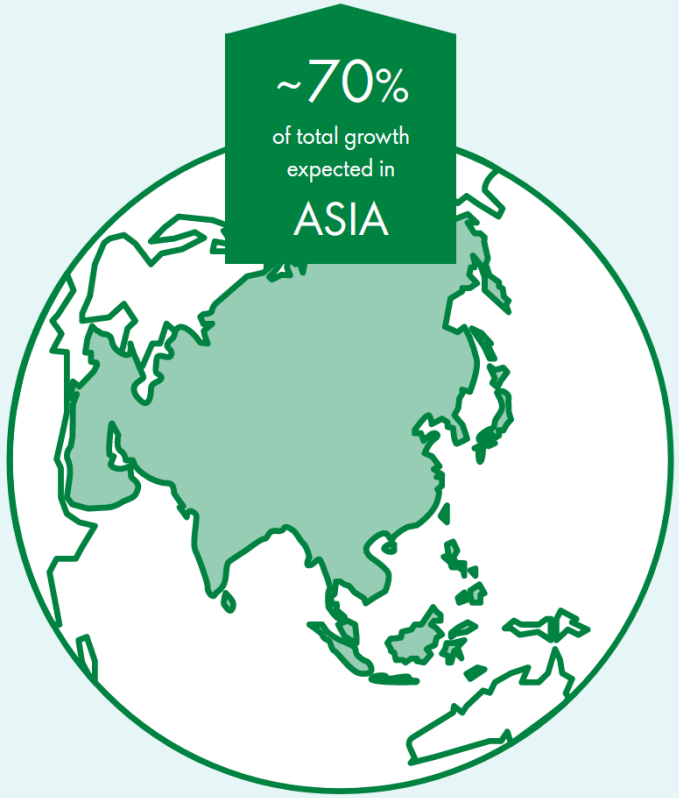
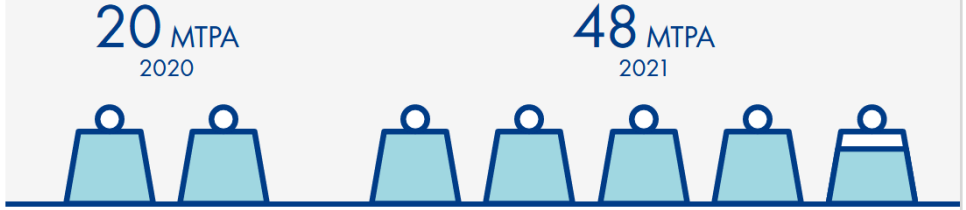
2021 in focus | **Longer-term demand** | Reaching net-zero

Asia to lead growth in LNG demand through to **2040**.



LNG supply-demand gap expected to emerge in the middle of the current decade.

Term LNG contracts more than **double** to 48MTPA, from 20MTPA in **2020**.



China signs over **20 MTPA** in term contracts, prioritising energy security and progressing net-zero emissions ambitions.

LNG - the link to net-zero emissions(Source: Shell)

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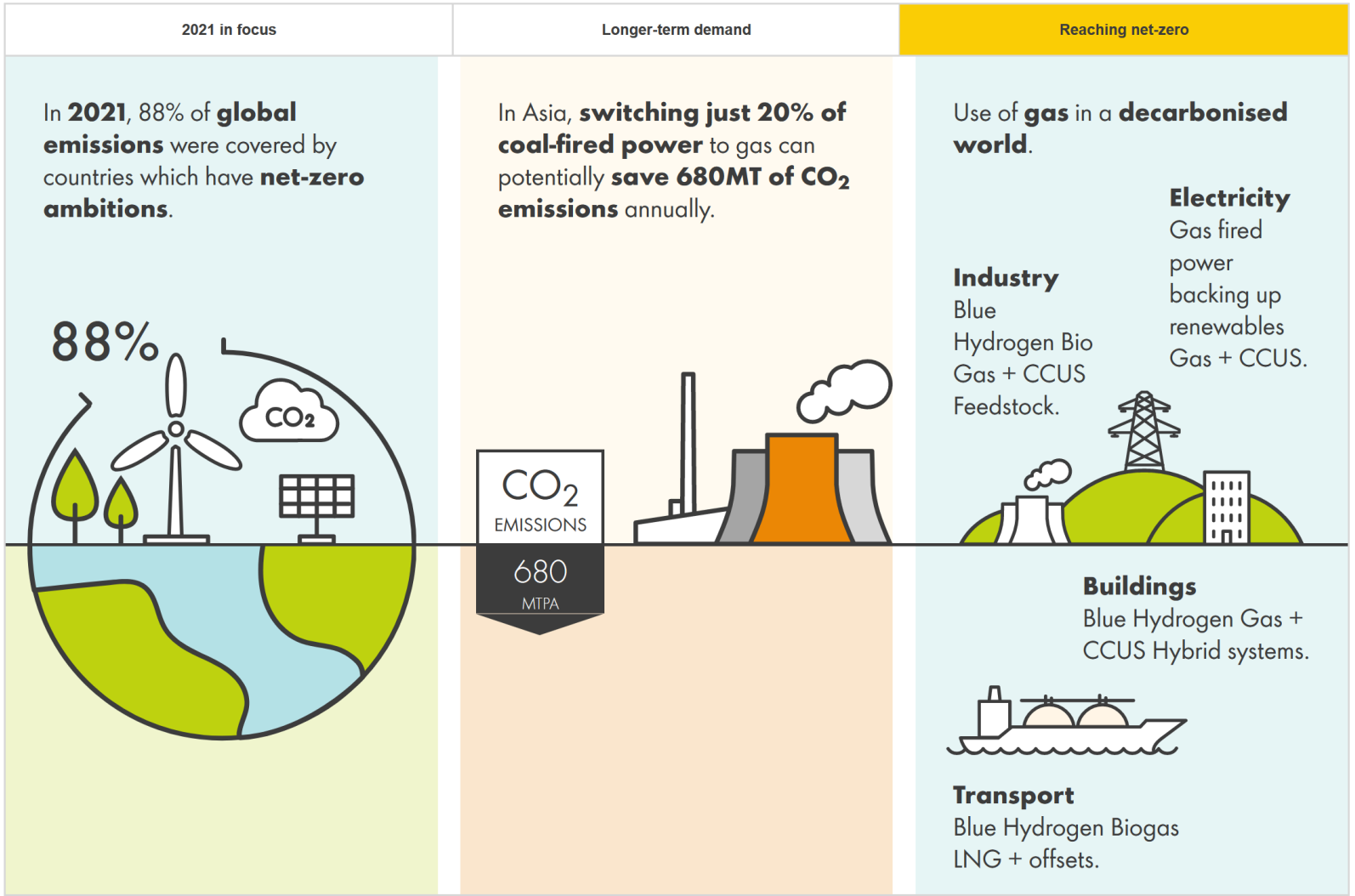

Key concept review

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- know the major pipelines (oil and gas)
- infrastructure constraints
- rail vs pipe
- firm service vs common carrier
- toll design
- open season
- apportionment and nominations
- LNG basics