California Refinery Crude Oil Sources and Trends

OSPR TAC Informational Meeting on Non-Floating Oil

Sacramento, CA

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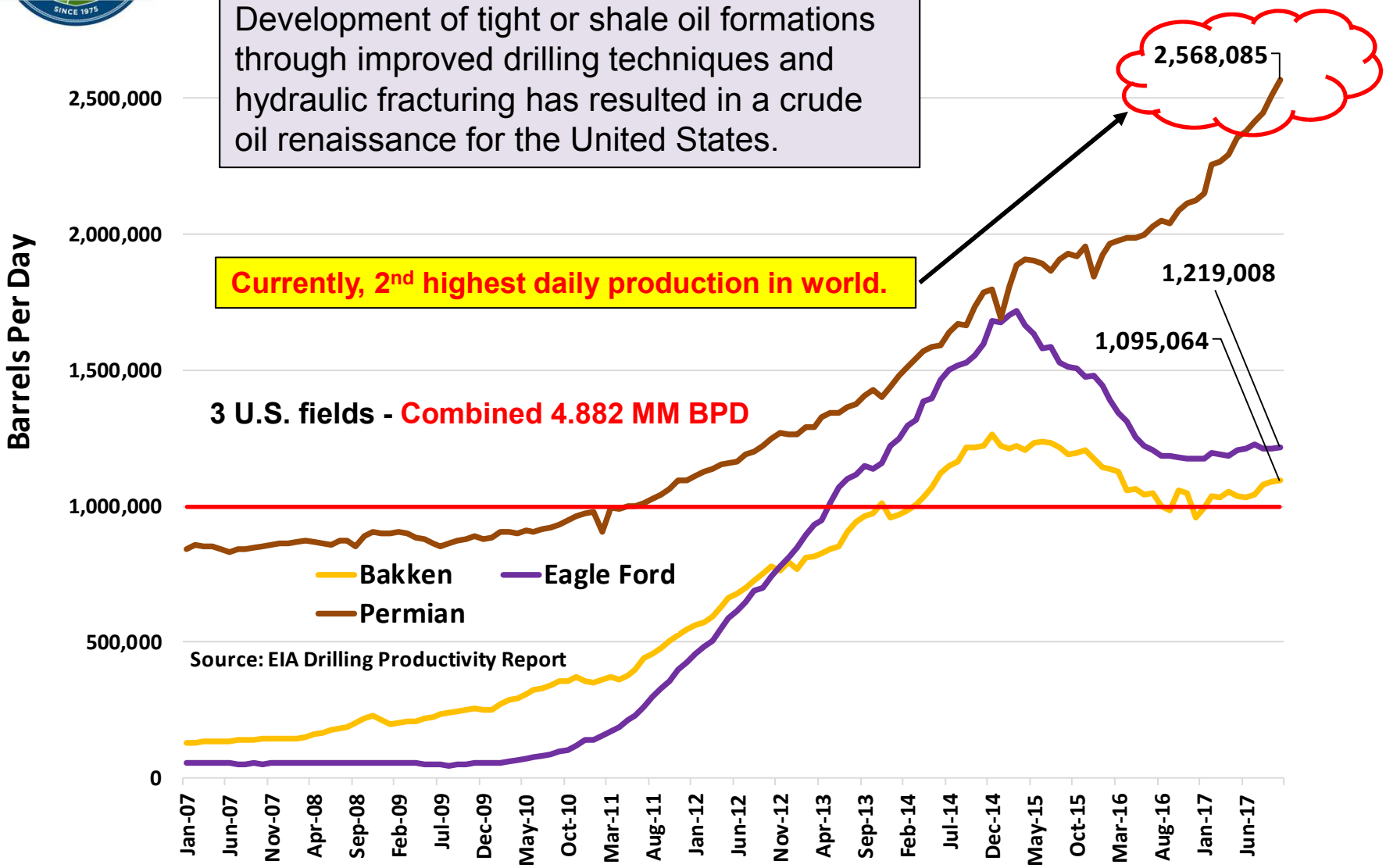
Presentation Topics

- Crude oil trends and sources
- Transportation of crude oil
- California refinery operations
- Ability to track crude oil movements

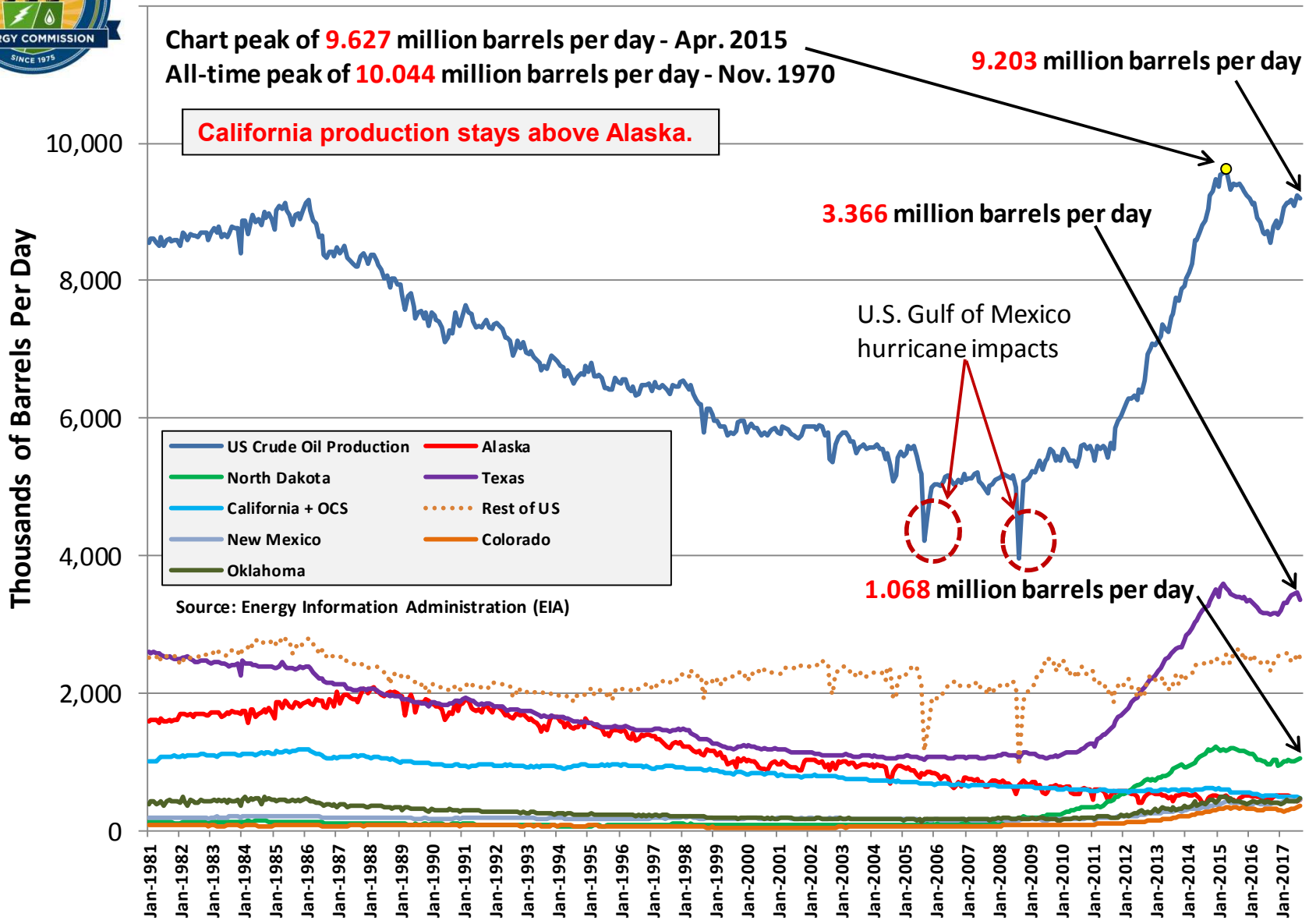
Crude Oil Trends & Sources

U.S. Oil Production by Shale Basin

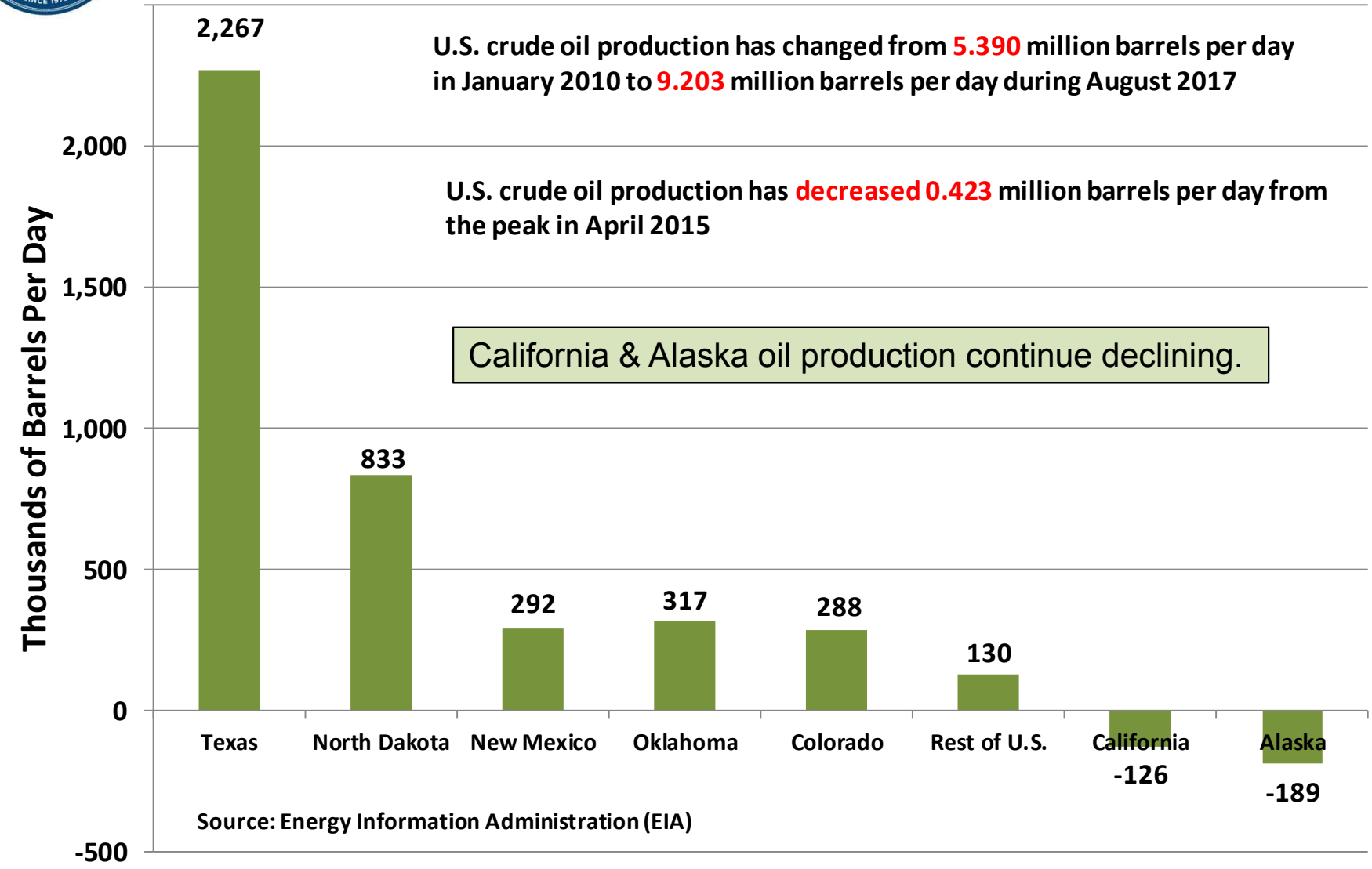
Development of tight or shale oil formations through improved drilling techniques and hydraulic fracturing has resulted in a crude oil renaissance for the United States.



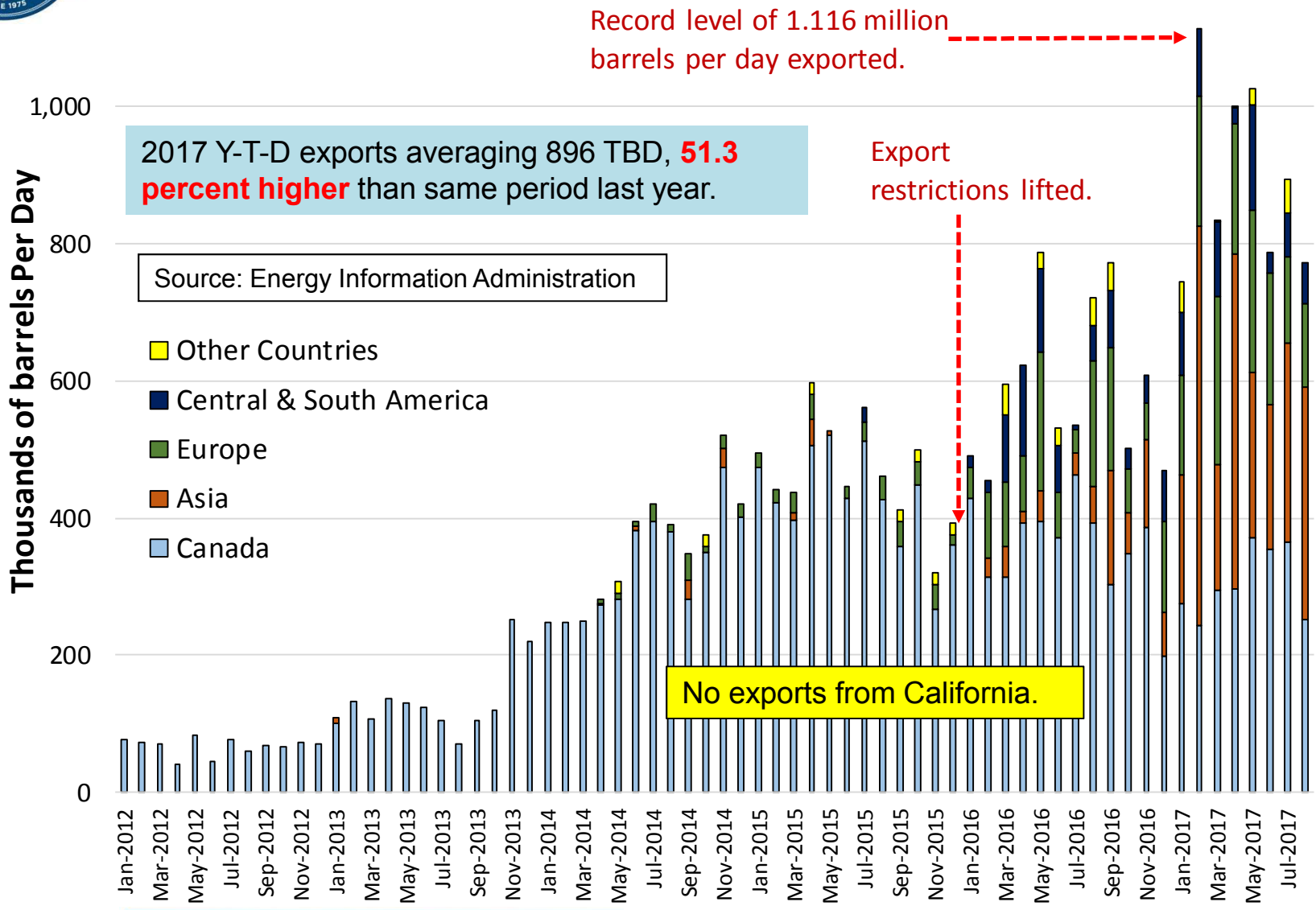
U.S. Crude Oil Production – Jan. '81-Aug. '17



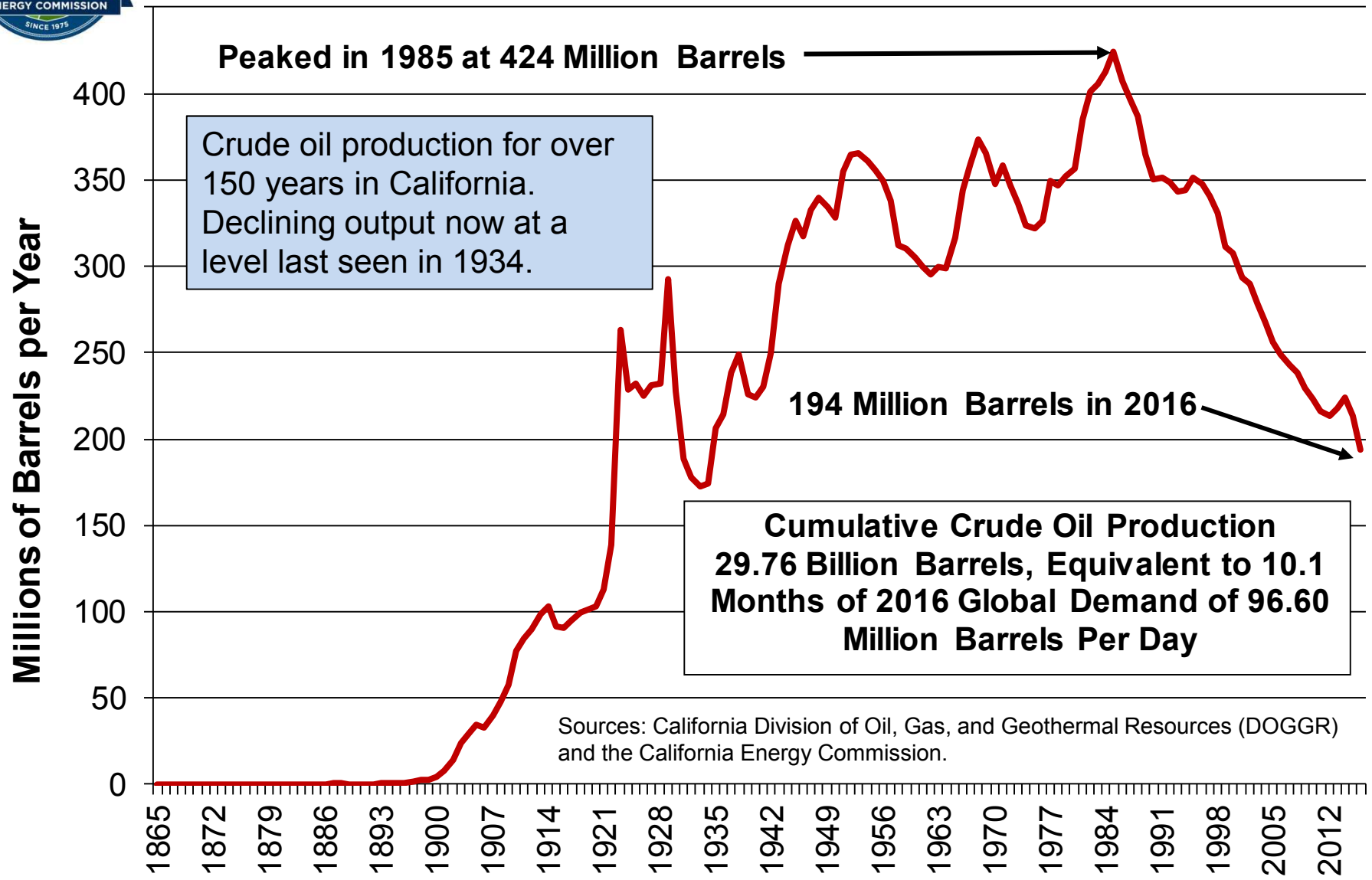
Change in Crude Oil Production
January 2010 vs. August 2017



Crude Oil Exports

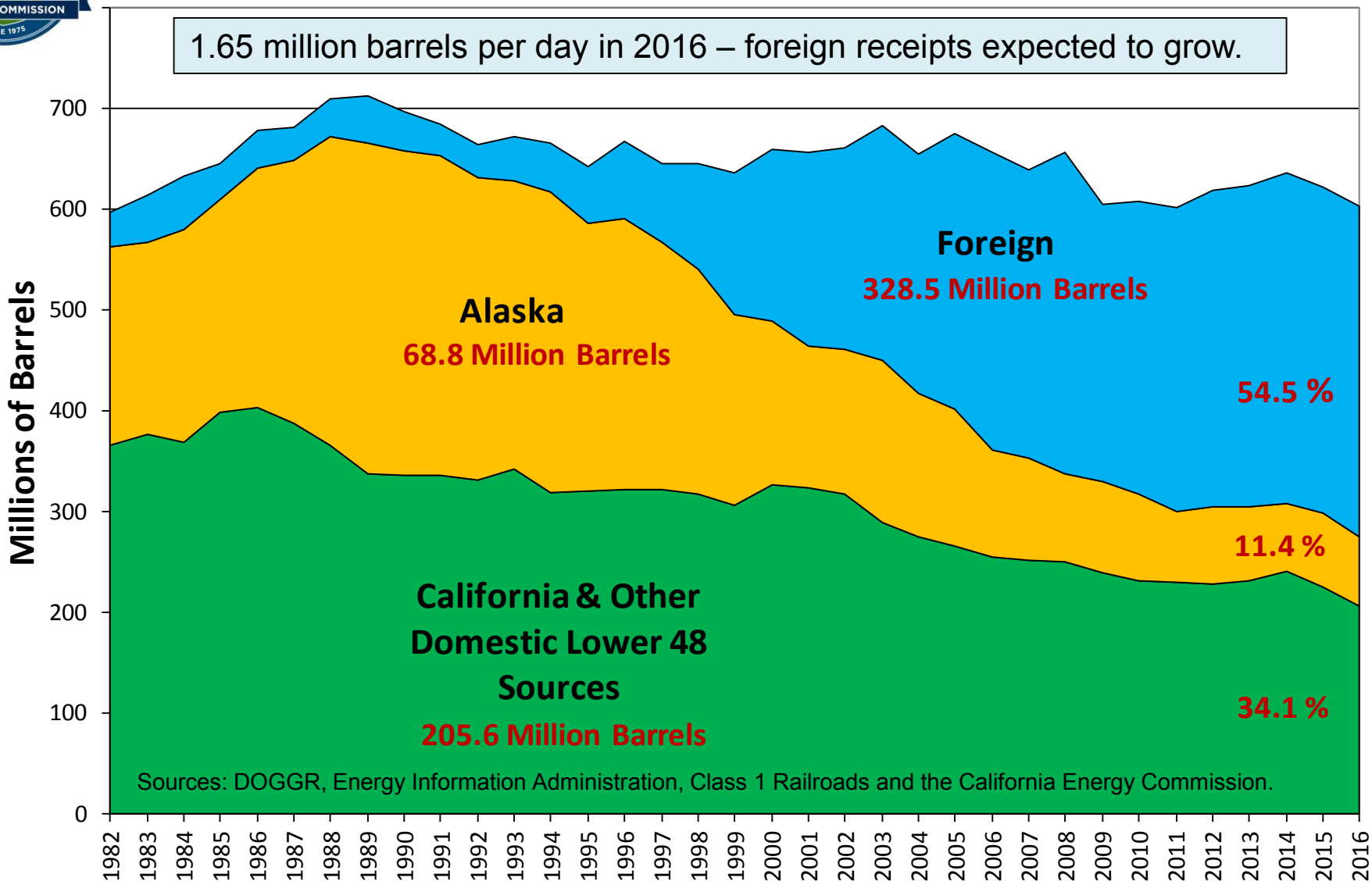


California Oil Production (1865 to 2016)

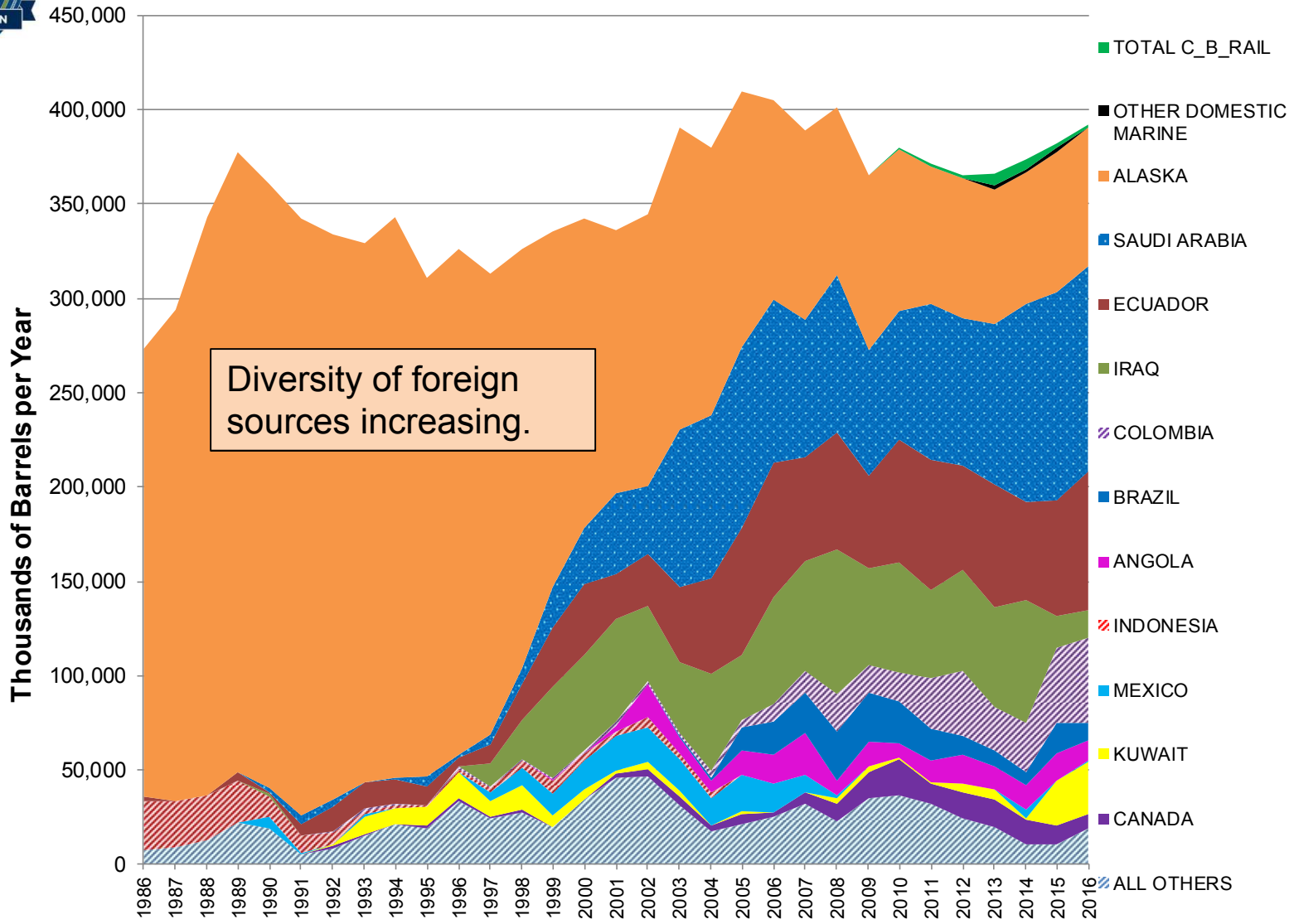


Sources: California Division of Oil, Gas, and Geothermal Resources (DOGGR) and the California Energy Commission.

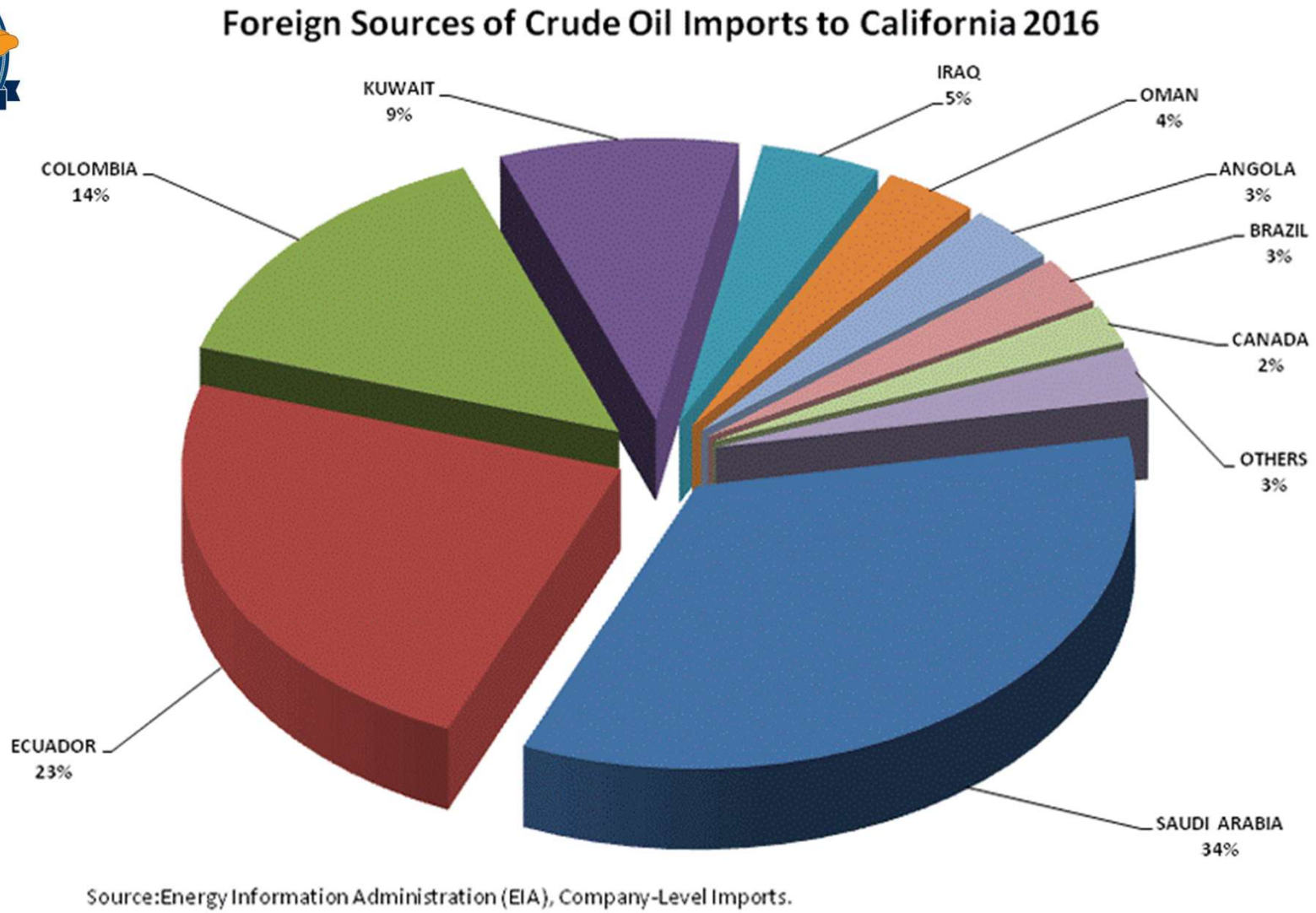
California Refinery Oil Sources (1982–2016)



Annual Crude Oil Imports into California

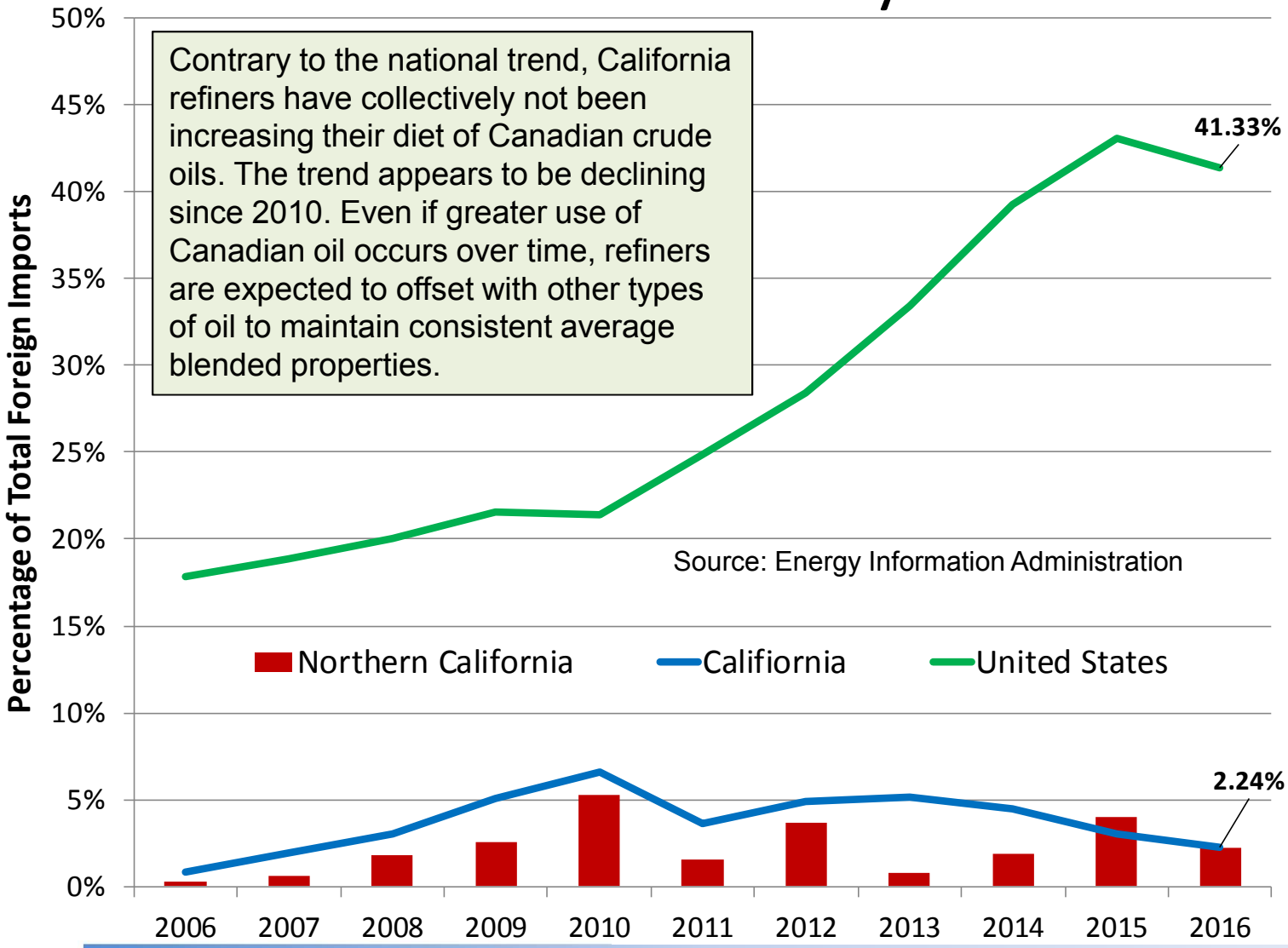


Sources: Energy Information Administration and the California Energy Commission.



Near-source countries (North & South America) 45 percent of totals.

Canadian Crude Oil Imports – California & SF Bay Area

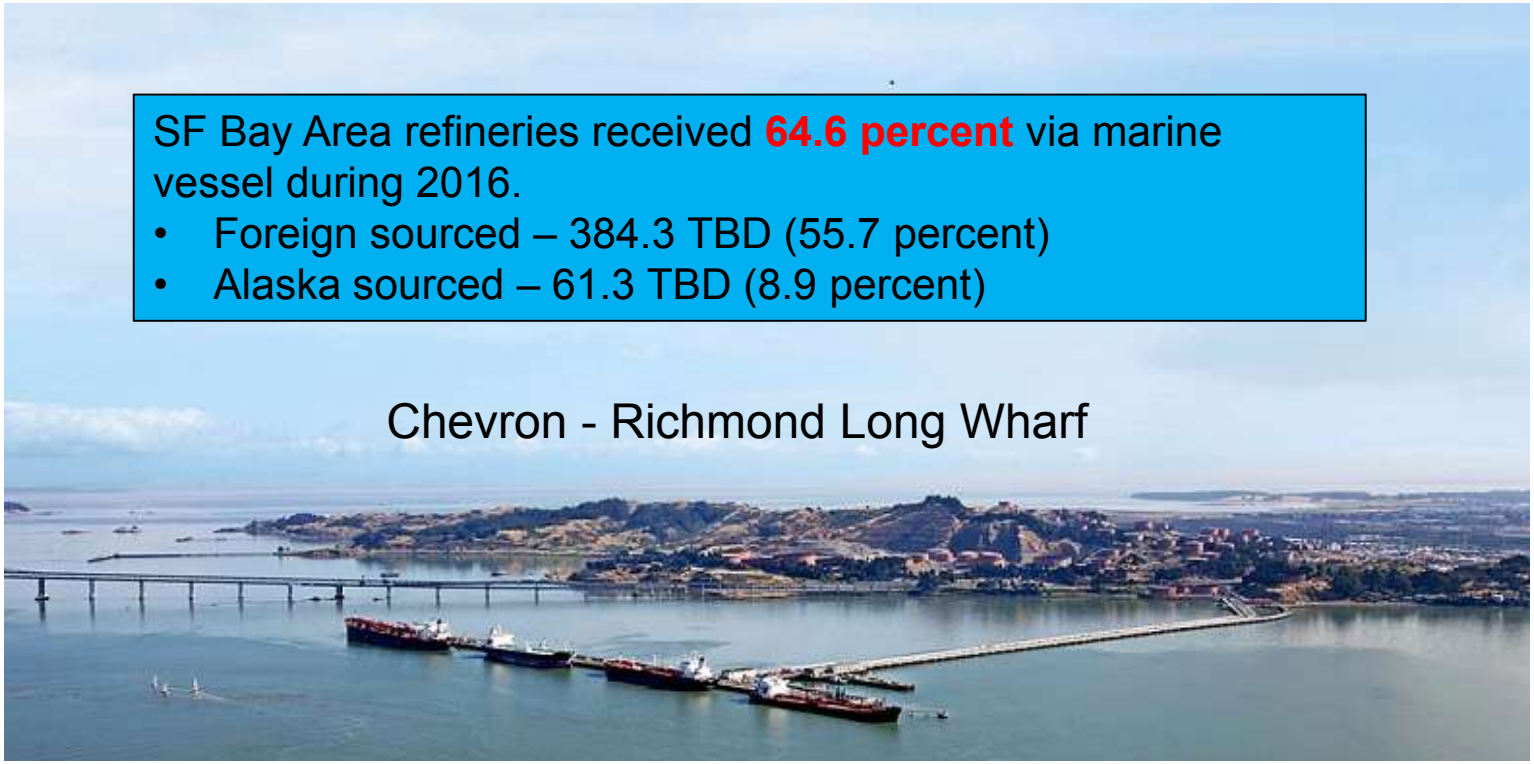


Transportation of Crude Oil

Diversity of Oil Movement

Crude Oil - Marine Movements

- **66.1 percent** of crude oil transported by marine vessel in 2016
  - Foreign sourced – 901.5 TBD (54.8 percent)
  - Alaska sourced – 185.4 TBD (11.3 percent)



Source: Quazoo.com.

Crude Oil - Marine Movements

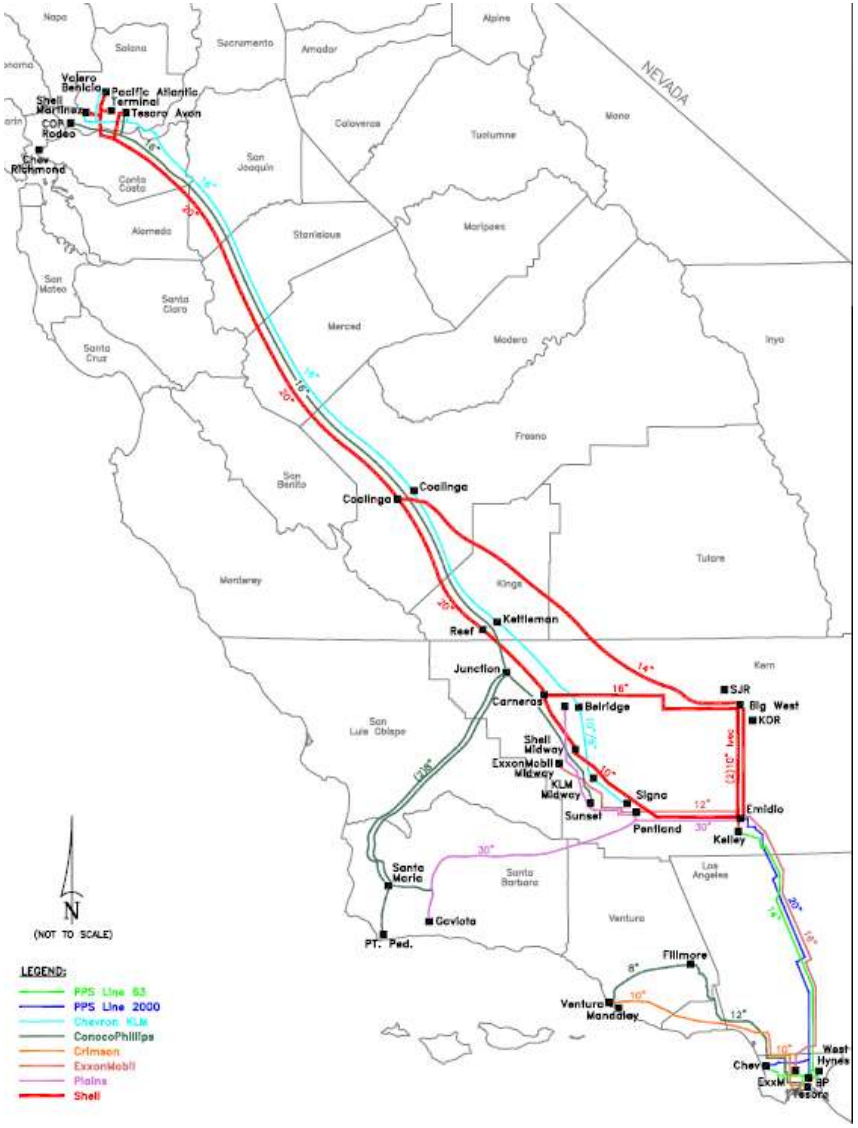
Southern California refineries received **67.2 percent** via marine vessel during 2016.

- Foreign sourced – 517.2 TBD (54.2 percent)
- Alaska sourced – 124.1 TBD (13.0 percent)

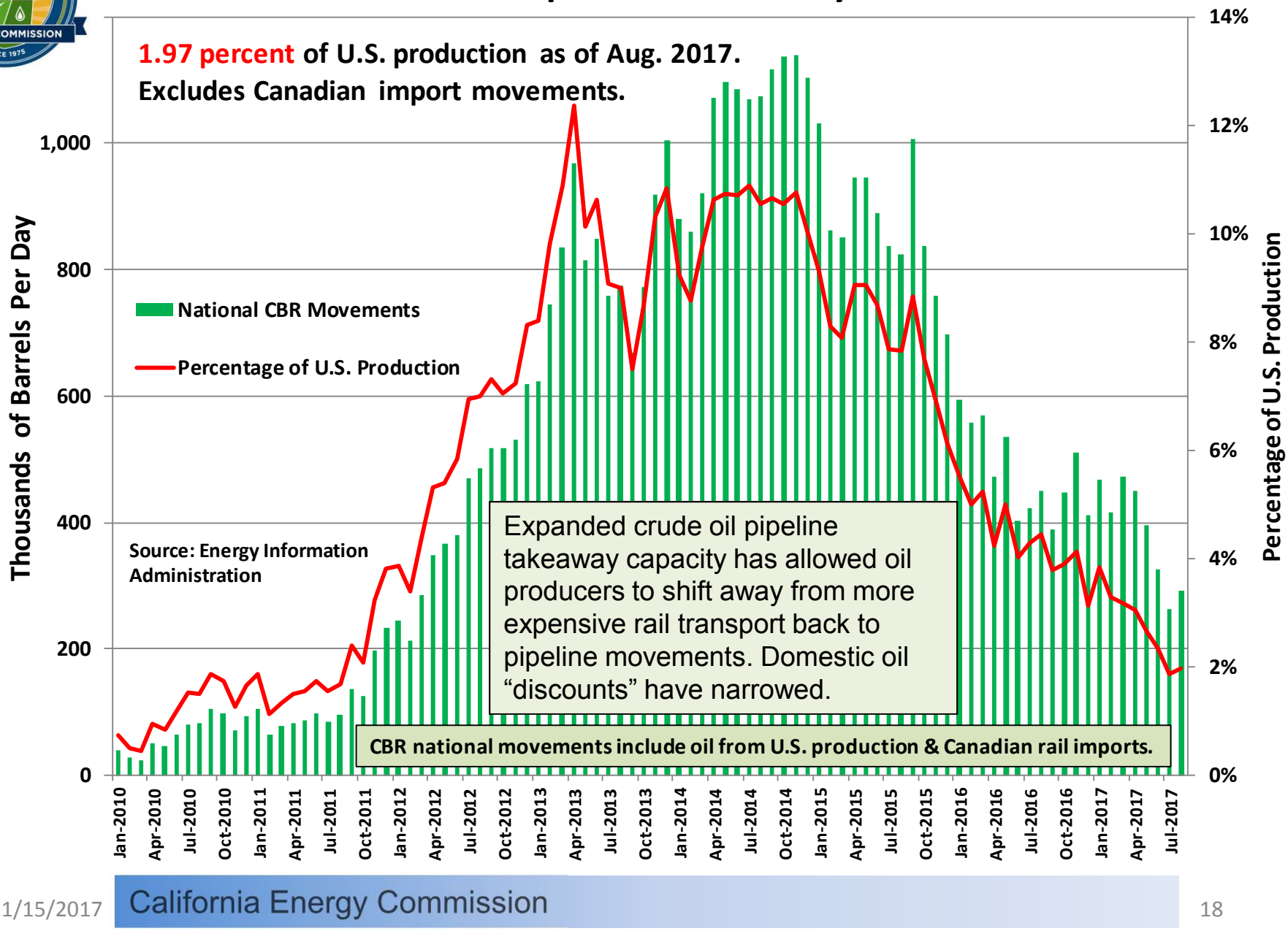
Source: General Steamship Agencies – Oil tanker Nissos Kythnos operated by Andeavor Maritime.

California Oil Sources – Pipelines

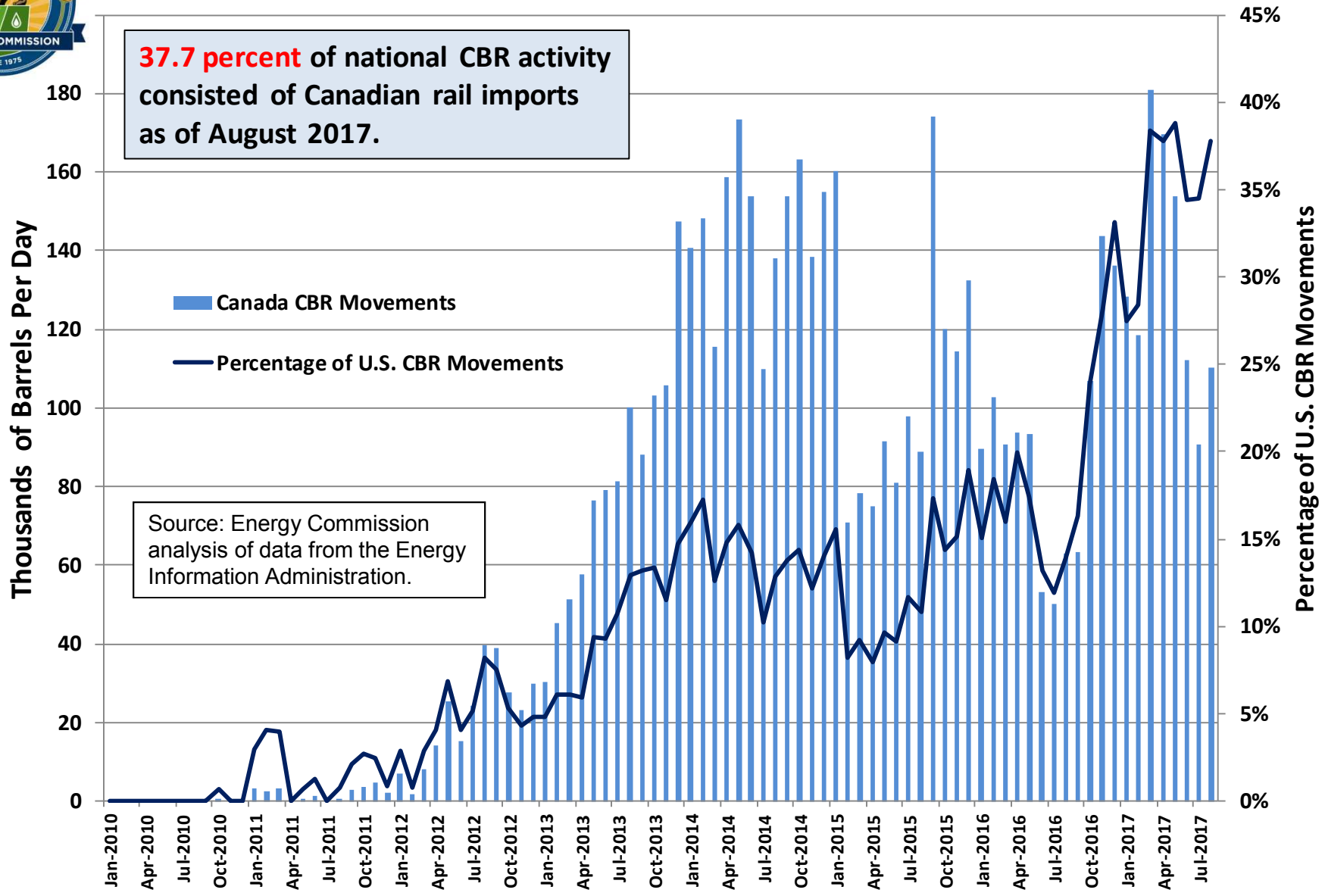
- **33.5 percent** of crude oil received by all California refineries transported via pipelines – 551.0 thousand barrels per day during 2016
  - SF Bay Area refineries received 243.9 thousand barrels per day of CA crude oil via three main trunk lines from southern San Joaquin Valley – **35.4 percent** of total receipts during 2016
  - Southern California & Bakersfield refineries received 307.1 thousand barrels per day of CA crude via local & main trunk lines from southern San Joaquin Valley – **32.2 percent** of total receipts during 2016



Crude Oil Transportation by Rail Tank Car

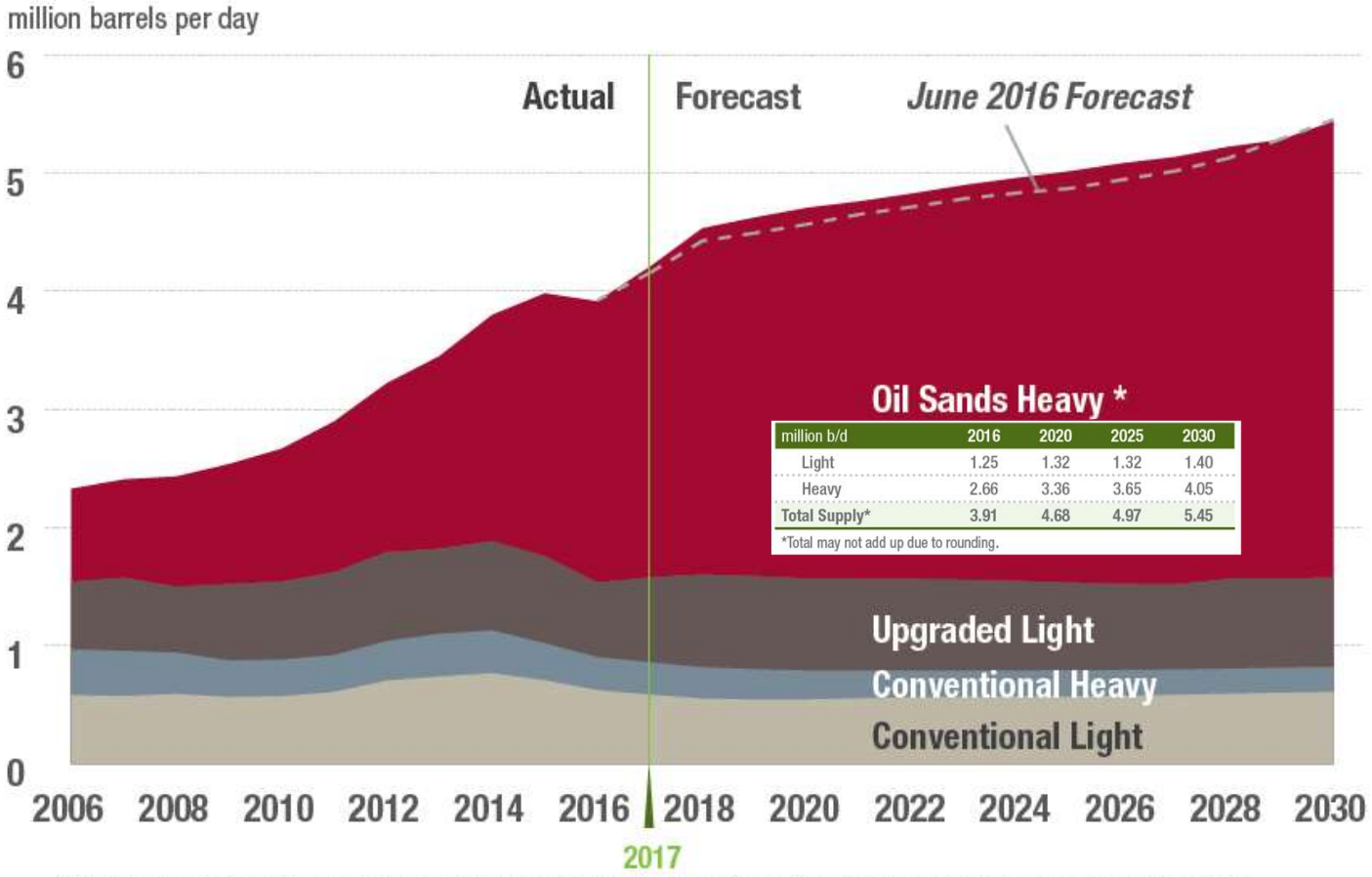


Canadian Rail Imports vs. U.S. CBR Activity



Western Canada – Heavy vs. Light

90.3 percent growth from heavy oil.



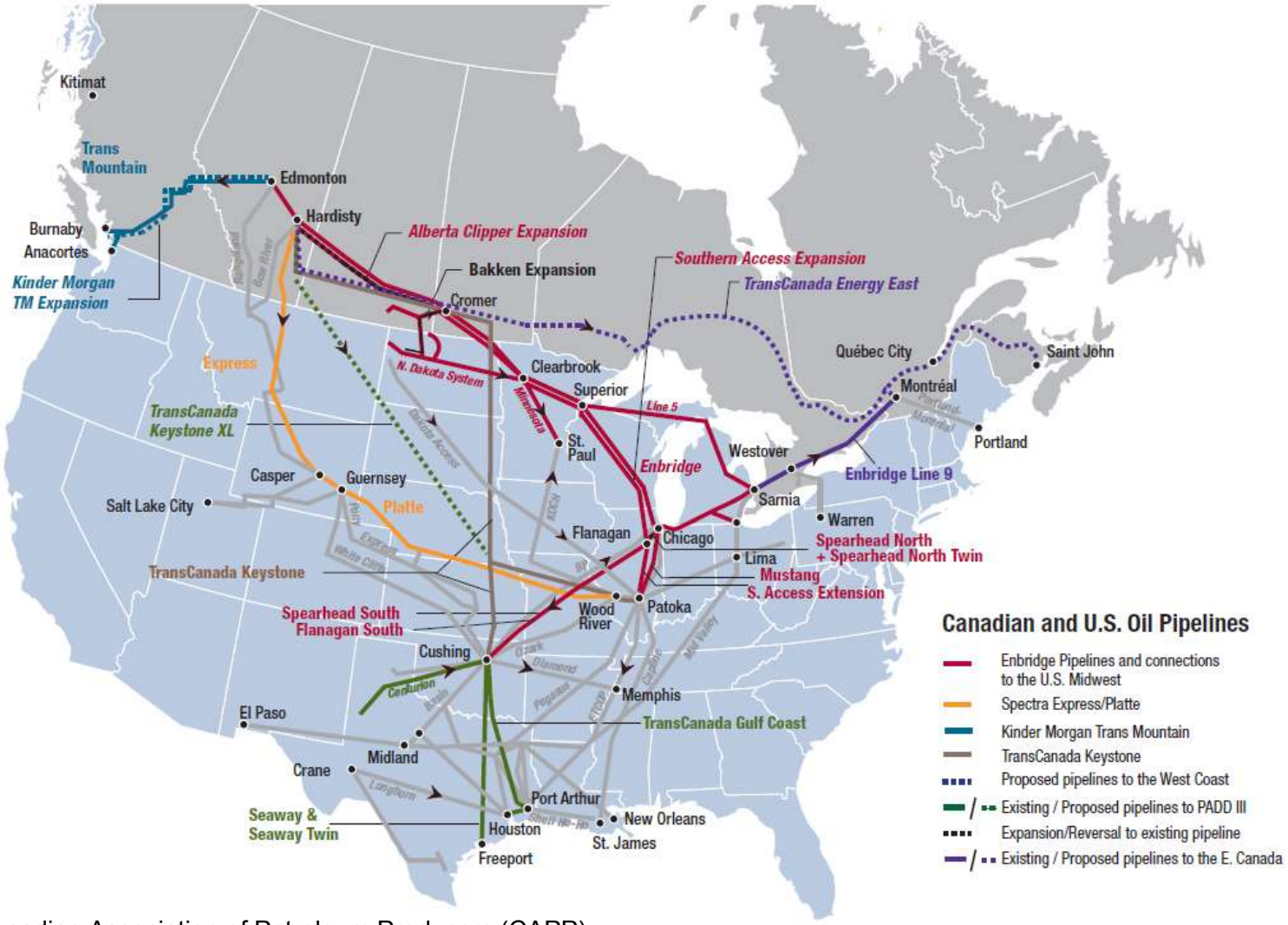
million b/d	2016	2020	2025	2030
Light	1.25	1.32	1.32	1.40
Heavy	2.66	3.36	3.65	4.05
Total Supply*	3.91	4.68	4.97	5.45

*Total may not add up due to rounding.

* Oil Sands Heavy includes some volumes of upgraded heavy sour crude oil and bitumen blended with diluent or ugpraded crude oil.

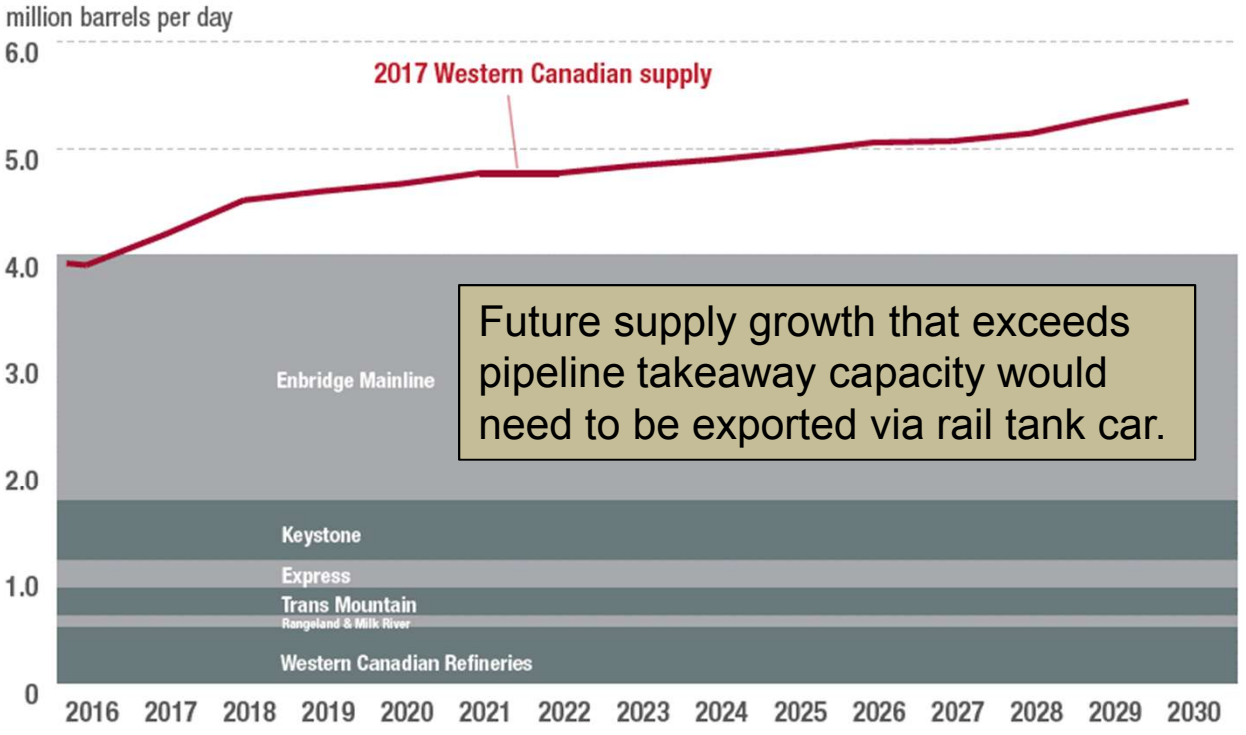
Source: Canadian Association of Petroleum Producers (CAPP).

Canadian Crude Oil Pipelines



Source: Canadian Association of Petroleum Producers (CAPP).

Existing Pipeline Takeaway Capacity vs. Crude Oil Forecast for Western Canada



Future supply growth that exceeds pipeline takeaway capacity would need to be exported via rail tank car.

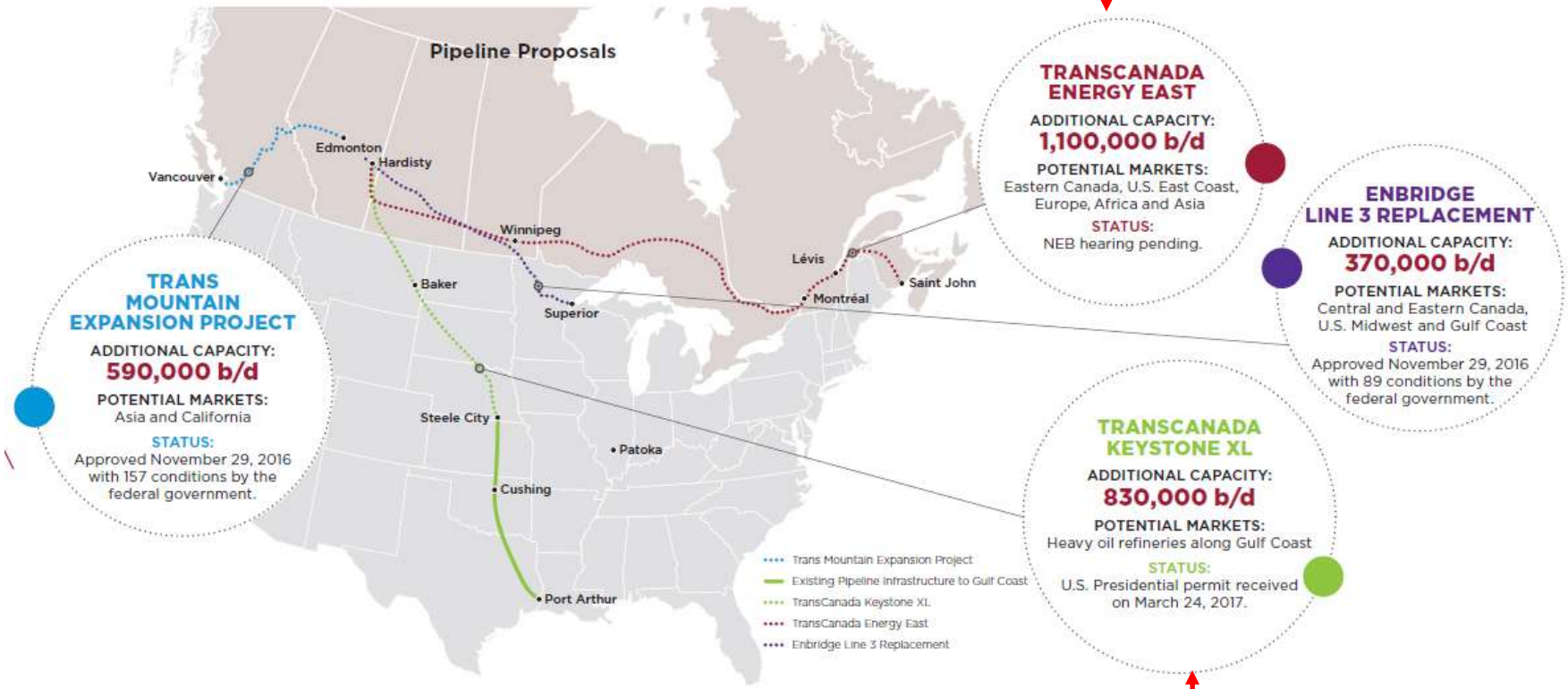
Capacity shown can be reduced by any extraordinary and temporary operating and physical constraints.

Notes:
1) Enbridge capacity adjusted by operational downtime and capacity for RPP and U.S. Bakken crude oil.
2) Keystone: adjustment to 95% of nameplate capacity for maintenance downtime.
3) Express: contract capacity only due to downstream Platte pipeline constraints.
4) Trans Mountain: RPP capacity requirements subtracted from nameplate capacity.
5) Rangeland & Milk River: throughput estimated @ 107,000 b/d, which is the maximum realized annual crude oil throughput since 2010.
6) Western Canadian refineries: Refinery intake in Alberta and Saskatchewan; excludes BC (85% of 616,000 b/d capacity).

Source: Canadian Association of Petroleum Producers (CAPP).

Canadian - Pipeline Expansions

October 5, 2017 – TransCanada announces termination of project.



Source: Canadian Association of Petroleum Producers (CAPP).

Nebraska Public Service Commission to vote of application on November 20, 2017.

Washington Crude-by-Rail

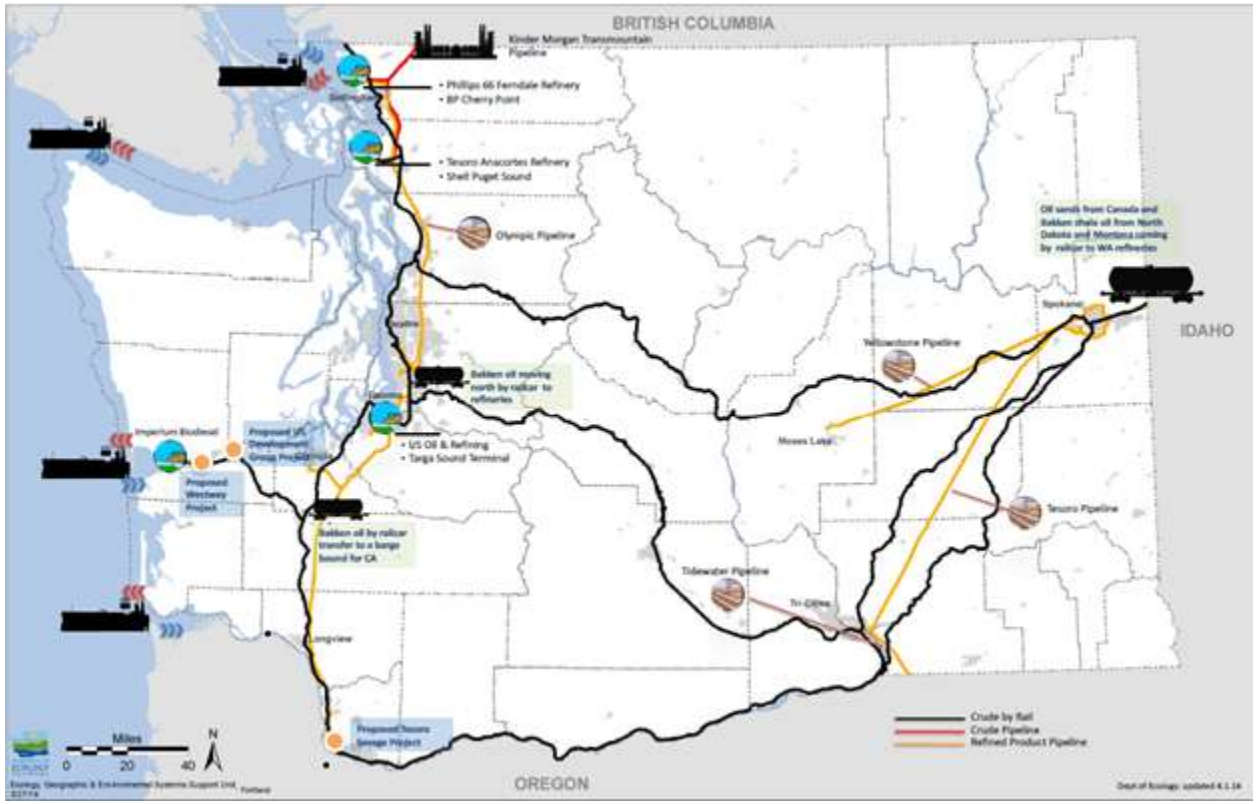
OPERATIONAL FACILITIES		
BP – Cherry Point refinery	60	Operational December 2013
Global Partners – Clatskanie, OR	120	Switched to ethanol 3Q 2016
Phillips 66 – Ferndale refinery	40	Operational December 2014
Tesoro – Anacortes refinery	50	Operational September 2012
US Oil & Refining – Tacoma	48	Operational April 2013

PROPOSED FACILITIES (all large) – Receipt Capability in Thousands of Barrels Per Day		
Tesoro-Savage – Vancouver, WA (SP)	360	EFSEC review extended to 6/30/17
Westway Terminals – Grays Harbor (SP)	49	FEIS issued 9/30/16

CANCELLED PROJECTS		
Imperium Renewables – Grays Harbor (CP)	78	Cancelled project 11/30/15
Nustar – Vancouver, WA (CP)	23	Cancelled project 3/30/17
Shell – Anacortes refinery (CP)	50	Cancelled project 10/8/16
Targa Sound – Tacoma (CP)	41	Cancelled project 9/6/13

Current receipt capability - 318,000 barrels per day (BPD)
Projects seeking permits (SP) - 409,000 BPD
Cancelled projects (CP) - 192,000 BPD

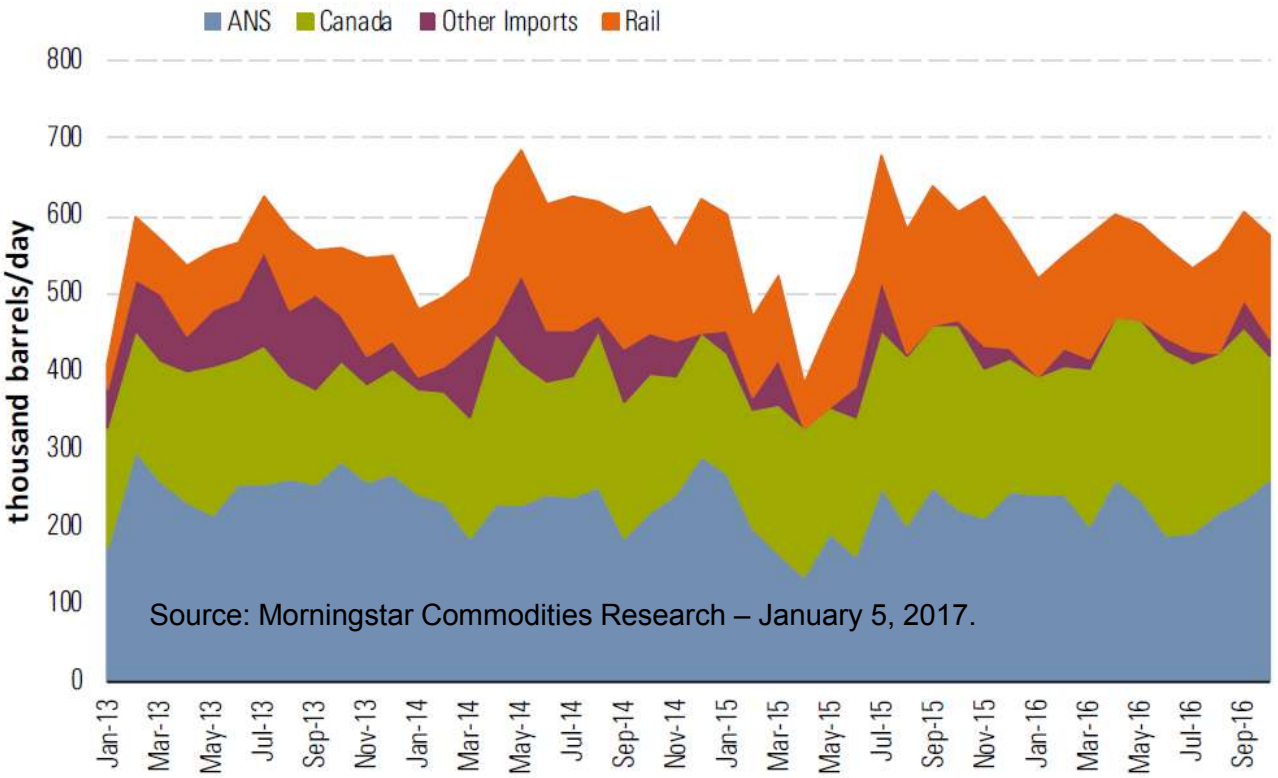
WA Crude Oil Imports Via Rail Tank Cars



Source: Washington Department of Ecology.

Washington refiners received approximately 25 percent of their oil via rail last year. Tesoro-Savage project, if approved and constructed, could be used to supply CA refiners with additional quantities of crude oil from Canada and domestic sources.

WA Crude Oil Imports Via Rail Tank Cars



Source: Pacific States-British Columbia Oil Spill Task Force 2017 Annual Report.

Balance of crude oil delivered to Washington refineries transported via pipelines and marine tankers primarily sourced from Alaska with declining waterborne movements from non-Canadian foreign sources.

California Crude-by-Rail

PROPOSED FACILITIES (all large) – Receipt Capability in Thousands of Barrels Per Day		
WesPac-Pittsburg	50	*Permit abandoned* late 2015
Valero-Benicia (SP)	70	*Permit denied* September 20, 2016
Phillips66-Santa Maria (SP)	37	*Permit denied* by the County Planning Commission March 17, 2017 Notice of Final County Action Delivered to Phillips 66
Alon-Bakersfield (APNC)	150	Permit issued September 9, 2014 – No construction initiated at this time

ALREADY OPERATIONAL FACILITIES		
SAV Patriot-Sacramento (PR)	10	Permit rescinded
KinderMorgan-Richmond	16	Permit rescinded
Kern Oil-Bakersfield	26	
Plains-Bakersfield	65	**Operational November 2014**
Tesoro-Carson	3	
Alon-Long Beach	10	
ExxonMobil-Vernon	3	

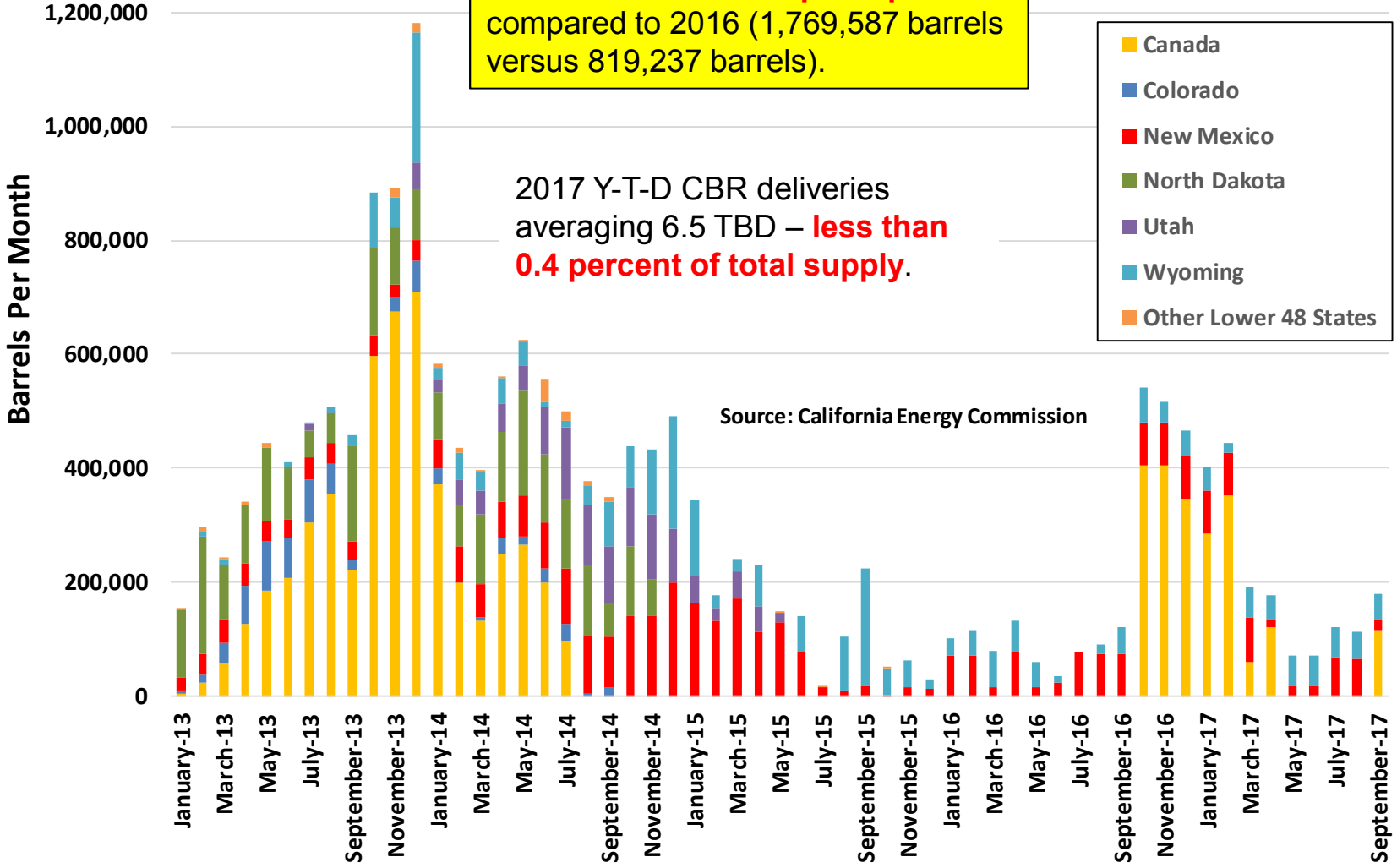
Current receipt capability	107,000 barrels per day (BPD)
Approved projects – not started construction (APNC)	150,000 BPD
Permit rescinded (PR)	26,000 BPD
Permit denied (PD)	107,000 BPD
No Longer Seeking Permit	50,000 BPD

2016 CBR volumes 2.345 million barrels or 6.4 thousand barrels per day, only 6.0 percent of capacity.

CA Crude Oil Imports Via Rail Tank Cars

Y-T-D CBR numbers **up 116 percent** compared to 2016 (1,769,587 barrels versus 819,237 barrels).

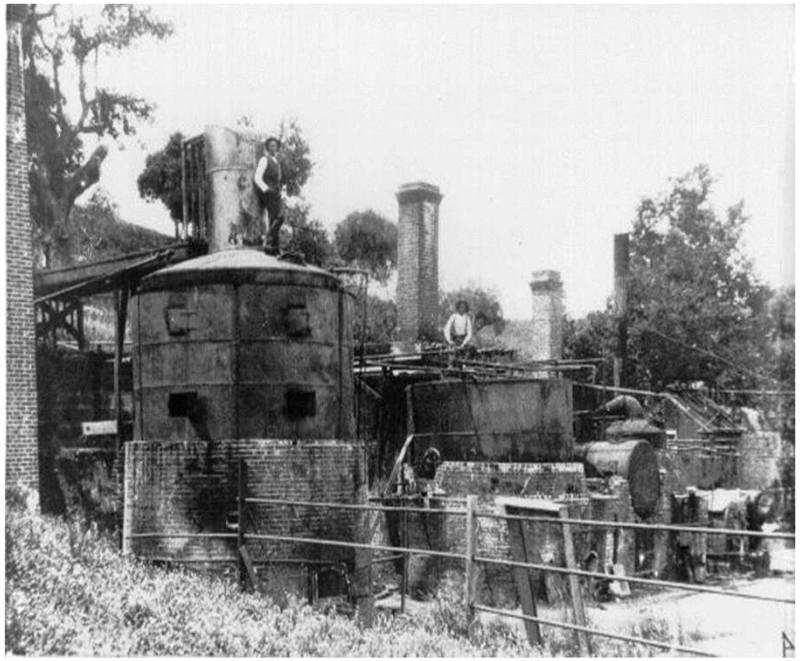
2017 Y-T-D CBR deliveries averaging 6.5 TBD – **less than 0.4 percent of total supply**.



California Refinery Operations

Refineries – Historical Changes

Pioneer Oil Refinery – Newhall - Circa 1877



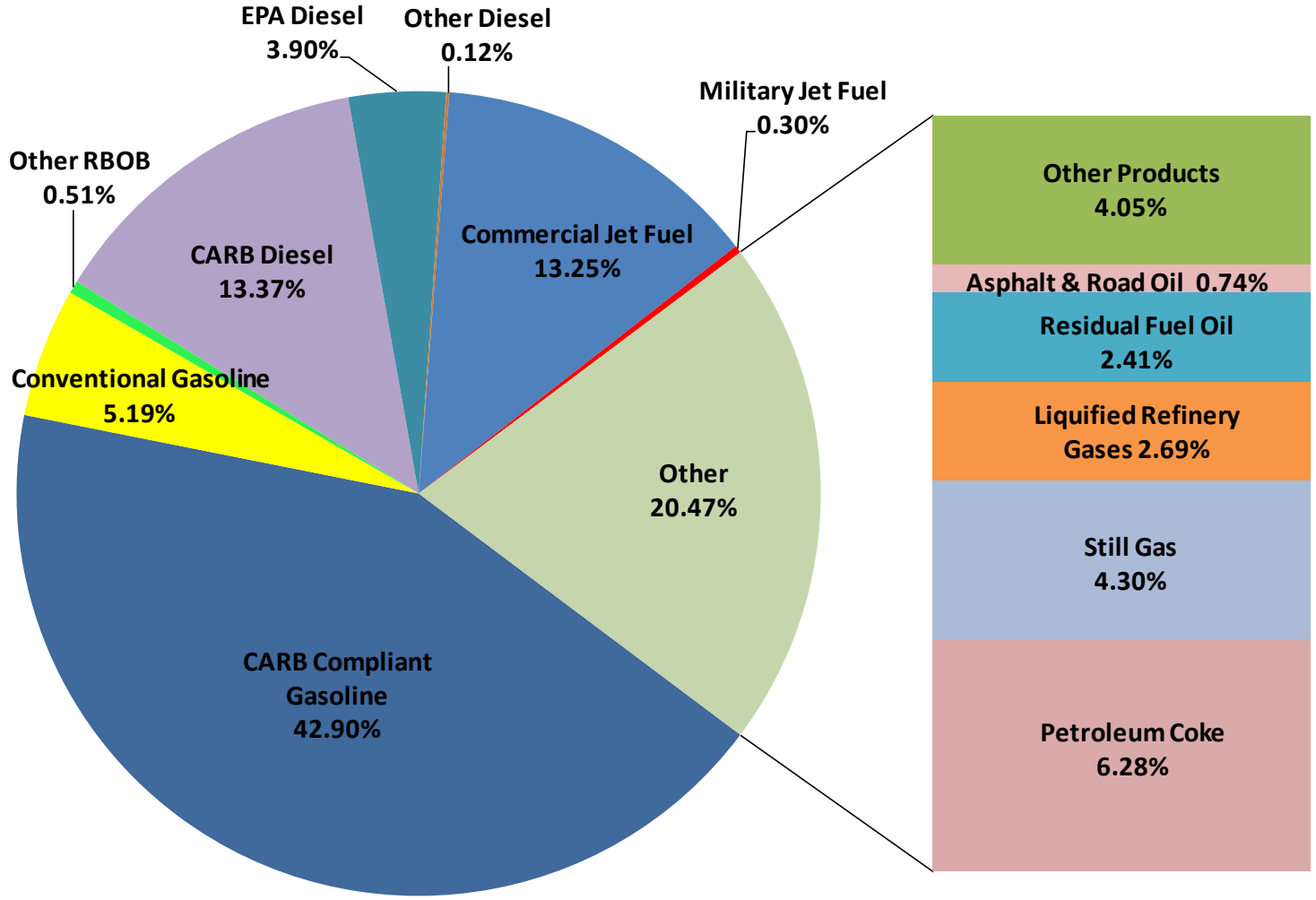
Source: SCV History.com

- Initial refining operations date to 1870s
- 1982 – 40 operating refineries
  - 2.565 MM barrels per day (b/d) capacity
    - 61.8 percent utilization rate
    - 956 thousand b/d gasoline
    - 241 thousand b/d distillates
    - 184 thousand b/d jet fuel
- 2016 – 15 operating refineries
  - 1.884 MM barrels per day (b/d) capacity
    - 85.6 percent utilization rate
    - 1,007 thousand b/d gasoline
    - 360 thousand b/d distillates
    - 281 thousand b/d jet fuel
- Increased complexity & higher utilization rates enable even greater fuel output with 62 percent fewer facilities

California Refineries - Overview

- Refineries are a primary hub of logistical activity
  - 15 refineries processed 1.644 million barrels per day of crude oil during 2016
  - 13 facilities produced California fuels
- Crude oil during 2016 received by
  - Marine vessels (foreign) – 901.5 TBD
  - Marine vessels (Alaska) – 185.4 TBD
  - California source via pipelines – 550.8 TBD
  - Rail/truck – 6.4 TBD
- Process units operate continuously at or near maximum capacity, except during periods of planned maintenance or unplanned outages

Product Slate of California Refineries (2016)

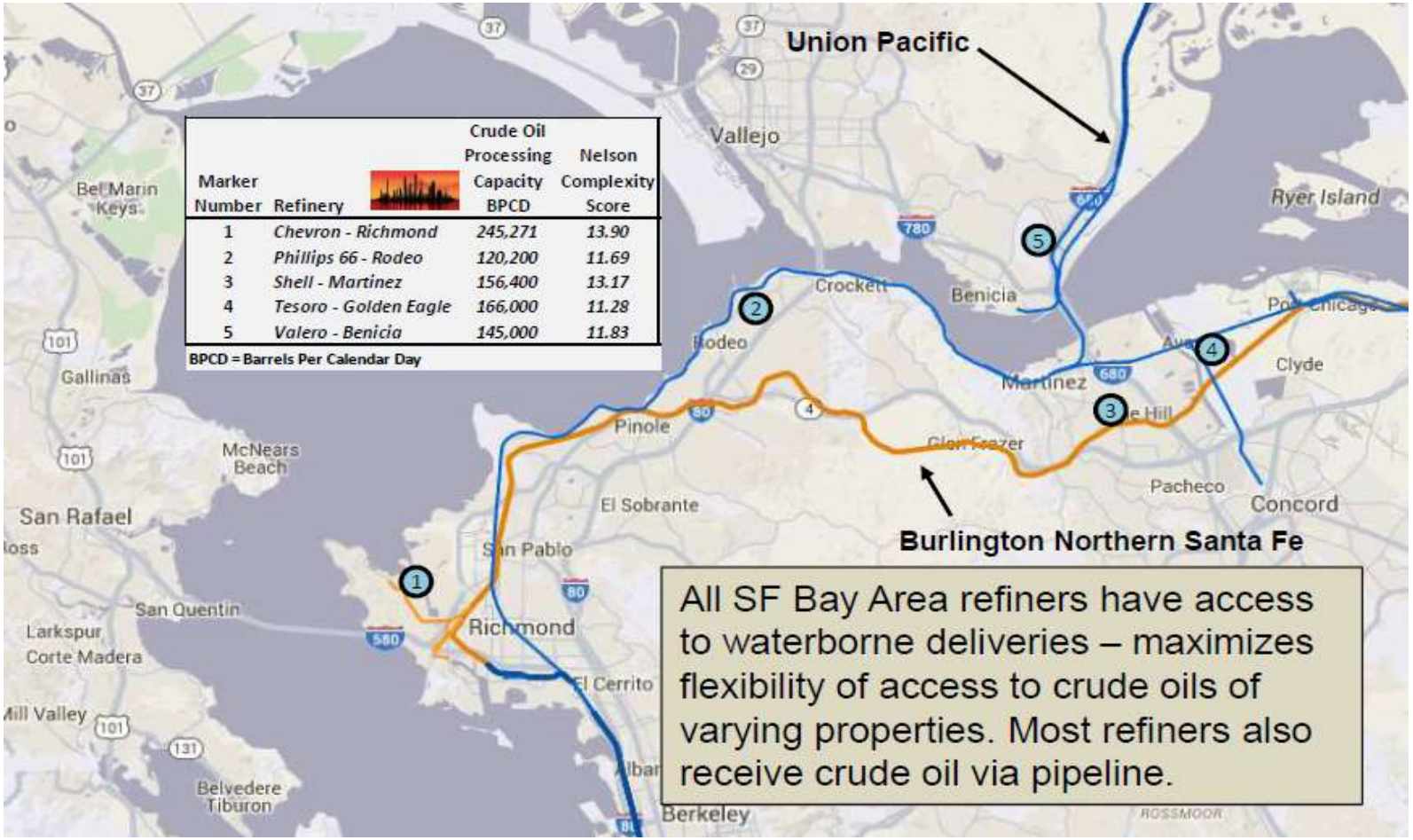


*Note: Does not include ethanol.

Source: California Energy Commission

Refinery Locations – Northern California

Processed 689.5 thousand barrels per day of crude oil during 2016.



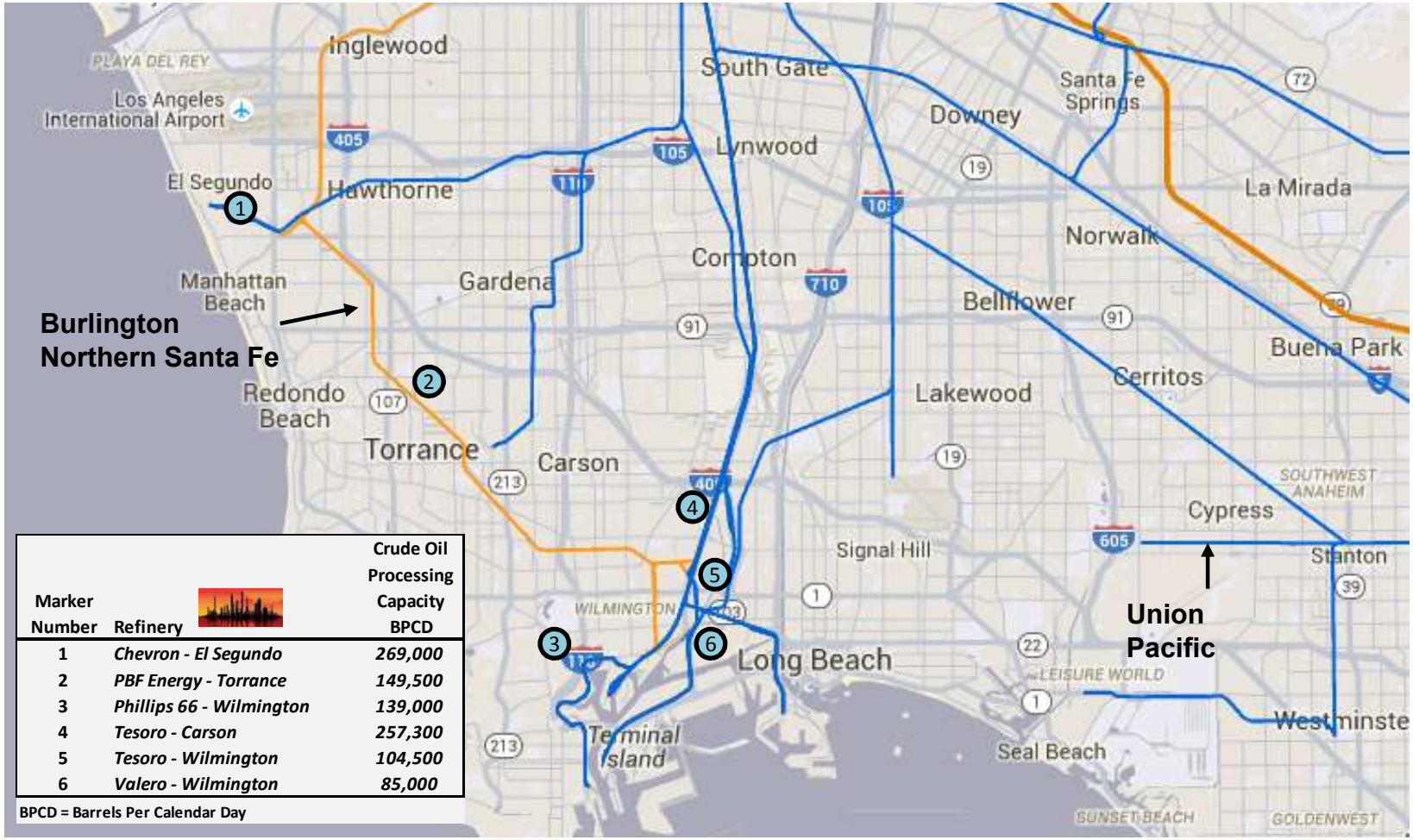
Marker Number	Refinery	Crude Oil Processing Capacity BPCD	Nelson Complexity Score
1	*Chevron - Richmond*	*245,271*	*13.90*
2	*Phillips 66 - Rodeo*	*120,200*	*11.69*
3	*Shell - Martinez*	*156,400*	*13.17*
4	*Tesoro - Golden Eagle*	*166,000*	*11.28*
5	*Valero - Benicia*	*145,000*	*11.83*

BPCD = Barrels Per Calendar Day

Sources: Oil Change International map, Energy Information Administration refinery data, and Energy Commission analysis

Refinery Locations – Southern California

Processed 954.7 thousand barrels per day of crude oil during 2016.

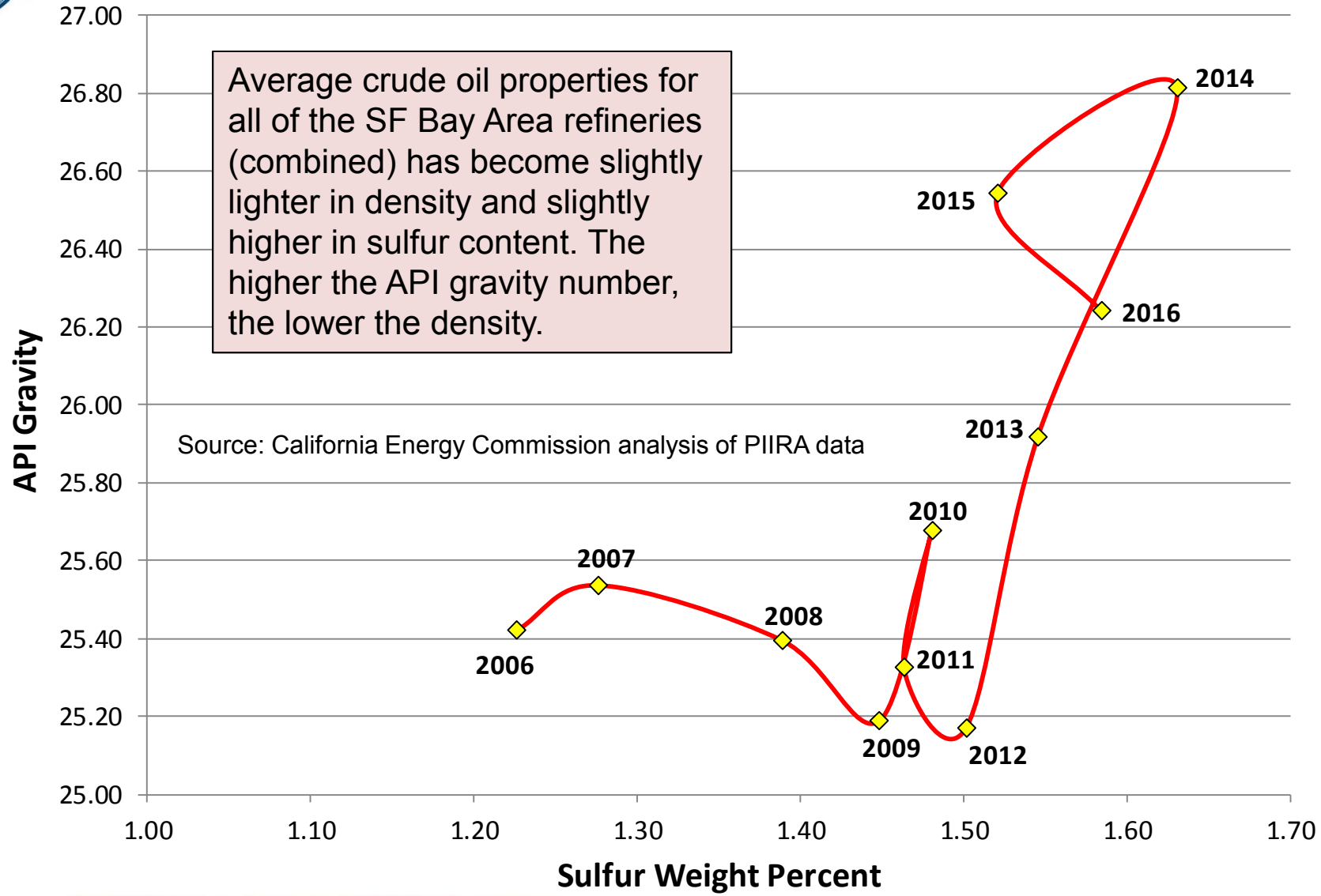


Marker Number	Refinery	Crude Oil Processing Capacity BPCD
1	*Chevron - El Segundo*	*269,000*
2	*PBF Energy - Torrance*	*149,500*
3	*Phillips 66 - Wilmington*	*139,000*
4	*Tesoro - Carson*	*257,300*
5	*Tesoro - Wilmington*	*104,500*
6	*Valero - Wilmington*	*85,000*

BPCD = Barrels Per Calendar Day

Sources: Oil Change International base map, Energy Information Administration refinery data and California Energy Commission analysis.

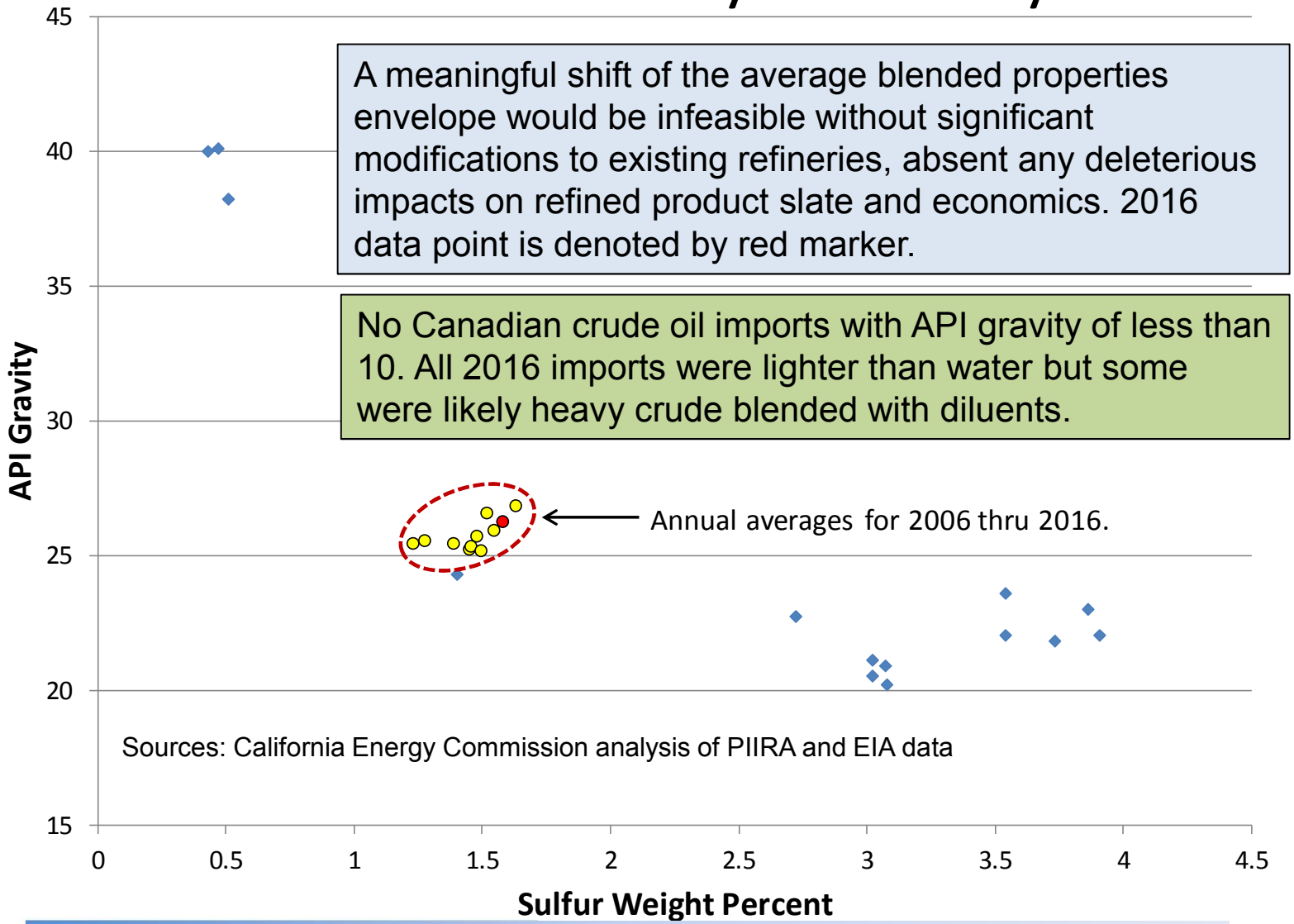
SF Bay Area Refineries – Crude Oil Properties



Refinery Operations - Crude Oil Blending

- As a general practice, refiners blend various types of crude oil together prior to processing in their facility for purposes of maintaining a steady overall quality of crude oil that helps to better control refinery operations and regulation the different ratios and types of transportation fuels produced from one month to the next
- Although the year-to-year variability of the average sulfur and density properties does shift, the degree of change is rather modest when the *scale is adjusted* to include properties of various types of Canadian crude oil processed in the SF Bay Area

Canadian Crude Oil Import Properties versus Annual Refinery Variability



Ability to Track Crude Oil Movements

CEC Data Collection

- California Energy Commission obtains confidential information from various industry stakeholders on a weekly, monthly, and annual basis
- Reporting is mandatory and involves variety of forms

Limited crude oil property data

Section of Industry	Forms collected under PIIRA
Marine and Pipeline Movements	W700 & M700 Import/Export and Movements
	Kinder Morgan Filings
Refining Operations	EIA800, W800 Weekly Refinery Report with California Addendum
	EIA810, M810 Monthly Refinery Report with California addendum
	M13 Refinery Monthly Fuel Use Report
	EIA820 Annual Refinery Report
	A04 Refinery Annual Report
Terminal Storage	W08,M08 Major Petroleum Product Storer and Terminal Report
	A08 Major Petroleum Products Storer Annual Tank Report
Trucking and Jobber Activities	W900, M900 Dealer Tank Wagon Price Report
	A06 Major Petroleum Product Transporter Annual Report
	M782B Monthly Sales Report
Retail Sales Volumes	A15 Retail Fuel Outlet Survey Annual Report

Crude Oil – Information Sources

- Monthly Energy Information Administration (EIA) Form 810
  - Only sulfur and API gravity (density) for *ALL* receipts for month
  - Due up to 45 days after the end of each month

PART 4. SULFUR CONTENT AND API GRAVITY OF CRUDE OIL (Report either 030 or 040 but not both)							
CRUDE OIL	Product Code	Weighted Average Sulfur Content			Weighted Average API Gravity (at 60° F)		
Receipts	030			%			° API
Input	040			%			° API

- EIA Company Level Foreign Imports
  - Crude oil imports by CA location – not always accurate
  - API gravity & sulfur content by each delivery
  - No crude oil "type" or name, just source country
  - Due up to 45 days after the end of each month

Crude Oil – Information Sources

Form Approved
OMB Number: 1905-0174
Expiration Date: 12/31/2012
Version No.: 20010.01

MONTHLY FOREIGN CRUDE OIL ACQUISITION REPORT
FORM EIA-856

Page ___ of ___

PART III. TRANSACTIONS

EIA ID NUMBER:

Report Period:
Date submitted:

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)
Trans-action Num-ber	Type of Trans-action	Country/ Crude Code	Crude Type	Gravity	Date of Loading (YYMMDD)	Port of Loading	Port of Desti-nation	Date of Landing (YYMM)	Vessel	Con-tract/Point Code	Volume Acquired (BBLs)	Acquisi-tion Price ($/BBLs)	Other Cost ($/BBL)	Landed Cost ($/BBL)	Days Credit	Name of Vendor

- EIA Monthly Foreign Crude Oil Acquisition Report (EIA-856)
  - Crude oil "type" from list of crude stream codes
  - Vessel name and discharge/load marine terminal
  - API gravity data included on form ***for each cargo***
  - Sulfur content from stream code list
  - Due within 30 days after the end of each month

Crude Oil – Information Sources

- CEC Monthly Import/Export Form 700
  - Crude oil imports by source, foreign and domestic, marine and rail
  - Vessel name and discharge/load marine terminal
  - *API gravity & sulfur content not included*
  - No crude oil "type" or name
  - Due up to 45 days after the end of each month
- PIERS Proprietary Monthly Import/Export Data
  - Crude oil imports by *foreign* source, no domestic movements
  - Vessel name and discharge/load marine terminal
  - *API gravity & sulfur content not included*
  - No crude oil "type" or name
  - Due up to 45 days after the end of each month

Crude Oil – Information Sources

- California State Lands Commission
  - Petroleum products & renewable fuels
  - Vessel name and discharge/load marine terminal
  - *API gravity & sulfur content not included for crude oil*
  - No crude oil "type" or name
  - No point of origin data
  - Includes both foreign and domestic movements
- Class 1 railroad monthly reports to CEC
  - Petroleum products & renewable fuels
  - Loading state or province & California delivery location
  - *API gravity & sulfur content not included for crude oil*
  - Volume provided by individual rail tank car – *but not weight of cargo*

CARB Annual Reporting

Crude Oil Marketing Name	Type of Crude Oil	Oil Sands Sourced	Mined	CI	2015 Barrels	2016 Barrels
Access Western Blend	Production is generated by SAGD thermal methods. Blended with condensate.	Yes	No	16.31	247,794	167,231
Albian Heavy Synthetic (all grades)	Partially upgraded dilbit produced from the Scotford Upgrader.	Yes	Yes	19.90	1,463,238	1,382,106
Boundary Lake	Light sour conventional crude.	No	No	8.27	102,760	
Burnaby Blend	Blend of conventional and synthetic crudes.	Partial	Partial	11.98	154,030	342,430
Canadian Conventional Heavy	Blend of conventionally produced heavy crudes.	No	No	9.27	269,969	8,028
Christina Dilbit Blend	Diluted bitumen produced at Christina Lake SAGD facility.	Mostly	No	13.34		71,874
Christina Synbit	Synthetic crude.	Yes	Yes	17.43		61,151
Cold Lake	Production is bitumen based and requires the use of steam.	Yes	No	18.40	3,605,136	3,205,705
Kearl Lake	Bitumen is mined by shovel and truck and then undergoes onsite paraffinic froth treatment.	Yes	Yes	12.05	308,662	1,235,972
Koch Alberta	Light sour conventional crude.	No	No	8.27		63,119
Mixed Sweet	Conventionally produced light sweet crude.	No	No	8.27	1,707,626	320,359
Peace River Sour	Conventionally produced light sour stream.	No	No	8.27		63,807
Shell Synthetic (all grades)	Light sweet synthetic crude produced from Shell Canada's Scotford complex.	Yes	Yes	21.39	199,994	
Suncor Synthetic (all grades)	Synthetic crude produced from the Suncor Canada Project.	Yes	Yes	23.71	2,286,703	557,872
Surmont Heavy Blend	Heavy sour synbit composed of SAGD production and domestic synthetic crude.	Yes	Partial	18.26	792,787	895,151
Wabasca	Blend of heavy oil production obtained by polymer injection and water flooding.	No	No	6.79	269,509	
Western Canadian Select	Blend of conventional and oilsands production.	Mostly	Partial	18.43	29,942	
Canadian Crude Oil - Total Volume					11,438,150	8,374,805
All Crude Oils - Total Volumes					605,749,048	582,101,235
Canadian Crude - Share of Total (Percent)					1.89%	1.44%
Canadian Volume Sourced from Oil Sands (Whole or Part)					9,088,286	7,919,492
Canadian Portion Sourced from Oil Sands (Whole or Part)					79.46%	94.56%
Oil Sands Portion of Total Crude Oil					1.50%	1.36%
Canadian Average Carbon Intensity (CI)					17.30	17.44
Total Average for All Crude Oils (CI)					12.06	12.14

Majority of oil imported from Canada was sourced from oil sands formations, transported via marine vessel. Not broken out by receiving facility. Data does not include density of crude oil.

Sources: California Energy Commission analysis of California Air Resources Board (CARB) crude oil carbon intensity data.

No Advanced Reporting

- California Energy Commission does not receive communications of future crude oil deliveries via marine vessel or rail tank car
- USCG Electronic Notice of Arrival or E-NOA
  - 96-hour advance arrival submittal
  - Only requires a simple description for General Cargo
    - Insufficient to identify crude oil cargo that consists of heavy or extra heavy crude oil
  - Should specific types of crude oils be characterized as Certain Dangerous Cargos and require more detailed descriptions?

Additional Q & A

Northern Pintail (male), Colusa NWR, Colusa County, CA 12-27-2016.