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Energy Security and Data Analysis Workshop
December 2-3, 2019
Washington D.C.

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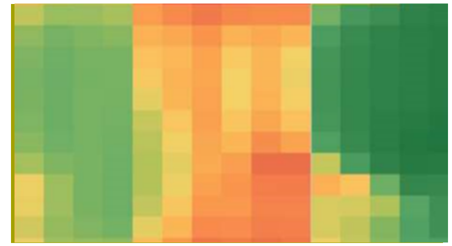


NASEO National Association of State Energy Officials

NARUC National Association of Regulatory Utility Commissioners

Qualitative & Quantitative Foundations of Energy Emergency Management

Jeffrey R. Pillon, Director of Energy Assurance
National Association of State Energy Officials

Workshop Topics

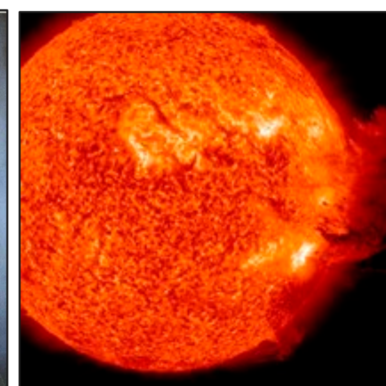
- Qualitative and Quantitative Foundations of Energy Emergency Management
- Communicating Energy Data Analysis for Informed Decision-Making
- Energy Assurance and Resilience: A Cross-Functional View
- Federal Resources to Support States' Energy Data and Risk Analysis
- DOE CESER/HAMMER ESF-12 Training Demonstration
- Transforming Raw Data into Actionable Data
- State-Led Training and Exercise Best Practices
- Protecting Critical Infrastructure Information from public disclosure

+ *Energy Assurance -- Preparedness and Resiliency*

- **Mitigate Risks** through policies, programs and investments that provide for a more secure and resilient energy infrastructure that also reduces interdependencies impacts

- **Plan and Respond** to events that disrupt energy supply and assure a rapid return to normal conditions. This is a coordinated effort involving the private energy sector's response, augmented by local, state, and federal governments as needed



+ *Qualitative vs. Quantitative*

- **Qualitative --** relating to, or involving peculiar and essential character
  - Example: I am hearing from a lot of energy suppliers that they are having supply problems.
- **Quantitative --** relating to, or involving the measurement of quantity or amount
  - Example: 75 percent of the 50 energy suppliers in our weekly survey are limiting deliveries

Note: both perspectives have value, but quantitative is of greater importance to most decision makers.

Qualitative and Quantitative Data Analysis Understanding what's going on

- How do you develop a big picture view from all the various sources of data and information to make informed decisions

- Consider three perspective's
  1. What is the data telling you (quantitative)
  2. What are the energy suppliers telling you (qualitative)
  3. Trade publications, mass media, social media (quantitative and qualitative)

- Where to the conclusions concur and diverge? How to you reconcile the divergent information?

- How is the information actionable?

Types of Analysis

- **Comparative and Predictive Statistics** e.g. how do market indicators like inventories, productions, prices, etc. from last year compare to today or an average of recent years, or with conditions in other states and regions. The use of introspection of the data using graphs and short term forecast can be very helpful in the analysis.

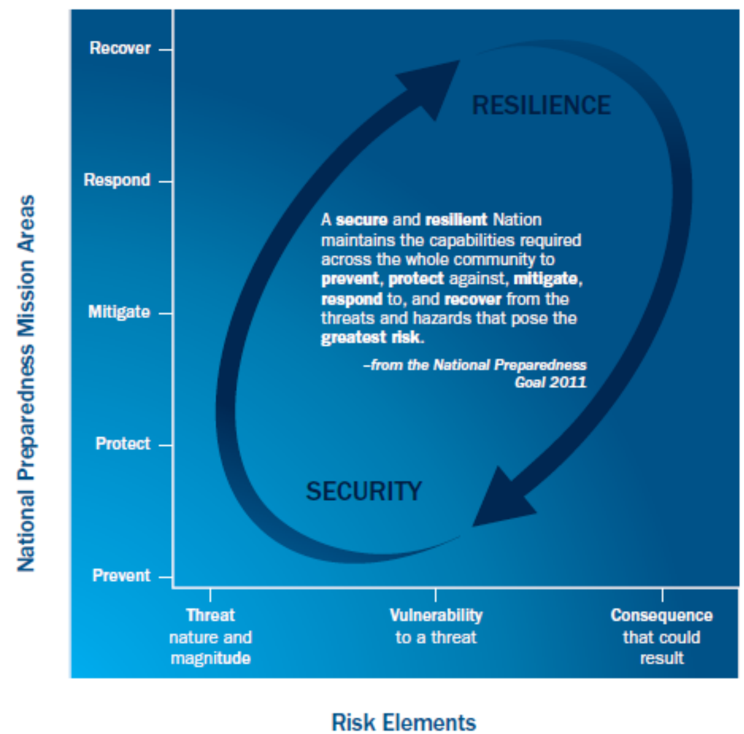
- **Time Series Statistical Analysis** looks at trends and relationships with other explanatory variables. How are various times series correlated? For example, how much residential natural gas is used by heating degree day which can be determined by using single of multiple regression analysis to see how two or more variables are related and the strength of the relationship.

- **Econometric Modeling** overlaps with statistical analysis to a considerable degree however the focused is more in economic data. For example adjusting a price times series in to real constant dollars which removes the effects of inflation and allows for prices to be compared over times in a more consistent ways. Models can be more complex and consider the dynamic relationships and how various economic activity measure's change in relationship with one another

Risk – The potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences.

- <u>Consequences:</u> If something happens, what are the <u>human and economic impacts</u> to society?
  - Must also consider how economic impacts will affect interdependent infrastructures and behavior of impacted populations
- <u>Threats/Hazards:</u> What can happen? What is the frequency/probability?
- <u>Vulnerabilities:</u> Are there weak links in the energy supply chain and infrastructure? Are components antiquated/old and failure prone? Are there infrastructure co-locations or bottlenecks? Why is it critical?
  - Includes consideration of energy infrastructure attributes and interdependencies

Figure 4 – Critical Infrastructure Risk in the Context of National Preparedness



Source: NIPP 2013Partnering for Critical Infrastructure Security and Resilience

+ *Risk Assessment*

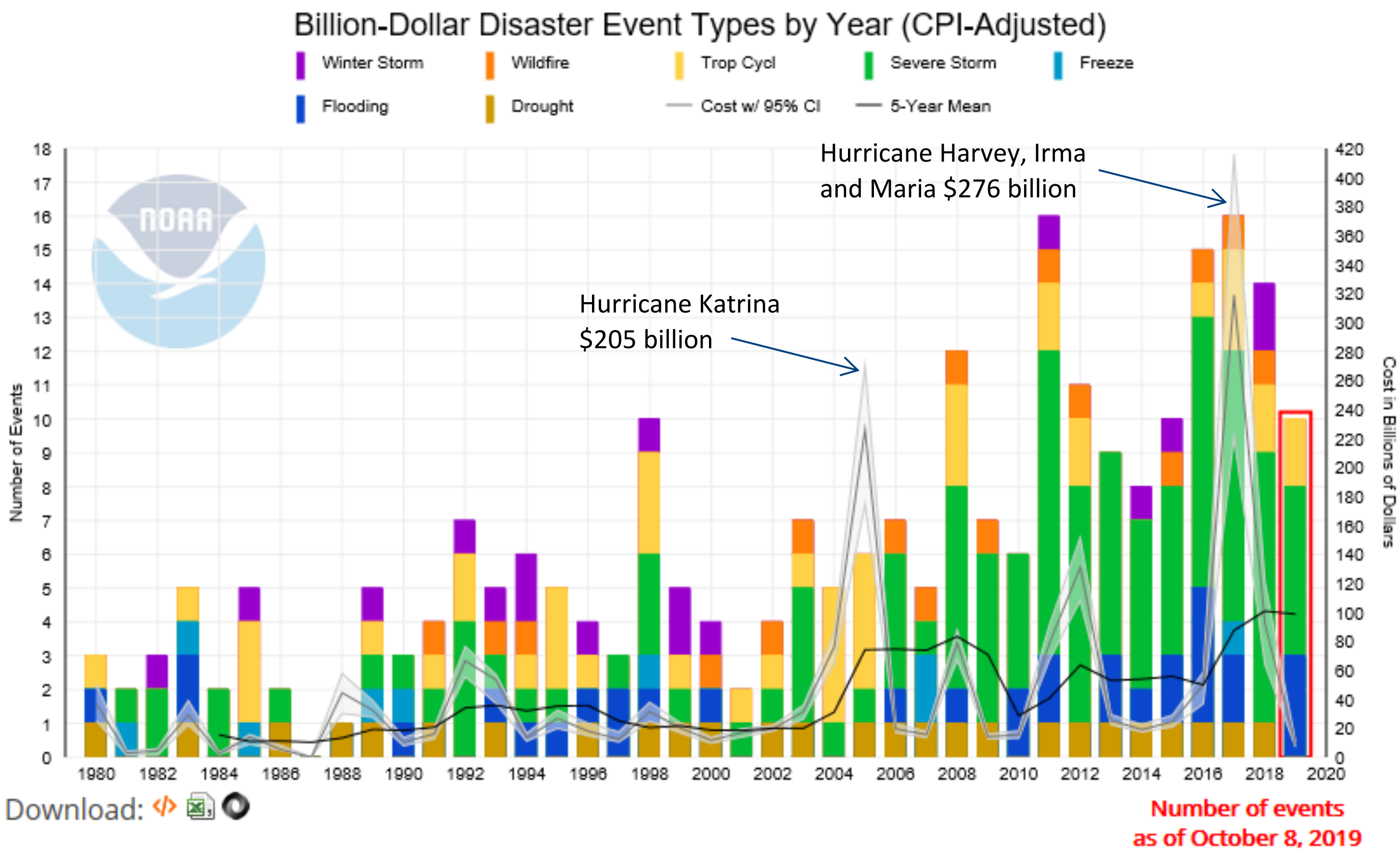
Risk is a function of

[Consequence x Threat x Vulnerability]

$15 million　　Rifle Attack　　Visible Line of Site

The April 16, 2013, assault on the Pacific Gas and Electric Company's Metcalf substation near San Jose, California damaged 17 transformers, caused $15 million in damage, and put the facility out of service for nearly a month.

In the last five years weather and climate disasters have costing a total of $513 billion & 3,910 deaths



Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2019). https://www.ncdc.noaa.gov/billions/

The Enbridge Pipeline – A Case Study

The Michigan Pipeline Safety Advisory Board, oversaw extensive studies on a single critical energy infrastructure the 65 year old Enbridge pipeline (Line 5) which moves 23 million gallons per day of light crude oil and natural gas liquids through Michigan.

- Two studies were done at a total costs of $3.6 million paid for by Enbridge and conducted under the direction of the State of Michigan to provide a cost benefit analysis.
  - An Alternative Analysis was which looked the cost and feasibility of a range of alternatives to replace the dual pipeline line crossing the bottom of the Straits of Mackinaw.
  - An Independent Risk Analysis that looked at the economic, environmental and human consequences of a worst case scenario from a pipeline rupture.

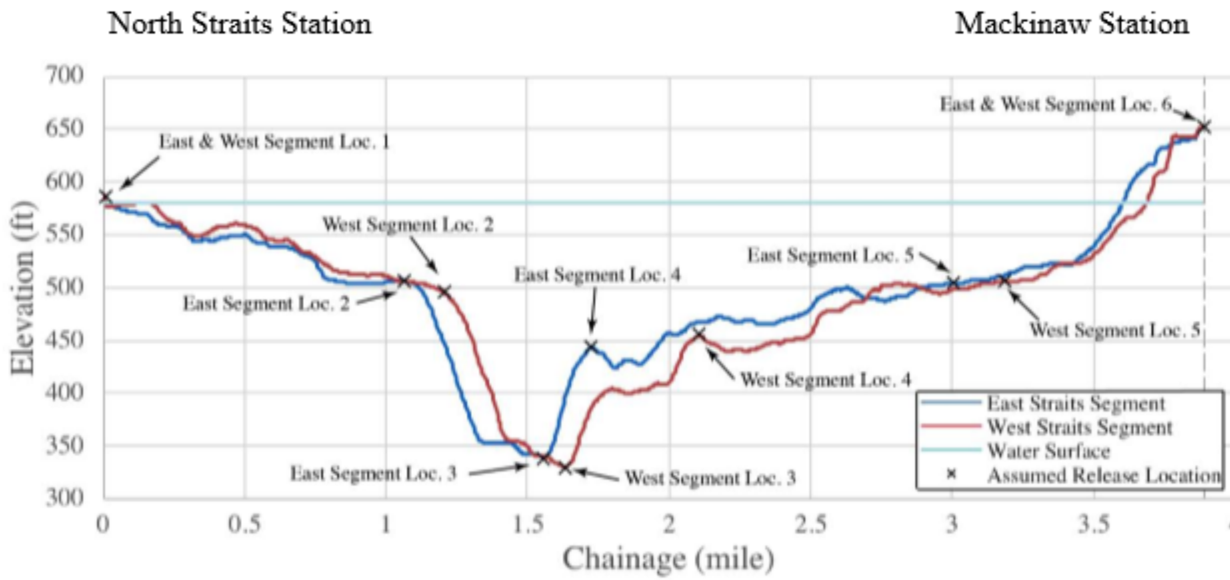
Alternative Analysis

A consultant analyzed the alternatives to Line 5. The Final Report includes an analysis of the alternatives that the state identified to transport the same amount of product that moved through the existing Straits pipelines. The cost of shutting down the existing pipeline was also included in the analysis. Lead timed for completion were also estimated.

Alternatives Assessed	Construction Cost in Millions	Operating Cost Million $ per year
Existing pipeline	N/A	$95
New Pipeline	$2,025	$586
Rail Transportation	$908	$1,220
New Trenched Crossing	$27	$95
New Tunnel Crossing	$153*	$95

**A subsequent Enbridge report to the State of Michigan titled "Alternatives for replacing Enbridge's dual Line 5 pipelines crossing the Straits of Mackinac" June 2018 concluded the tunnel crossing would cost between $300 and $500 million and take 5 to 6 years to complete based on additional geological data.*

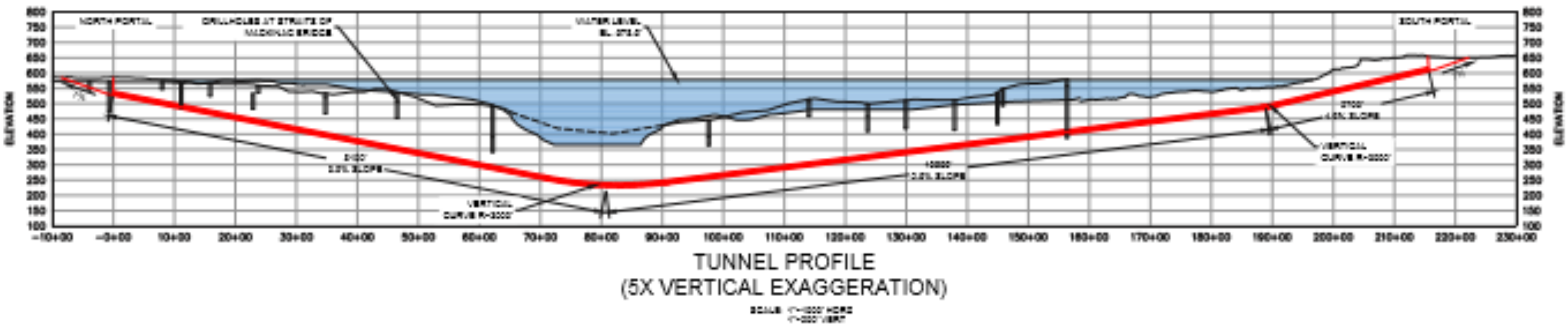
+ Risk Analysis



- Based on this, six critical locations, shown above the analysis looked at the impact of each including both pinhole leak and full-bore rupture failure modes.
- The "worst-case scenario" was the release of 58,000 barrels (2.4 million gallons) of oil from a double rupture which would cause at least $1.9 billion in costs for environmental cleanup, property loss, lost income from tourism and recreation, and other damages and impact more than 400 miles of shoreline in Michigan, Wisconsin, and Canada.

Cost Benefit Summary

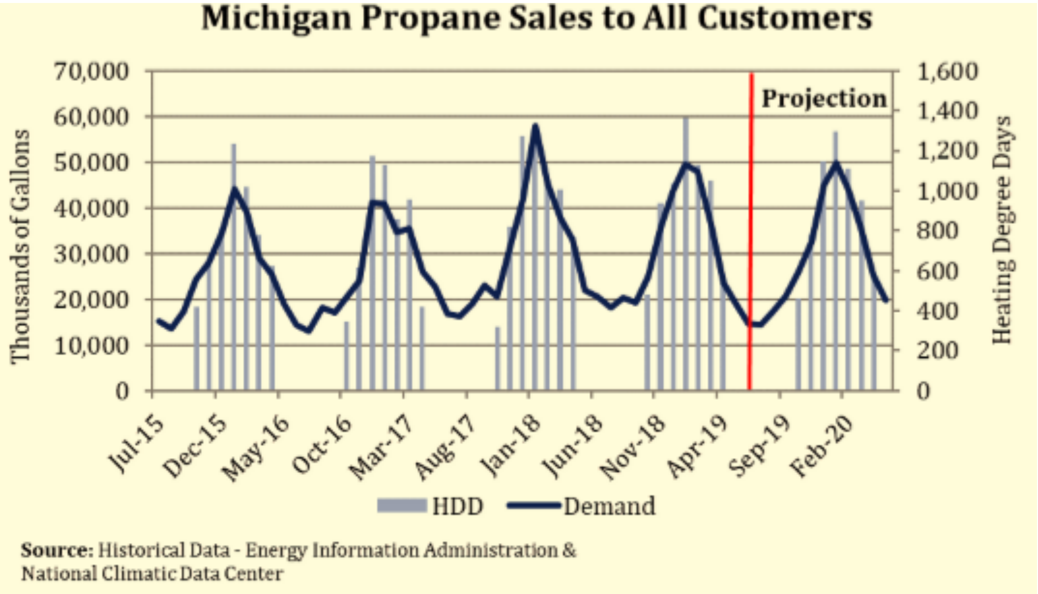
- The cost to construct the pipeline tunnel is currently estimated to be between $350 and $500 million which would reducing the environmental od a risk of a spill into the great lakes to near zero vs. the $1.9 billion plus risk estimate.
- Will improve reliability create jobs, and minizine the risk of a fuel shortage.
- Enbridge will pay for the cost of constructing and operation of the tunnel which will be owned by the state upon completion.
- For more information and copies of the studies go to https://mipetroleumpipelines.com/



+ Forecasting

- Short-term time series forecast Like the EIA Short-Term Energy Outlook can be useful due to the lag in the reporting of actual data. For example, forecasting residential propane demand under normal weather conditions and a plus and minus 10% range can provide baseline and boundaries for actual observed conditions.

- The Michigan Energy Appraisal used a statistical method called Auto-Regressive Integrated Moving Average (ARIMA) which is an econometric forecasting tool which uses a maximum likelihood estimation and not ordinary least squares used in regression analysis.



Use of Graphs and Other Means to Visually Display Quantitative Data

- Types of Displays
  - Time series graphs
  - Mapping (GIS)
  - Comparative graphs
  - Showing relationships
  - Process flow charts
  - Dashboards
  - Pictures
  - Short videos

- Some Do's & Don't
  - Don't use legends use direct labels
  - List the sources used or the URL reference(s)
  - Include the date (mm/yy)
  - Make sure it tells the story
  - Don't use decimal places when displaying numbers unless they are significant

Crude Oil Prices react to a variety of geopolitical and economic events

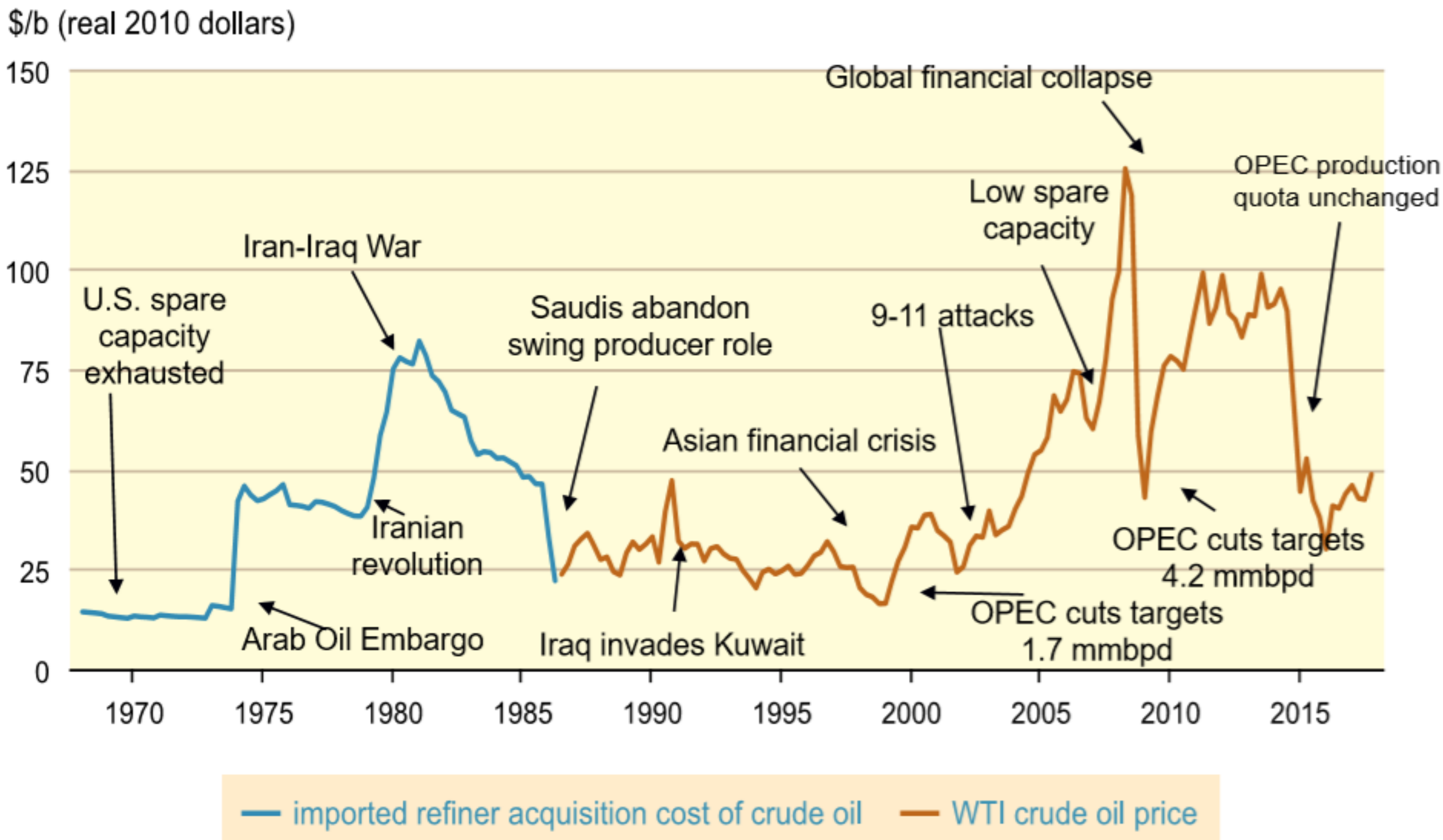
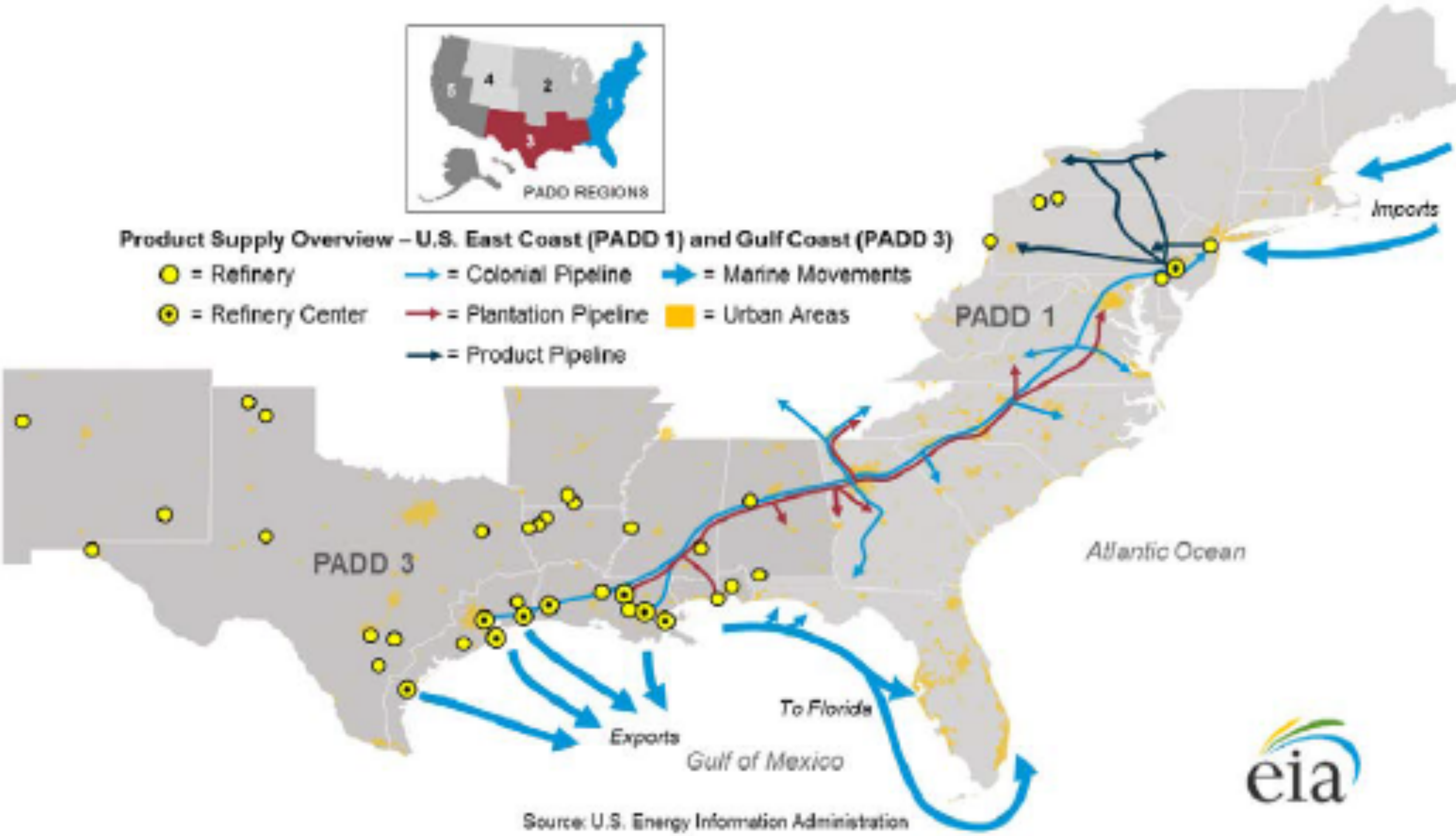


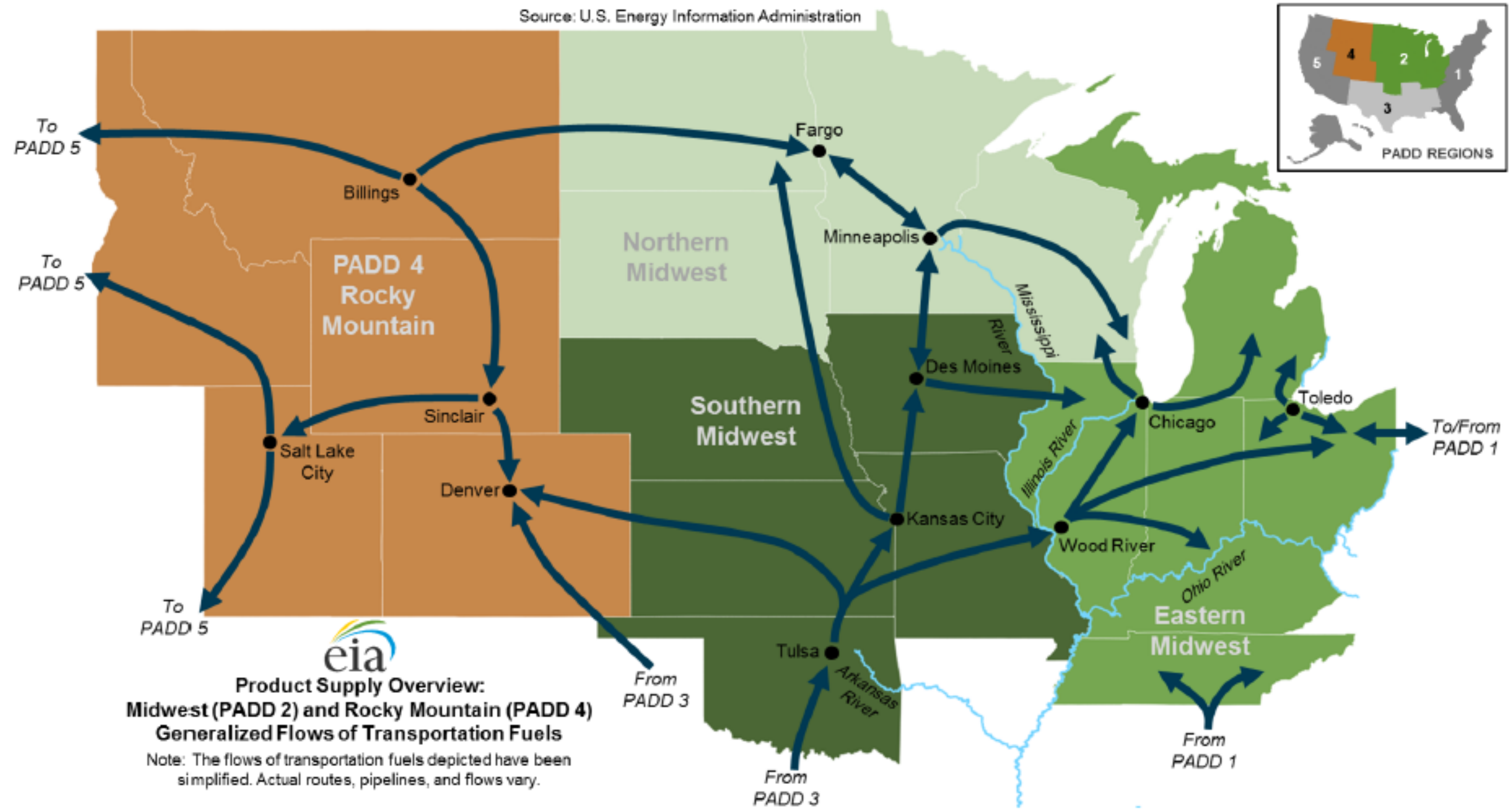
Figure 6. East Coast and Gulf Coast refineries and key product flows



https://www.eia.gov/analysis/transportationfuels/padd1n3/pdf/transportation_fuels_padd1n3.pdf

Figure 6. Generalized Midwest and Rocky Mountain key refinery hubs and product flows

Source: U.S. Energy Information Administration



https://www.eia.gov/analysis/transportationfuels/padd2n4/pdf/transportation_fuels.pdf page 4

FIGURE 1. US OIL AND GAS EMPLOYMENT AND OIL PRICES

Figure 1: US oil and gas employment and oil prices

Sources: US Bureau of Labor Statistics; includes NAICS codes 211 and 213. US EIA for WTI (spot) price.

https://energypolicy.columbia.edu/research/report/economic-volatility-oil-producing-regions-impacts-and-federal-policy-options

NEW ENGLAND DASHBOARD

Last daily update: November 14, 2019 10:00 AM | Next daily update: November 15, 2019 10:00 AM (unless otherwise noted) | Commentary last updated: August 2, 2019 |

ARCHIVED REPORTS

11/14/19 Capacity status, megawatts (MW)

20,315 MW
Today's capacity

17,350 MW
Today's forecasted peak demand
hour ending 6:00 p.m.

17,409 MW
Yesterday's peak demand
hour ending 6:00 PM

7,236 MW
Generation outages / reductions

100 %
Regional nuclear utilization

Normal
Current grid status
as of 11/14/19, 10:29 a.m.

15,990 MW
Current demand
11/14/19,
hour ending 8:00 a.m.

28,130 MW
Historic winter peak demand
8/2/06

-3,356 MW
Today's peak hour interchange
(-) imports / (+) exports
11/14/19, hour ending 6:00 PM

3.68 Bcf/d
Net natural gas inflows

1.69 $/MMBtu
Algonquin Citygate Basis to Henry Hub

Spark spread
($/megawatthour)

Current	Previous
19.00	14.59
11/14/19	11/13/19

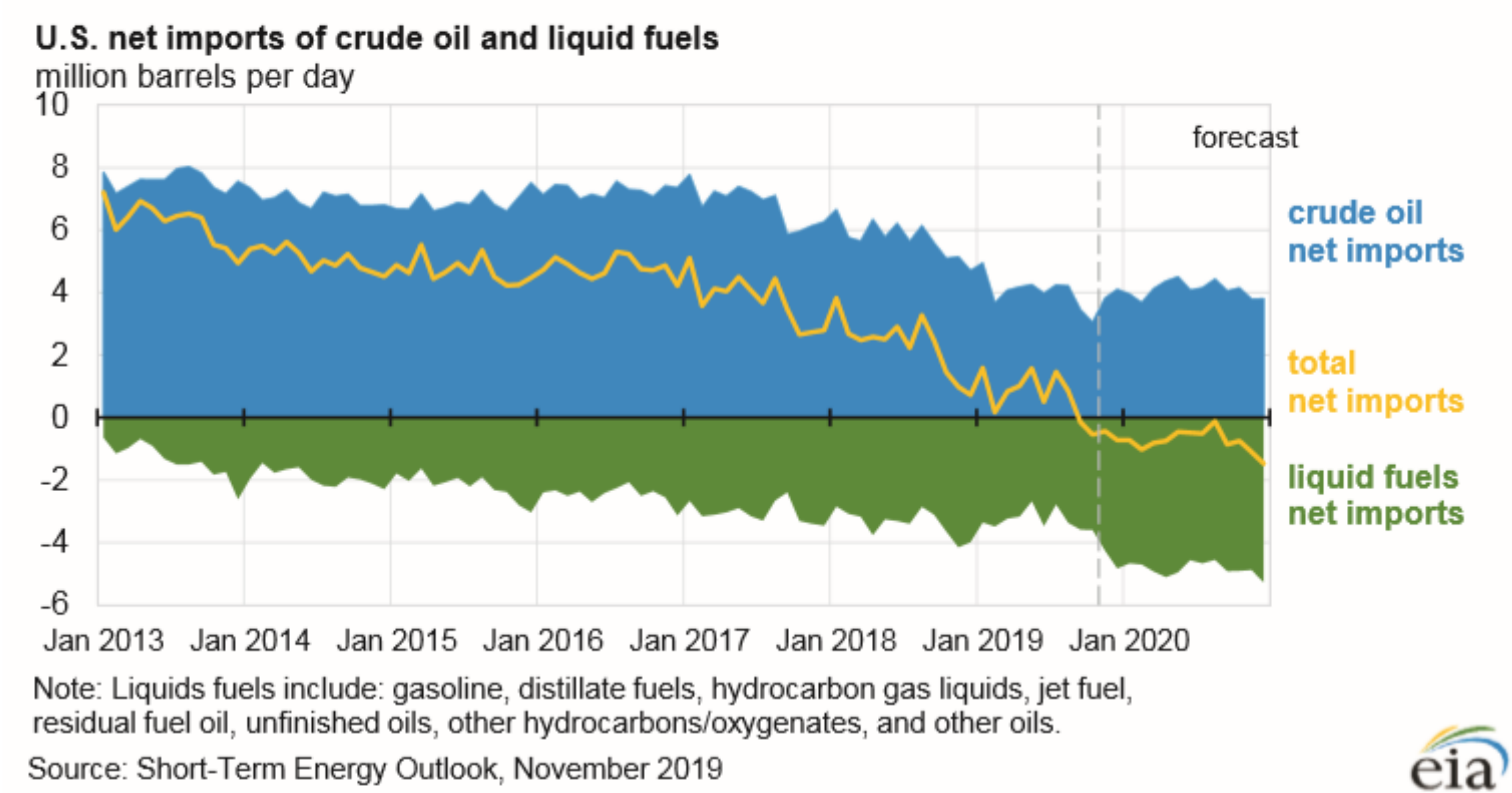
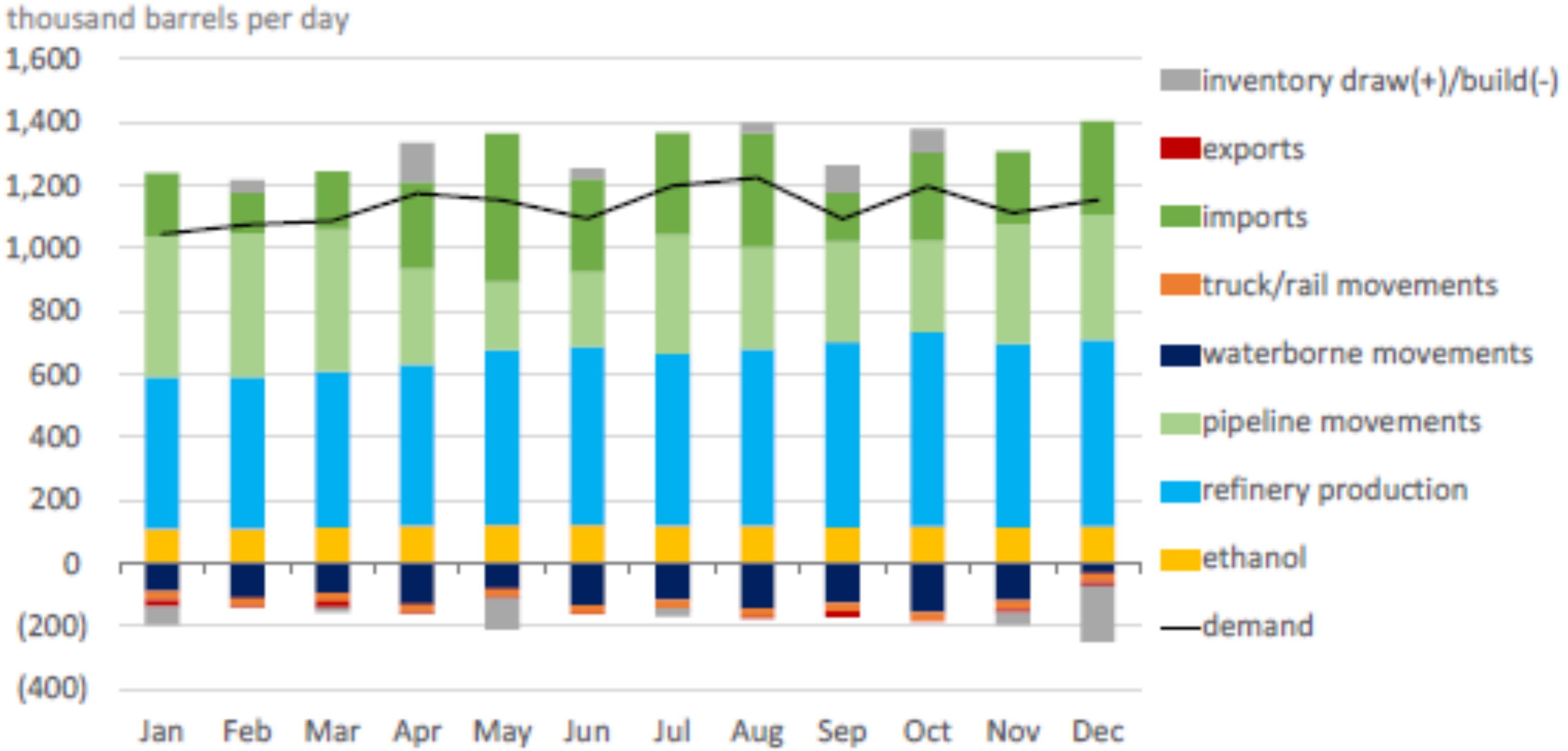

U.S. net imports of crude oil and liquid fuels
million barrels per day
10
8
6
4
2
0
-2
-4
-6
Jan 2013
Jan 2014
Jan 2015
Jan 2016
Jan 2017
Jan 2018
Jan 2019
Jan 2020
forecast
crude oil net imports
total net imports
liquid fuels net imports
Note: Liquids fuels include: gasoline, distillate fuels, hydrocarbon gas liquids, jet fuel, residual fuel oil, unfinished oils, other hydrocarbons/oxygenates, and other oils.
Source: Short-Term Energy Outlook, November 2019

Figure 3.20 **Infrastructure Interdependencies**

	Element	Electrical Power	Natural Gas	Oil Industry	Water Purification	Sewage Treatment	Hospital & Health Care Services	Food Industry	Postal and Courier Services	Meteorological Services	Financial Services	Rail Services	Trucking	Municipal Transit Systems	Roads Infrastructure	Hazardous Materials	Public Works	Police Services	Fire Services	Ambulance Services	911 Services	Warning Sirens	Flood Control	Search and Rescue	Office Building Systems	Shelters	Telecommunications	Television Industry	Radio Industry	Other Critical Facilities
Energy & Utilities	Electrical Power			M	L				L	L	M	L	L		M	M		L	L	L	L				L		H			
	Natural Gas	L		L					L	L	M		L		L	L		L	L	L	L				L		M			
	Oil Industry	H			L				L	L	M	L	H		M	L		L	L	L	L				L		M			
	Water Purification	H		M					L				M		L	L		L	L	L	L				L		M			
	Sewage Treatment	M		H	H					L			L		L	L		L	L	L	L				L		M			
Services	Hospital & Health Care Services	H	H	H	H	L		H	M				M		M	M		L	M	M	L	L			H		H	L	L	
	Food Industry	H	L	M	H	H	L		L	L	L	H	H		H	L		L	L						H		H			
	Postal and Courier Services	H	L	H	L					L	M	L	H	L	H			L	L						H		H			
	Meteorological Services	L	M	L	L				L						L				L		L		L		M		H	L	M	
	Financial Services	H	M	M	M	L	L		M									M	L		L				H		H			
Transportation	Rail Services	M	L	H	M	M	M	M	L	L	L		H	L	L	M		L	L	L	L		L		M		M			
	Trucking	M	L	H	L	L	M	M	M	L		M			H	M		L	L	L					M		H			
	Municipal Transit System	M	L	H	L	L				L			L		H			L	L	L					M		M			
	Roads Infrastructure	M	L	H	L	L				M			M			M		M	L	L			L		L		M	L	L	
	Traffic Control	H																												
Safety	Hazardous Materials	M	M	M	M		L		L	M		M	M		M			L	M		L		L		L		M		M	
	Public Works	H	M	M	L	L						L	M		H	M							M				M			
	Police Services	H	M	H	L	L	L		L	M					H				H	M	M			M	H		H	L	L	
	Fire Services	M	M	H	H	L	L			L					H	M		M		M	M				M		H			
	Ambulance Services	M	M	H		L	H		L	L					H			M	M		M			L	L		H			
	911 Services	H	M	M		L																			M		H			
	Warning Sirens	H																L	L								H	M	M	
	Flood Control	M	L							M						L									L		H			
	Search and Rescue	L	L	H	L	L	M			M					L			L		L			L		L		M	L	L	
	Office Building Systems	H	M	M	H	M			L						L												M			

improve reliability

Figure 16. Central Atlantic motor gasoline supply/demand balance, 2014

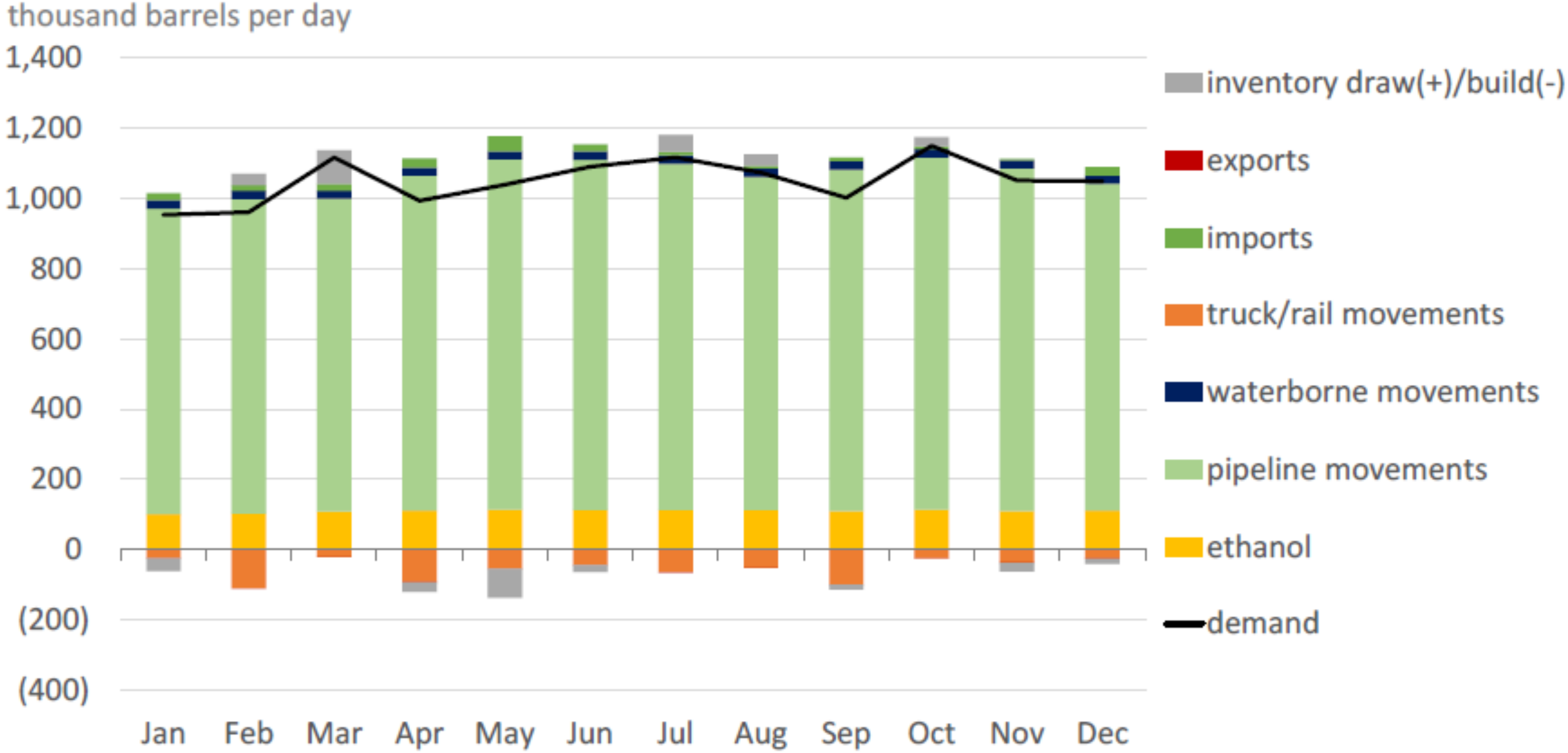


Note: All domestic movements and inventory changes are reported on a net basis.

Source: ICF Analysis of EIA, FHWA, FERC, and company 10-K data

https://www.eia.gov/analysis/transportationfuels/padd1n3/pdf/transportation_fuels_padd1n3.pdf page 39

Figure 25. Southeast motor gasoline supply/demand balance, 2014

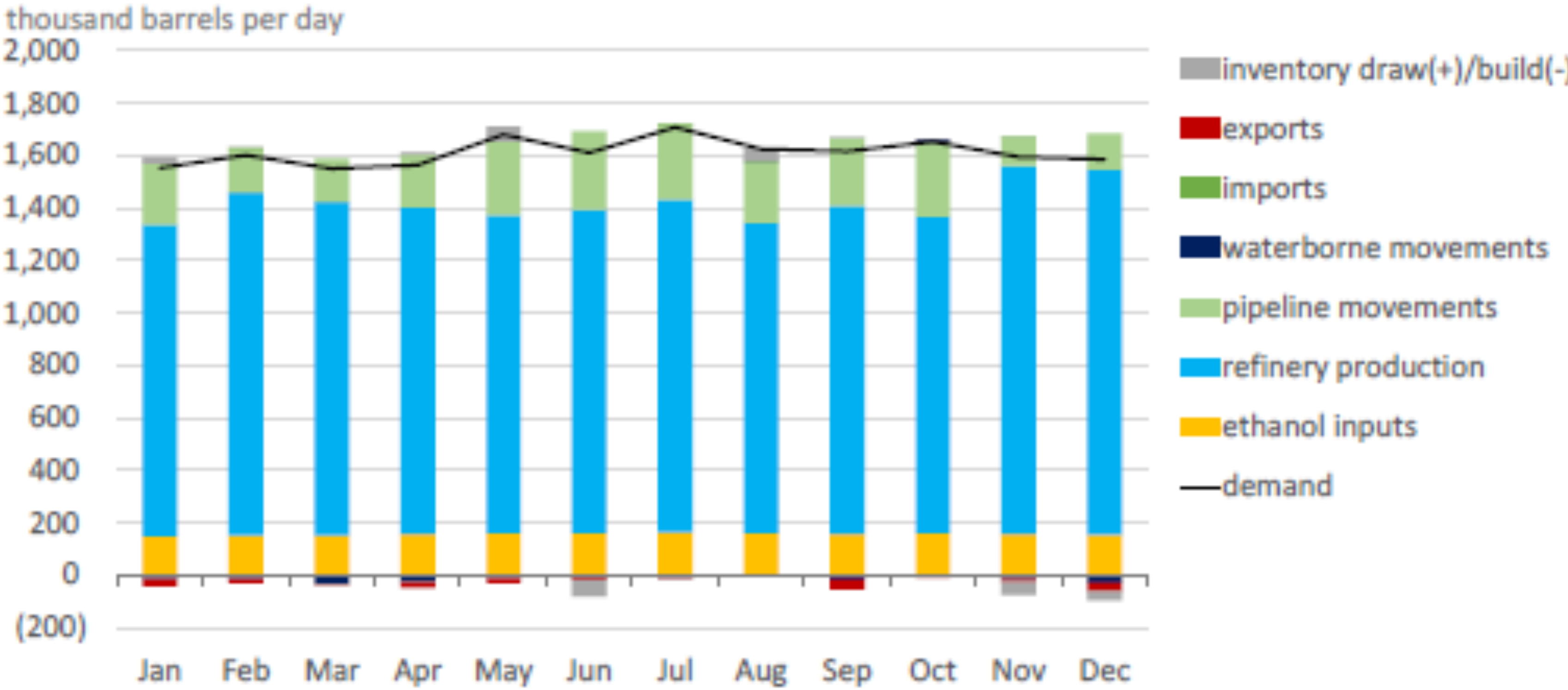


Note: Note: All domestic movements and inventory changes are reported on a net basis.

Source: ICF Analysis of EIA, FHWA, FERC, and company 10-K data

https://www.eia.gov/analysis/transportationfuels/padd1n3/pdf/transportation_fuels_padd1n3.pdf page 59

Figure 13. Eastern Midwest motor gasoline supply/demand balance, 2015

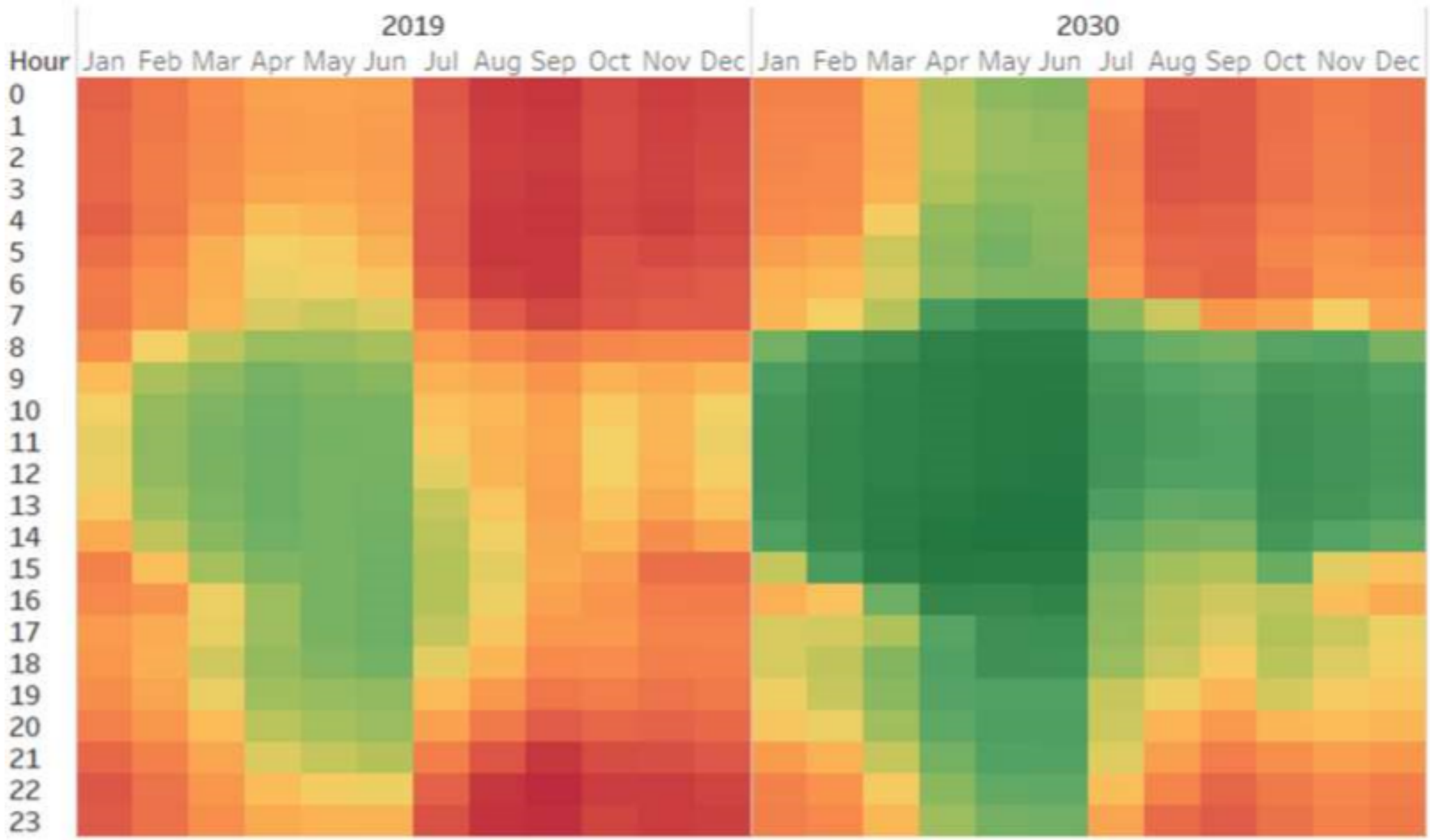


Note: All domestic movements and inventory changes are reported on a net basis.

Sources: ICF analysis of EIA, FERC, and company 10-K data.

https://www.eia.gov/analysis/transportationfuels/padd2n4/pdf/transportation_fuels.pdf page 23

Electricity CO2 Emission Intensities



Source: Commissioner J Andrew McAllister, California Energy Commission, NASEO Annual Meeting Septembers 2019

Tonne per MW

In Conclusion:

Key Points to Remember

1. Know the state's and local critical energy infrastructure supply chains and its capacity and throughput.
2. Know about energy infrastructure in other regions and states that are important to your energy supply.
3. Maintain and use energy sector and Energy Emergency Assurance Coordinators contacts
4. Maintain up to date spreadsheets or date bases or references on your State's key energy statistics you'll never know when you might really need them
5. Keep a library of other important on-line statistics of supply and demand indicators like Heating Degree Days, measures of economic activities, state demographic -- population, housing units by heating fuel, vehicles registrations, etc.
6. Find and use graphs you like, don't use legends or too many decimal points

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Questions, Comments, or Observations?

Thank you!

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NASEO

National Association of State Energy Officials