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# Strategic Oil Product Stockholding

## International Experience and American Prospects

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# CONTENTS


Executive Summary 1

Introduction 3

Oil Stockholding Past and Present: A Shifting Paradigm 4

Holding Strategic Oil Product Stocks: International Experiences 7

American Oil Product Storage Today: Infrastructure, Debates, and Risks 15

Making US Strategic Oil Storage Fit for Purpose:
Lessons and Recommendations 27

Conclusion 31

About the Author 32


# EXECUTIVE SUMMARY


Strategic oil stocks have been held in the US Strategic Petroleum Reserve (SPR) since 1975, within the context of an international strategic stockholding regime coordinated by the International Energy Agency (IEA). While the United States has traditionally held those stocks almost exclusively as crude oil, recent events have shown that short-term domestic supply crises tend to see shortfalls of refined oil products such as gasoline or jet fuel. The original all-crude conception of the SPR was intended primarily to address shortages in the global oil market, and took advantage of specific oil production patterns in the United States where extraction and refining were regionally concentrated. Those patterns are changing thanks to the boom in unconventional oil, particularly from shale. At the same time, risks to short-term domestic oil supply stem increasingly from local events (like natural disasters or even terrorism) and less from international crises (due to greater dynamism in the global oil market).

Since 2000, the United States has taken small steps toward developing strategic stocks of refined oil products, including regional reserves of heating oil and gasoline in the Northeast.

In developing emergency oil product reserves, the United States joins most of its fellow IEA members, many of whom mandate oil product stockholding precisely to address local disruptions. As the oil market has changed in recent years, many of them have focused even more on oil products, emphasizing product stockholding that can facilitate rapid local emergency supply distribution.

This report reviews existing oil product stockholding regimes worldwide, and garners information and lessons pertinent to the US discussion.

It assesses the contemporary American debate about oil product storage, the state of domestic infrastructure, and the risks at hand.

Based on those risks, past experience, international best practices, and the current state of the infrastructure, it draws the following lessons:

- Risks, especially those to Petroleum Administration for Defense District (PADD) 1 and PADD 3, stem from multiple overlapping, interdependent events.
- Too-small reserves are a waste of money (beyond supporting first responders, which could otherwise be done more efficiently).
- Sustained disruption to intra-regional transport for liquid fuels is unlikely.
- There are clear examples where the market works, and the risks of stockholding to efficient market operations should be recognized.
- All emergency fuel distribution plans should be as independent as possible of outside power, internet, or fuel dependency.
- Release authority should be reviewed, and oil reserves should enjoy tailored funding and authority from Congress.
- The long view is uncertain due to major changes on the oil product demand side.

Ultimately, the report makes the case for the incremental implementation of strategic product reserves in a decentralized and limited fashion in order to address contemporary oil security risks, and for targeted probabilistic risk analyses to accurately track those risks. A “distributed model” for local government–owned stocks should initially focus on leasing storage for finished gasoline, despite the higher cost, as well as a lesser amount of jet fuel where the need is identified. The areas of greatest concern are those that

- heavily depend on one mode of oil product delivery (eg. a single pipeline or import terminal);
- have little or no local refining capacity, or risk losing access to crude supply;
- do not have local accessible commercial product storage that is regularly sufficient to meet at least a week of local demand;
- are vulnerable themselves to natural events that may damage surrounding infrastructure (roads, power, refining assets, commercial fuel storage, ports, product pipelines);
- are not easily supplied in a timely manner by seaborne fuel shipments; and contain economic


Guam, December 11, 2002. Gas shortages on the island of Guam are seen at this gas station, where emergency vehicles only are allowed to pump gas. This was caused by Supertyphoon Pongsona.
Photo by Andrea Booher/FEMA News Photo

assets that are important for emergency response or daily needs and dependent on specific fuels (airports that need jet fuel, first responder hubs that need gasoline).

In addition, the report recommends that

- existing regional analysis created by the Department of Energy should be reviewed and a simpler methodology chosen to reexamine regional oil product supply risks in the United States;
- government-owned stocks should be stored in facilities with set requirements for hardening, with due consideration to new "silo" cavern designs and to emergency distribution plans with minimal requirement for external power, communications, or fuel; and
- release authority be decentralized down from the president to the SPR administrator, on the basis of a declaration of emergency at the federal or state level.



# INTRODUCTION

The United States has held strategic oil stocks since 1975 in the Strategic Petroleum Reserve (SPR) and within the framework of the International Energy Agency's (IEA's) collective stockholding regime.[1] The reserve is meant as a safeguard against acute oil supply shortages. Unlike most fellow IEA members, the United States has traditionally held that oil overwhelmingly in the form of crude. The SPR is wholly owned by the government, and geographically concentrated along the US Gulf Coast amidst the traditional cluster of the US refining sector. Until 2000, no American strategic stocks were held as refined oil products (such as gasoline, diesel, or jet fuel). Since then, two very small reserves were established in the Northeast for heating oil (Northeast Home Heating Oil Reserve, NEHHOR) and gasoline (Northeast Gasoline Supply Reserve, NGSR, technically considered part of the SPR).

The unique structure of the US SPR as a government-owned, almost-all-crude, centralized stockholding regime reflects its original purpose: to stabilize national (and global) oil markets in the event of an embargo or other global supply disruption. However, changing oil market dynamics, risk profiles, and energy security challenges mean that such a conception appears increasingly out of date.

Since 2000, infrastructure resilience has become an increasing concern due to terrorist activity, catastrophic weather events, and the changing vulnerability of a domestic oil transport system ill-suited to new production patterns enabled by the shale oil boom. A string of hurricanes repeatedly caused acute product shortages, sometimes compounding issues by arriving in quick succession. In 2008, Hurricanes Gustav and Ike sent regional gasoline prices up 22 percent and caused many gas stations to go empty, until eventually a 30 percent increase in product imports slowly and unevenly began to normalize the situation. Hurricane Harvey's catastrophic effects on the heart of American refining in 2017 is a reminder that localized disruptions can have outsized impacts, even in the absence of international shocks. The SPR's current design as a concentrated supply of crude does not adequately address these risks.

Ongoing discussions in the American oil policy community about the value of strategic oil product stocks focus on the purpose of those stocks, the risks they are designed to mitigate, and the nature of the domestic industry and its ability to cope. Similar discussions are underway in other IEA member countries, and also in some emerging market economies that have established their own oil stockholding regimes. The European Union (EU) mandates product stockholding, but its members comply in a variety of manners. Japan's own experience with natural catastrophe in 2011 induced a move from a crude-dominated reserve to regional product stockholding. China has been building large national crude oil reserves, reflecting its strategic concerns. Meanwhile, some countries like New Zealand hold their reserves thousands of miles away overseas.

The experiences of other countries can provide input for US policy makers and industry leaders, precisely as American strategic stockholding is under review. That ongoing review is subject not only to changing realities on the ground, but also to changing politics. Drawing on international experience can yield concrete lessons for optimizing the US strategic stockholding regime and making it fit for modern purpose.

This report reviews existing oil product stockholding regimes worldwide, and garners information and lessons pertinent to the US discussion. The report assesses the contemporary American debate about oil product storage, the state of domestic infrastructure, and the risks at hand. Drawing on international best practices, the report offers insights and recommendations regarding the future of US oil strategic product stockholding. Ultimately, it makes the case for the incremental implementation of strategic product reserves in a decentralized and limited fashion in order to address contemporary oil security risks, and for targeted probabilistic risk analyses to more accurately track those risks.

1 "Oil Security," International Energy Agency, accessed October 2017, https://www.iea.org/topics/energysecurity/oilsecurity/.

# OIL STOCKHOLDING PAST AND PRESENT
## A Shifting Paradigm

Since the early twentieth century, strategic oil stockholding has been driven by the need to ensure that increasingly oil-dependent economies can successfully navigate physical shortages of oil supplies and their resultant price spikes. The economic and military importance of oil resulted in national strategic stockholding programs, followed by the 1974 founding of the International Energy Agency and development of an international regime to coordinate strategic stocks.

Short-term supply disruptions can have very different impacts in countries, regions, or cities with various oil product demand structures, supply sources, and risks. Modern strategic oil stocks are organized at the national level and loosely coordinated at the international level within the IEA. National strategic oil agencies organize themselves and the oil reserves they oversee differently, both in terms of storage site distribution and the various mixes of crude oil and oil products they manage. In fact, holding oil products at all is neither a universal activity nor required in many countries. While the European Union mandates that its members hold specific proportions of their strategic petroleum stocks in product, other IEA members, including Japan and notably the United States, have held overwhelmingly crude oil.

The US Strategic Petroleum Reserve, located in the country with the highest oil consumption among IEA members, was originally held entirely in crude oil. Since 2000, the United States has added two smaller national strategic reserves in the Northeast that hold gasoline and heating oil (one as part of the SPR). This shift in the United States to include more petroleum product stockholding, similar to the changes made in Japan, reflects the evolving role of strategic oil reserves more broadly.

After the founding of the IEA and the Coordinated Emergency Response Measures (CERM) process to coordinate strategic stock management and release, the emergence of a truly global commodity market for oil meant that such stocks came to be seen in Washington primarily as a tool to mitigate the price effects of supply disruption elsewhere. This view became clearer in 1990 when the US Congress passed an amendment to broaden presidential authority to release oil from the SPR in cases of international (rather than narrowly American) supply disruption. The CERM itself had been born of the Organization of the Petroleum Exporting Countries (OPEC) oil embargo of the Netherlands during the Yom Kippur War and the resulting 1973 oil crisis. Such an embargo could not actually target one country, and so in practice the action hurt consuming countries as a whole. Indeed, the fungibility of oil as a globally traded commodity means that even localized disruptions can impact the world market. The CERM was thus designed as an insurance scheme for such events.

Countries with large and flexible domestic refining sectors, like the United States and Japan, saw greater flexibility and lower costs in maintaining all-crude stockholdings, and were less exposed to the risks associated with it. Other countries like New Zealand even maintained their stocks abroad where they could reach world markets more easily.

However, the world's energy economy has changed significantly since 1974. The oil market is more globally integrated and diversified, and price controls that may have caused physical shortages in 1974 have given way to more responsive worldwide pricing and more efficient supply allocation. Additionally, global oil supply and demand have both shifted, with profound implications for the efficacy and design of strategic stockholding regimes.

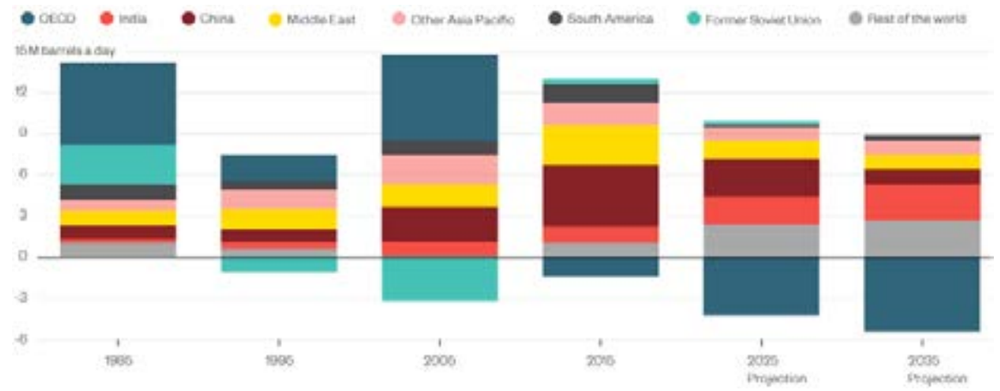
In recent years, oil demand has plateaued in OECD countries, and most Energy Information Administration (EIA) scenarios project US consumption will remain below 2005 levels out to 2040.[2] Oil demand growth has shifted almost entirely to Asia, and particularly to China. That means that since 2013, IEA members and CERM participants have accounted for less than half of

2 US Energy Information Administration, *Annual Energy Outlook 2017*, slide 40, January 5, 2017, https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf.



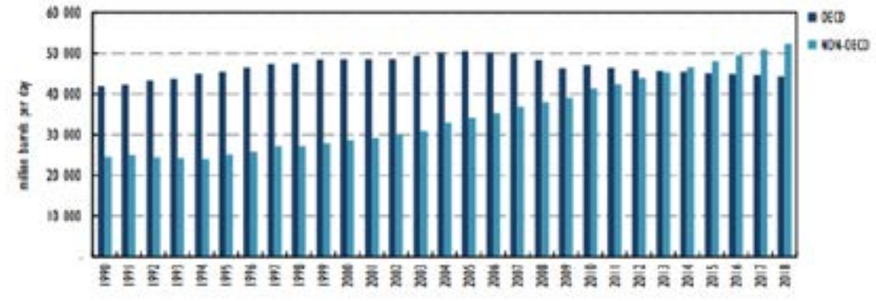


Figure 1. Westworld, change in average oil demand compared to a decade earlier




*Source*: Bloomberg Gadfly, with data from BP and IEA, November 28, 2016.

Figure 2. World oil demand, 1990-2018




*Source*: International Energy Agency, Energy Supply Security: Emergency Response of IEA Countries, 2014, 17.

global oil consumption (down from about 75 percent in 1974), and their share continues to fall.[3] These changes call into question the efficacy of a global strategic stockholding regime that does not include the fastest-growing consumers.

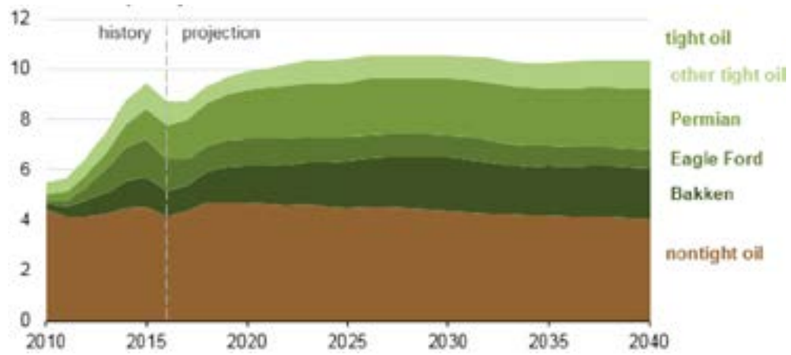
Global oil production has also changed dramatically since 1974, from high growth among non-OPEC producers in the 1970s and 1980s to the more recent advent of widespread unconventional oil extraction, and particularly American light-tight oil (LTO), or shale oil. Apart from significant impacts on global oil price dynamics, supply elasticity, and the role of the United States as a producer, the rise of LTO has highlighted the outdated nature of midstream infrastructure inside the United States. Existing pipelines, storage, and refineries are designed to serve supply centers around Texas and the Gulf of Mexico, rather than more recent LTO production in places like North Dakota. The congested pipeline system has difficulty handling this massive reverse flow (as the path of oil "traffic" changes directions). The risk is that oil released from the SPR during a crisis could simply displace commercial barrels rather than add additional oil onto the market.[4] Moreover, while not a new problem, limited oil product pipelines from Gulf Coast refineries to northeastern demand centers can expose the United States to domestic supply risks that have become more prominent in recent decades.

Changes in oil market dynamics and production and consumption patterns are not the only factors

3 International Energy Agency, *Energy Supply Security: The Emergency Response of IEA Countries – 2014 Edition*, 2014, 14, https://www.iea.org/publications/freepublications/publication/energy-supply-security-the-emergency-response-of-iea-countries-2014.html.

4 Ernest Moniz, "Moniz: We Need a Modernized Strategic Reserve, Not a Smaller One," *Houston Chronicle*, July 10, 2017, http://www.chron.com/business/energy/article/Moniz-We-need-a-modernized-strategic-reserve-11271157.php.

Figure 3. US oil production (2010-40), million barrels per day




*Source*: "Today in Energy," US Energy Information Administration, February 13, 2017.

necessitating a reexamination of the design of strategic stocks. Since the September 11 attacks, risks to domestic critical energy infrastructures have taken on greater importance. The US government has followed an "all-hazards" approach to critical energy infrastructure protection, recognizing that risks can be posed by humans (including terrorist or cyberattack) or by extreme natural events.

Indeed, extreme nature has proven particularly impactful for energy infrastructures in the United States and Japan. In 2005, Hurricane Katrina made landfall along the Gulf Coast, in the region where more than half of US refining capacity is concentrated, prompting the second-ever IEA-coordinated release of strategic stocks (the first since the 1991 Persian Gulf War). In 2011, the earthquake, tsunami, and nuclear incident at Fukushima in Japan led to a widespread rethink of Japanese energy security and emergency planning.

The following year, Hurricane Sandy hit major demand centers in the US Northeast and the greater New York City area, prompting gasoline and other oil product shortages and the first-ever release from the NEHHOR since its creation in 2000.[5] Sandy also led to new discussions about the need for regional oil reserves, culminating in the 2014 establishment of the NGSR. In 2017, Hurricane Harvey serves as a reminder that natural risks are ever-present, and climate change data imply that they will worsen.

In short, the fundamental purpose and concept of strategic stockholding has been shifting in some countries from global market management to domestic supply resilience.[6] Decisions about the size and cost-value of strategic oil stocks are extremely complex, since they are designed to mitigate low-probability high-impact events. Costs themselves are also variable, ranging from cheap storage of crude oil in caverns, to progressively more expensive above-ground product storage requiring regular refreshment, to ownership and leasing arrangements that might put more or less emphasis on capital or marginal operating costs. The organization and efficacy of strategic stocks also depends on the nature of the domestic oil refining and storage sector, geographical realities, current policy, and existing infrastructure. These questions remain a source of debate, particularly in the United States where President Donald Trump's budget proposal would eliminate the NGSR and reduce the crude SPR by over half.[7] Such efforts to pad massive shortfalls elsewhere in the budget by using the SPR as a piggy bank seem characteristically shortsighted, particularly in light of Department of Energy (DOE) analysis estimating the benefits of sustaining the SPR to meet current statutory requirements at $300 billion to 2040.[8]

5 US Department of Energy, Office of Electricity Delivery and Energy Reliability, *Comparing the Impact of Northeast Hurricanes on Energy Infrastructure*, April 2013, https://energy.gov/sites/prod/files/2013/04/f0/Northeast%20Storm%20Comparison_FINAL_041513b.pdf.

6 Moniz, "Moniz: We Need a Modernized Strategic Reserve."

7 US Office of Management and Budget, *Budget of the US Government: A New Foundation for American Greatness – Fiscal Year 2018*, May 2017, https://www.gpo.gov/fdsys/pkg/BUDGET-2018-BUD/pdf/BUDGET-2018-BUD.pdf.

8 US Department of Energy, *Long-Term Strategic Review of the US Strategic Petroleum Reserve*, Report to Congress, August 2016, https://energy.gov/sites/prod/files/2016/09/f33/Long-Term%20Strategic%20Review%20of%20the%20U.%20S.%20Strategic%20Petroleum%20Reserve%20Report%20to%20Congress_0.pdf.



# HOLDING STRATEGIC OIL PRODUCT STOCKS
## International Experiences

While national and regional circumstances may vary, many countries hold significant oil product stocks, and their experiences provide valuable lessons and best practices. In Europe, where oil product stockholding is mandated by Brussels, different models exist to satisfy that requirement. Emerging economies keen to build up their strategic oil security have also established product stockholding regimes, and learned lessons themselves.

Strategic oil stocks, particularly within the IEA structure, are one tool within the broader effort to respond to oil supply disruptions. Other emergency response measures may include domestic production surges, demand restraint through public campaigns or rationing, and fuel switching where substitutes exist (in limited parts of the power sector).

Susceptibility to disruption, as traditionally determined at the national level, is a product of import dependency, which varies considerably among oil-consuming OECD countries. In the United States, domestic LTO production has lessened that dependency. However, the United States is an anomaly among OECD countries, and many IEA members are more exposed to specific physical supply disruptions—a situation that informs their emergency response choices. For example, Japan and the Republic of Korea are almost entirely dependent on oil imports, and Europe's dependency is increasing despite relatively flat demand growth.[9] In some Eastern European countries, high import dependence is exacerbated by the paucity of import routes, and landlocked countries may rely on a few pipelines, and in practice few suppliers (often Russian).

Most countries use a combination of three approaches to meet strategic stockholding obligations: industry stocks, agency stocks, and government stocks. Industry stocks are held by companies, including importers, refiners, product suppliers, or wholesalers, and most governments require them to hold a minimum number of days of stocks—usually as a proportion of the company's import share or share of sales in the domestic market.[10] Of twenty-nine IEA member countries, twenty meet their strategic stockholding requirements at least partly with industry stocks, and six use solely industry stocks.[11]

Some countries establish a separate agency to be responsible for stockholding, which can be government administered or owned by industry as a consortium (but still defined by legislation). Government stocks are typically financed through the central government budget and held exclusively for emergencies, as with the US SPR and the two regional product storages. Six other IEA countries also use government stocks.[12] In practice, emergency stocks may be "commingled" or mixed with operational stocks in the same supply chain. This makes them harder to distinguish for purposes of oversight, but easier than "segregated" stocks to release quickly in times of crisis.

In addition to various forms, stocks can also be held in various locations. Some countries hold some of their stocks abroad, often for efficiency. For example, some Austrian stocks are held at the Italian port of Trieste, where volumes are unloaded and then delivered by pipeline to Austria. Industry may also use capacity in neighboring countries to meet its obligations, for reasons of flexibility, but there is usually a requirement to rapidly repatriate in the case of an emergency. Some countries (such as Japan) prohibit this practice completely, while most limit stock obligations held abroad to between 10 and 30 percent of actual stocks.[13] Some countries, including New Zealand, also use leasing agreements known as "tickets" where one entity may hold another's stockholding obligation (sometimes abroad).

9 International Energy Agency, *Oil Information 2017*, 2017, http://www.iea.org/bookshop/754-Oil_Information_2017.

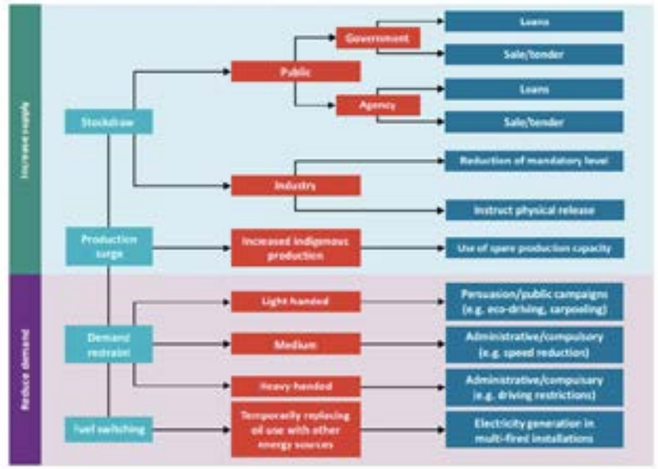
10 International Energy Agency, *Energy Supply Security,* 31.

11 Those countries are Greece, Italy, Luxembourg, Sweden, Turkey, and the United Kingdom.

12 Those countries are the Czech Republic, Ireland, Japan, the Republic of Korea, New Zealand, and Poland.

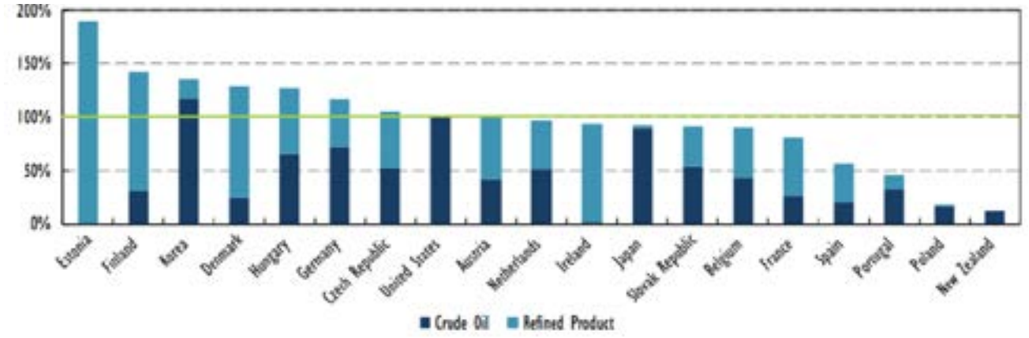
13 International Energy Agency, *Energy Supply Security*, 36.

Figure 4. IEA Emergency Response System




Source: International Energy Agency, "Oil Security and Oil Stocks Table," IEA Emergency Response System.

Figure 5. Public stocks as a share of a country's IEA stockholding obligation




*Source*: International Energy Agency, Energy Supply Security: Emergency Response of IEA Countries, 2014, 33.

The EU requires at least one-third of the stockholding obligation to be held as oil products. As of 2013, total stocks (both commercial and strategic) were 60 percent products and 40 percent crude in IEA Europe. Meanwhile, in the IEA countries as a whole, stocks were 60 percent crude and 40 percent products, thanks to particularly large crude holdings in the United States and Japan. At the same time, Luxembourg and Switzerland hold virtually all of their stocks as products due to the lack of domestic refining capacity, and commercial product importers are required to stock a given share of their imports.[14]

In this section, the stockholding regimes of a few key countries that hold strategic oil product stocks are reviewed.

14 Ibid., 34.




A man works beside gasoline tanks on the outskirts of Shanghai December 5, 2007. Reuters/Aly Song

## Germany

Germany's national oil production is minimal, and its large economy relies heavily on imports delivered via crude and oil product pipelines and import terminals. In 2012, German oil imports amounted to 1.9 million barrels per day (mb/d) of crude oil and 713 thousand barrels per day (kb/d) of oil products primarily from Russia (37 percent), the United Kingdom (14 percent), Norway (10 percent), and Libya (9 percent).[15]

Germany's strategic stockholding obligation to the EU and the IEA is managed by its stockholding agency, the Erdoelbevorratungsverband (EBV), whose board consists of three government seats and six industry seats.[16] Since 1998, the agency has maintained a stock volume equivalent to ninety days of net imports, without any requirement or stockholding obligation on industry. Industry-held commercial stocks are totally independent of strategic stocks, which are solely under the agency's responsibility. The agency is funded by membership fees from all importers and refiners of gasoline, diesel, light fuel oil, and kerosene, amounting to about €300 million per year. German stockholding activities are guided by the 1978 Oil Stockholding Law, most recently updated in December 2016 to simplify procurement procedures and broaden the agency's membership base to include companies from other EU countries, Norway, and Switzerland.

About one-third of total oil stocks are held above ground and two-thirds in underground caverns. The agency operates sixty-one caverns through a subsidiary (making that entity the largest operator of liquid storage caverns in Europe), but oil products (which constitute half of total stocks) are mainly held in 130 above-ground storage sites located primarily at refineries.[17] Tank storage is contracted on the basis of Frame Storage Agreements covering periods of one to

15 Ibid., 205.

16 "Wir über uns," Erdölbevorratungsverband, accessed October 2017, https://www.ebv-oil.org/cms/cms2.asp?sid=57&nid=&cof=57.

17 "Logistics and Stocks," Erdölbevorratungsverband, accessed October 2017, https://www.ebv-oil.org/cmse/cms2.asp?sid=60&nid=&cof=60.

five years, with longer contracts for kerosene. Jet fuel storage is key in the west and south due to demand from major international airports in Frankfurt, Munich, Cologne, and Dusseldorf.

While the bulk of the stock is held in north Germany (half are in Lower Saxony), German stocks are intentionally regionalized to better respond to local supply emergencies. To meet this regional obligation, the agency holds stocks of finished oil products in five designated "supply regions" as defined by refining concentrations, with sufficient stocks to meet fifteen days of demand in each respective region. This is particularly important given the lack of oil pipeline infrastructure, particularly between the eastern and western parts of the country.

The Oil Stockholding Law requires that all product stocks have the capability to be released within ninety days. If the agency releases part of its legally required quota to the market, it is at market prices, with the agency retaining any profits realized over purchase costs.

## Belgium

Belgium is entirely reliant on oil imports, and oil demand is dominated by middle distillates that account for 44 percent of the oil products consumed in the country.[18] The transport sector accounts for 45 percent of oil demand, while residual fuels play a large role as well in fueling international shipping. The country's main import terminal at Antwerp is directly connected via the Antwerp-Rotterdam line to Europe's wider oil logistics system. The country is also supplied with oil products (and especially jet fuel) by the NATO Central Europe Pipeline System, an integrated fuel line connecting France, Belgium, Germany, Luxembourg, and the Netherlands. Otherwise, oil products are largely transported by inland waterway—so much so that strategic oil stocks are held in floating storage. Thus, stocks held abroad must be within three days' sailing time from Belgian demand centers.

Until the 2007 launch of the national stockholding agency, APETRA, Belgium had relied on industry to hold strategic stocks. The transition period following APETRA's founding saw annual reductions in industry obligations until 2012, when the agency assumed full responsibility. APETRA initially relied largely on stockholding contracts with industry, or so-called "tickets," but the number of tickets was insufficient in recent years and they proved unstable and unreliable for quick drawdown. As a result, the agency has been moving to reduce its gasoline ticket holdings and increase directly held stocks, purchased by tender.

To mitigate the higher costs of product holdings, APETRA devised a novel scheme to take advantage of Belgium's unique qualities. The country's size and significant refining sector mean that a variety of oil products are available in sizable commercial stocks, so the agency created the Crude Against Product Agreements (CAPA) program. These reciprocal contract agreements with qualifying refineries allow APETRA to sell crude oil and immediately take delivery of specific products from local refineries at the point of crisis, allowing for cheaper centralized crude holding along with quick regional product delivery. Even so, Belgian legislation limits the share of crude holdings to 50 percent of all owned stocks, and it must fix refining yields and costs with a domestic refinery to process the crude in the event of sale.

## Ireland

In Ireland, an island nation with no domestic oil production, oil is the dominant energy source, representing 48 percent of total primary energy supply in 2015. Crude sourced mainly from Africa feeds a single 75 kb/d refinery at Whitegate, while oil product imports come overwhelmingly from the United Kingdom.[19] In a 2013 report, the Irish government emphasized the strategic value of maintaining the Whitegate refinery to offer flexibility in times of crisis.[20] However, Ireland is highly dependent on oil product imports and holds all of its strategic oil stocks as products, mainly as middle distillates (76 percent), with the remainder as motor gasoline.[21] The product balance is adjusted to mirror Irish demand.

The Irish stockholding National Oil Reserves Agency (NORA) originally held some of its stocks as tickets and some abroad, but the government recently concluded that neither tickets nor physical stocks held abroad would be useful in times of domestic shortage. Thus, NORA now physically holds all stocks within the country, half of them at a single facility offshore on Whiddy Island, requiring shipping to one of the country's six marine import terminals, which serve major Irish demand centers at Dublin, New Ross, Whitegate, Cork, Foynes, and Galway.[22]

## Japan

Along with the United States, Japan has traditionally stood out among IEA members for its large amounts of government-owned crude stocks, managed by the publicly owned Japan Oil, Gas and Metals National Corporation (JOGMEC) under the Oil Stockpiling Act. In 2013, JOGMEC held about eighty-four days of import coverage, or 321 mb, 97 percent of which are held as crude. Unlike the United States, Japan also places an obligation on industry, requiring refineries, specified distributors, and importers to hold seventy days of their daily imports, sales, or refinery production based on an average of the previous twelve months, totaling about 275 mb. As a result, about 70 percent of total stocks are held as crude.[23]

The public stockholding regime managed by JOGMEC came under scrutiny after the 2011 Great East Japan Earthquake and resulting tsunami. While Japanese crude stocks have proved flexible and easily deliverable to the Asian market in crises, they were ineffective in addressing the domestic shortages that followed the natural disaster and power cuts after the Fukushima nuclear disaster. The Oil Stockpiling Act was amended in 2012 to require the government to hold up to four days of refined products (including gasoline, kerosene, fuel oil, and diesel oil) in its emergency reserves.

The major problem experienced after the earthquake was not just of the oil mix, since industry held the majority of its stocks in product—it was also that roads and infrastructure to transport products to stricken areas were destroyed, complicating oil distribution. As a result, Japan regionalized its public stockholding along German lines, dividing the country into ten regional areas, with stocks held at separate bases in each region to improve post-disaster delivery.

However, the new requirement to hold oil products regionally presented challenges, as JOGMEC prefers industry to hold product because of the need for refreshment and cycling.[24] Managing that process for separate government stocks is more expensive and complicated than industry-held stocks within the logistics chain, which are generally commingled with commercial and operational stocks. Constant buying and selling has put a greater spotlight on the public entity's purchasing decisions, leading to accusations that it "buys high and sells low." While any public entity engaged in acquisitions and sales is likely accustomed to that kind of pressure, the Japanese found that higher transaction frequency adds political scrutiny.[25]

## The Netherlands

The Netherlands is unique largely because of Rotterdam, one of the world's busiest ports and the primary oil terminal port for much of Europe as well as a major refining center. The total volume of oil that transits the Netherlands is over four times the national demand, as crude and product pipelines crisscross the country, and the Netherlands is the largest European hub for inland waterway bunkering.[26] The Netherlands has significant refining capacity and large amounts of commercial product stocks, making it a net exporter of refined products. Amsterdam in particular has developed into one of the world's most important gasoline stockholding sites.

However, Dutch oil production from Schoonebeek and the North Sea has been dwindling in recent years, making it increasingly reliant on imports. As a result, the country's stockpiling agency, COVA (Centraal Orgaan Voorraadvorming Aardolieproducten), has favored cheaper crude holdings when it comes to strategic and especially government-owned stocks (over 50 percent). The Netherlands holds the EU minimum of product, mostly concentrated in the 20 percent of strategic stocks held as industry obligations. However, thanks to large commercial product stockholding, the Netherlands is always holding well in excess of its international obligations.

The country tends to be more secure in terms of oil products as national demand is dominated by transformation (power plants, oil production companies, and refineries) and especially industrial use, which together account for over 80 percent of oil consumption. On the demand side, high population density and reliable public transportation have resulted in relatively low levels of car ownership and miles driven. All this means that risks to domestic oil security are generally low, particularly exposure to the kinds

18 International Energy Agency, *Energy Supply Security*, 101.

19 Sustainable Energy Authority of Ireland, *Energy in Ireland 1990-2015*, 2016, http://www.seai.ie/resources/publications/Energy-in-Ireland-1990-2015.pdf.

20 Barry O'Halloran, "State-Commissioned Report Finds Ireland Does Not Need Own Oil Refinery," *The Irish Times*, July 31, 2013, https://www.irishtimes.com/business/energy-and-resources/state-commissioned-report-finds-ireland-does-not-need-own-oil-refinery-1.1479964.

21 Sustainable Energy Authority of Ireland, *Energy in Ireland*.

22 "Where Are NORA's Oil Stocks Stored?" National Oil Reserves Agency, accessed October 2017, http://www.nora.ie/frequently-asked-questions/frequently-asked-questions.246.html.

23 International Energy Agency, *Energy Supply Security*, 281.

24 Per comments by a Japanese attendee to the March 2017 Atlantic Council Roundtable of select delegates to the IEA Standing Committee on Emergency Questions.

25 Ibid.

26 International Energy Agency, *Energy Supply Security*, 321.

of heating or transport-crippling short-term supply emergencies that product stocks would ameliorate.

The main risk concern is over major weather events from the North Sea and potential flooding, to which the country has historically been vulnerable. More recently, seismic activity as a result of extraction has also been an issue. Despite their interconnected nature and specific hardening measures (to make installations more resilient to weather), many systems could conceivably fail simultaneously.

## Portugal

Like many of the other product stockholding countries surveyed in this report, Portugal is heavily dependent on oil imports and largely lacking in domestic oil production. In 2012, oil imports consisted of 227 kb/d of crude oil and 63 kb/d of oil products, but thanks mostly to the Sines refinery (accounting for 70 percent of the country's total refining capacity) it remains a net exporter of oil products, sending more than 76 kb/d abroad primarily in the form of fuel oil. The Sines and Matosinhos refineries, both owned by Galp Energia, underwent significant upgrades earlier in the decade, making them more flexible and responsive to the country's changing product needs and creating a fully integrated refining system with product exchange. These two refineries provide 80 percent of the country's total storage capacity and 31 percent of its crude storage capacity.[27]

Of the country's strategic stockholding requirements, one-third is met by industry obligations, while the other two-thirds are met by the national stockholding agency ENMC (Entidade Nacional para o Mercado de Combustíveis, formerly EGREP)—a public corporation jointly overseen by the ministries of finance and energy. Regulations dictate that ENMC must hold at least one-third of the country's stock obligation, and it must directly own at least 25 percent of its stocks.[28] In 2017, around 43 percent of ENMC physical stocks were held as crude oil, and 33 percent as middle distillates.[29] Portuguese law requires at least one-third of stock obligations (both of private industry and ENMC) to be held as oil products, including semi-finished products. They are mostly commingled to ensure adequate stock rotation. Companies are allowed to hold a maximum of 10 percent of their stocks abroad, and no more than 20 percent of the country's total stocks can be held abroad.

In Atlantic Council discussions, Portuguese oil product strategic stockholding was described as "critical infrastructure." It is also clear that, even with a 20 percent cap on foreign-located stocks, Portugal is inclined to hold as much as possible domestically. As jet fuel is one of the few products for which demand outstrips national refining capacity, Portugal is particularly concerned about supply to the airports in Lisbon, Porto, and Faro. Portugal also expressed that it values centralized control over stockholding and stock release, particularly in the event of an acute domestic shortage. Hence, ENMC holds double its legally mandated share of the country's stock obligation.

## Czech Republic

The Czech Republic also imports almost all of its oil, mostly Russian crude delivered via the Druzhba Pipeline, while around a third of its imports arrive as finished products, mostly from Germany and Slovakia. Refined product pipelines and storage are monopolized by the state-owned oil distribution company CEPRO, also a significant fuel retailer with its own network of petrol stations. Domestic refining can supply 85 percent of domestic diesel needs, but only 40 percent of jet fuel demand, so refined product imports are important (if in the minority), and supplied largely via the sole international product pipeline to Slovakia.[30]

A landlocked country relying on only three pipelines (the Ingolstadt–Kralupy–Litvínov Pipeline also connects from Germany), the Czech Republic has developed a responsive structure of public oil stockholding overseen by the Administration of State Material Reserves (ASMR). Above the minimum requirement imposed by the EU, the chairman of ASMR has authority to release stocks himself, providing a rapid authorization procedure for smaller local disruptions or shortages. Czech law requires ASMR to hold at least 40 percent of its strategic stocks as refined product, but in practice it holds 50 percent as product (of which half is diesel) distributed at CEPRO's seventeen storage sites throughout its network. Fully 75 percent of that storage capacity is reserved for strategic product stocks, 95 percent of which is held in separate tanks.[31]

The Czech system is designed to be secure and responsive, and the country benefits from both centralized state-owned storage and midstream monopolies, as well as direct government control over the stocks. It does not use tickets, and no stocks are held abroad. Drawdown is preferred by ASMR in the form of loans directly to retailers rather than tender due to the speed of release, and drawdown rates far exceed national daily demand.

## China and India

Asian emerging markets' interest in oil security has grown in recent decades as oil demand (and imports) have boomed. In 2001, China embarked on an ambitious strategic petroleum reserve program, aiming to construct 500 mb of strategic storage tankage by 2020. Filling these storage facilities could have a real impact on global oil prices. However, as the details of the reserve are a state secret, it is difficult for analysts to discern how much of Chinese demand was due to strategic reserve filling rather than a statistical catch-all for barrels they could not account for. While it appears that the Chinese strategic petroleum reserve is currently all crude, there are plans for a product reserve.

As China has become the world's largest oil importer, the design of its strategic reserve implies a focus on large-scale strategic threats like a shipping blockade. While past inland energy shortages have occasionally been caused by blocked rail deliveries of coal due to harsh winters, China is also vulnerable to typhoons along its crowded coast that could hinder inland oil deliveries. With rapidly rising personal and commercial vehicle use, even brief petrol shortages can cause major disruptions to global logistics-sensitive industries.

India, another major energy consumer and one the IEA has pointed to as a country to watch in global energy markets, is also considering strategic stockholding, but currently relies on emergency management in cooperation with industry. Major modern large-scale refining additions in the 2000s have turned the country into a global refining hub, and privately owned coastal facilities like Jamnagar are decidedly export oriented, while domestic demand is primarily served by government-owned refineries near population centers. The 2008 Oil Industry Contingency Plan emphasizes uninterrupted supply of oil products in times of crisis, particularly to priority sectors like utilities and transportation. Product storage capacity near population centers has since expanded significantly.

## Round-Up

Discussions organized by the Atlantic Council in Paris in March 2017 and held among select oil product stockholding members of the IEA revealed a few key points of general consensus that can inform US experience going forward.[32]

In general, countries have been moving away from tickets and stockholding abroad. For example, Belgium, Ireland, and Portugal have all actively done away with their ticket systems, moving reserves home in recent years.

Tickets, or leasing agreements in which the seller agrees to hold or reserve an amount of oil on behalf of the buyer in return for a fee, are tempting as they allow refiners holding excess commercial stocks to lease them to agencies or other companies so they can cover their stockholding obligations. Tickets enable flexible fulfillment of compulsory stockholding requirements by allowing oil held abroad or among various affiliates to count toward a domestic company's obligation. Companies can avoid the cost of acquiring and storing stocks at home and shift tickets as inventory levels dictate. However, while tickets are a useful accounting mechanism to avoid breaching obligations, they are not of much practical use if they prove unstable or unreliable when the oil products are needed in a particular location.

Incidents such as weather events and industrial action, and lessons learned over the past decade, convinced discussants that the initial period of vulnerability is the most critical because of market uncertainty. That puts a greater emphasis on release speed and quick distribution. This is a major reason why Germany and Japan have divided their stocks among "emergency response regions," and why many countries created stockholding agencies over the past fifteen years to assert more direct control.

27 Ibid., 380.

28 "Legislation," Entidade Nacional para o Mercado de Combustíveis, October 2017, http://www.enmc.pt/en-GB/activities/oil-reserves/legislation/.

29 "Mapa de Reservas—2º Trimestre 2017," Entidade Nacional para o Mercado de Combustíveis, 2017, http://www.enmc.pt/static-img/2017-07/2017-07-17124623_f7664ca7-3a1a-4b25-9f46-2056eef44c33$$72f445d4-8e31-416a-bd01-d7b980134d0f$$f15a0905-aa16-4262-a9b1-d1d80a8e4b7d$$File$$pt$$1.pdf.

30 "Oil 1st - 3rd quarter 2015," Czech Republic Ministry of Industry and Trade, accessed October 2017, https://www.mpo.cz/assets/dokumenty/54252/61989/640307/priloha001.pdf.

31 International Energy Agency, *Energy Supply Security*, 135.

32 In March 2017, the Atlantic Council convened a roundtable meeting in Paris among select delegates to the IEA Standing Committee on Emergency Questions (SEQ), comprised of senior administrators of national stockholding administrations and dedicated to emergency response and stockholding coordination. The Atlantic Council roundtable meeting brought together the SEQ delegates from major product stockholding countries to discuss how those stocks are managed and the evolving thinking behind them. Participants included representatives from select product stockholding IEA member countries. Over a working lunch, participants described their own systems and their challenges and solutions when it comes to oil product stockholding.



Strategic Oil Product Stockholding

There was also an informal consensus among most discussant countries that **ten days** was more or less a good rule of thumb to define the critical period of necessary coverage by product stocks in the event of localized product shortage. After that, product imports, adjusted refinery runs, necessary midstream repairs, or other market mechanisms would most likely be sufficient to cope. Particularly in Europe, where oil products can usually be diverted from abroad relatively quickly, the market is usually able to manage within a week or two.

The emphasis for risk assessment is therefore on catastrophic events, and the possibility of multiple simultaneous events, particularly across borders. But there was also agreement that in each case, risk assessments had to be done on a national basis.



# AMERICAN OIL PRODUCT STORAGE TODAY
## Infrastructure, Debates, and Risks

Other IEA members' experiences with strategic oil product stocks reflect the same shifting concerns and questions as in the United States. As oil geopolitics and economics have evolved from the dichotomous producer-consumer standoff of the early 1970s to a more integrated global market where the lines between producers and consumers blur, the focus is less on building arsenals for an "energy cold war." That is not to say that major geostrategic concerns no longer exist—the mindset of rising powers like China demonstrates this quite clearly. It would also be foolish for American policy makers to ignore the low-probability high-impact risks deriving from conflict, large-scale embargoes, or wholesale state failure among major global oil producers. However, there is a growing realization among IEA members that pertinent risks to oil supply stability are often more local and more frequent. Strategic oil stockholding is changing to reflect that, as other countries bring more of their stocks home, assert more direct control over them, and hold them in fuel mixes most suited to immediate consumer needs.

The issue is ultimately one of effective cost-benefit analysis of strategic stockholding—specifically insurance risk calculation on the basis of probabilities of various events, their potential impacts, and the costs of mitigation. Determining the first (the probability of failure scenarios) is the most difficult of the three. In 2013, the IEA published a study looking at the costs and benefits of strategic stockholding in general, and assessed the benefits derived from offsetting oil supply losses and mitigating price spikes by modeling "tens of thousands" of possible oil supply disruption scenarios and market outcomes.[33] Such models can be infinitely complex due to overlapping risks and risk interdependencies, and deserve to be taken with at least a grain of salt. However, the IEA estimated that the average benefit from holding existing strategic stocks amounted to $41 per barrel per year, billed as conservative because it did not take into account the mitigation of domestic or product supply disruption. As the US Department of Energy found out recently, those calculation exercises are distinctly more difficult. Large public insurance schemes (from economic defenses against uncertainty all the way to military ones) face multiple risks that need to be balanced effectively. The danger is to produce muddled solutions that do not properly provide for real situations while still incurring real costs and shifting risk onto the public purse to the benefit of private interests.

### American Oil Security Infrastructure Today

At the national level, US oil distribution infrastructure is often broken up among regions known as Petroleum Administration for Defense Districts (PADDs). The five PADDs, created during the Second World War to allocate refined products, are still used for statistical and analytical purposes. The western PADDs 4 and 5 traditionally function more independently as oil "islands," with little infrastructure connecting PADD 5 (West Coast) to the rest of the country, and PADD 4 (Rockies) refineries receiving cheap feedstock from Canada (and more recently from North Dakota) to serve a sparse population. The eastern part of the United States is much more integrated. PADD 1 covers the East Coast, traditionally a high-consumption, low-production region forced to buy significant quantities of both crude and product from other domestic regions and also from abroad. PADD 2 covers the Midwest, traditionally a significant refining center receiving ample crude from Canada and the Gulf Coast, but one that has also become a production center thanks to the shale oil revolution of the past decade. PADD 3 covers the Gulf Coast where over half of US crude oil imports arrive, and more than half of the 18.5 mb/d of US operable refining capacity is located in that region (PADD 3).

As discussed, this was a major rationale for centralizing the US SPR and for holding crude. The SPR is made up primarily of four salt cavern storage facilities across Texas and Louisiana with a total capacity of 727 mb of crude oil. The current inventory of the SPR is lower than that as a result of plans initiated in 2015 to start selling off a portion of those holdings due to lower imports; the inventory now stands at around 695 mb.[34]

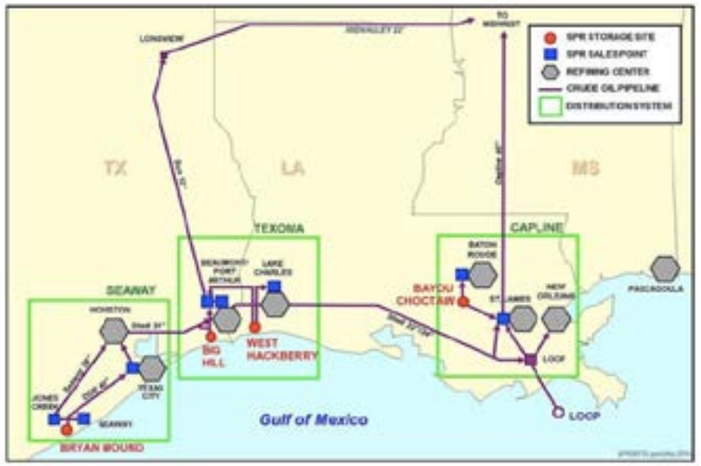
33 Jan Stelter and Yuichiro Nishida, *Focus on Energy Security*, International Energy Agency, 2013, http://www.iea.org/publications/insights/insightpublications/FocusOnEnergySecurity_FINAL.pdf.

34 "SPR Quick Facts and FAQs," US Department of Energy Office of Fossil Energy, accessed October 2017, https://energy.gov/fe/services/

Figure 6. Petroleum Administration for Defense Districts


Source: "Today in Energy," US Energy Information Administration, February 7, 2012.

Figure 7. SPR Infrastructure on the Gulf Coast




*Source*: US Department of Energy, Long-Term Strategic Review of the US SPR, 2016, 15.

Its location allows direct access to all major commercial supply and distribution infrastructure within the region in the event of a supply disruption. The region is also home to large salt cavern formations that provide the lowest-cost storage option.

Domestic and imported crude oil is transported from the Gulf Coast to refineries within the region and in the Midwest. Once refined, marine vessels and pipelines carry products such as gasoline, diesel, and jet fuel around the country. While this refinery complex is therefore integrated with the entire country, the great majority of products from the Gulf Coast region are either consumed within the region itself or shipped to the Northeast, Midwest, or Southeast. Four major oil product pipeline systems carry the bulk of the products, including the Magellan system north through the Great Plains; the Explorer Pipeline system via Cushing to Chicago; the TEPPCO (now Enterprise)

petroleum-reserves/strategic-petroleum-reserve/spr-quick-facts-and-faqs.



During Hurricane Katrina in 2005, one of the Chevron oil terminal's storage tanks was severely damaged on top, possibly after being hit by something extremely large carried by the storm waters. (NOAA)

system via the Mississippi and Ohio River basins; and the critical Colonial Pipeline supplying major demand centers through the Southeast and mid-Atlantic, as far north as New York Harbor.

Despite also having significant refining capacity, the Midwest receives over 900 kb/d of refined product from the Gulf Coast.[35] In the event of a disruption in the Gulf Coast region, the SPR can supply refineries in the Midwest with crude oil (as long as SPR and transport infrastructure remain sufficiently operable). Otherwise, the region must rely on local commercial product stocks or seek additional imports to make up for product losses from the Gulf. Since 1990, the average storage for gasoline in the Midwest has been about 50 mb (or about thirteen days of regional consumption), and about 29 mb for middle distillates.[36]

There is about 1.6 mb/d of refining capacity in the whole of the Southeast, mid-Atlantic, and East Coast, all of which is concentrated between Delaware and New York City. Thus, the heavily populated US Eastern Seaboard relies on substantial refined product supplies from either foreign imports or domestic refiners in other regions, consuming more than 3 mb/d from Gulf Coast refiners. With the exception of 500 to 600 kb/d shipped by sea, most is carried by pipeline.[37]

The largest of these is the Colonial Pipeline, which starts in Houston and transports up to 2.5 mb/d from the Gulf Coast region across the South and up the

35 In 2016, per "Movements by Pipeline, Tanker, Barge and Rail between PAD Districts, PADD 3 to PADD 2," US Energy Information Administration, https://www.eia.gov/dnav/pet/pet_move_ptb_dc_R20-R30_mbbl_a.htm.

36 "Gasoline Stocks (Million Barrels) and Days of Supply," US Energy Information Administration, October 25, 2017, https://www.eia.gov/petroleum/weekly/gasoline.php#tabs-stocks-regional; "Midwest and Rocky Mountains Transportation Fuels Markets," US Energy Information Administration, March 8, 2017, https://www.eia.gov/analysis/transportationfuels/padd2n4/.

37 US Department of Energy, *East Coast and Gulf Coast Transportation Fuels Markets: A Report Prepared by ICF International for EIA*, February 2016, https://www.eia.gov/analysis/transportationfuels/padd1n3/pdf/transportation_fuels_padd1n3.pdf.

Figure 8. US East Coast and Gulf Coast refineries and key product flows


*Source*: "Today in Energy," US Energy Information Administration, February 22, 2016.

Eastern Seaboard to New York Harbor.[38] The smaller Plantation Pipeline carries as much as 600 kb/d mainly to the mid-Atlantic. The Eastern Seaboard also imports about 1.1 mb/d of product from abroad.[39] Aside from the relatively small quantities of heating oil and gasoline held in the NEHHOR and NGSR, respectively, in the event of a Gulf Coast disruption the region must rely on commercial product stocks stored in the region or additional imports. Commercial product stocks in the Northeast seasonally fluctuate, but between 1990 and 2010 they averaged about 5 mb each of gasoline and distillates.[40] Those numbers have been lower in recent years, and when Hurricane Harvey hit in 2017 there were enough gasoline stocks for only about ten days of consumption (about 400 kb/d of gasoline in New England).[41] From Europe, imports can take between a week and a month to arrive, presuming they are available.

Given these vulnerabilities, the lack of product stocks may seem to be an oversight. However, as mentioned, the cost of storing refined products has been a major factor in considering an all-crude SPR. The cost of storing refined products varies significantly based on storage method, location, product, and fixed versus operating cost. As an example, for Fiscal Year, 2018 the average Northeast Home Heating Oil Reserve (NEHHOR) leased commercial storage cost for heating oil is $9.08 per barrel per year and tight conditions mean the average Northeast Gasoline Supply Reserve (NGSR) leased commercial storage cost for gasoline is $19.62 per barrel per year.[42] In comparison, the cost to store crude oil in the SPR is $0.21 per barrel per year.[43] In Europe, average costs tend to be higher than in the United States, reflecting greater product stockholding and generally higher construction costs. The IEA calculates that across all its members, total yearly oil stockholding costs range from about $7 to $10 per barrel.[44] However, this calculation also includes the cost of acquiring the oil itself, which accounts for between 50 and 85 percent of the total figure depending on oil prices and product mixes.

## Debates

When it comes to American strategic product stocks, discussions and debates over risks, design, and costs have certainly taken place, but usually as a reaction to events. Like most large conservative organizations, the government always risks fighting the last war. Still, the debate over the establishment of a US strategic oil product reserve has evolved, and it is useful to recap

38 Kevin Saville, "Oil Factbox: Texas Refineries, Pipelines, Ports Continue Post-Harvey Recovery," S&P Global Platts, September 2, 2017, https://www.platts.com/latest-news/oil/newyork/oil-factbox-texas-refineries-pipelines-ports-21824122.

39 "PAD District Imports, East Coast (PADD 1)," US Energy Information Administration, last updated September 29, 2017, https://www.eia.gov/dnav/pet/pet_move_impcp_a2_r10_EPP0_IP0_mbblpd_a.htm.

40 "Stocks of Motor Gasoline, Distillate Fuel Oil, Residual Fuel Oil, Propane and Propylene, New England," US Energy Information Administration, last updated September 29, 2017, https://www.eia.gov/dnav/pet/PET_STOC_TS_DCU_R1X_M.htm.

41 "Midwest and Rocky Mountains Transportation Fuels Markets," US Energy Information Administration.

42 As per December 2017 discussions with DoE officials regarding FY2018 storage costs.

43 US Senate Committee on Energy and Natural Resources, "Senate Hearing 111-67: Testimony on S.967 and S.283."

44 International Energy Agency, *Energy Supply Security*.






A Cascadia fuel truck re-supplying an Irving station in West Lebanon, New Hampshire. December 14, 2008. Photo by Jason Lawrence

the conversation within the government over the past decades.

Holding refined products as part of the SPR has been considered since its creation in 1975. However, the initial Strategic Petroleum Reserve Plan prepared by the Federal Energy Administration (FEA) and sent to Congress in 1977 found that it was more cost effective to maintain a centralized crude oil reserve rather than multiple oil product reserves dispersed around the country, and made the case that American refineries and a robust logistics system would amply protect the country as long as the refineries had sufficient access to crude.[45]

Subsequent DOE studies on the inclusion of oil products took place in 1982 and 1989, but each time the proposal was rejected as expensive and unnecessary. A 1998 DOE study into the creation of a home heating oil reserve did not make specific recommendations, but found that such a reserve would have net negative benefits.[46] Nevertheless, during the winter of 1999-2000, home heating oil prices nearly doubled in some northeastern locations, and lawmakers pointed to the sharply lower levels of commercial middle-distillate stocks going into the winter. With support from the White House, Congress included $8 million in the fiscal year 2001 Interior Appropriations Act to establish the NEHHOR, and sites in New Haven, Connecticut, Woodbridge, New Jersey, and Providence, Rhode Island, were filled by the middle of October 2000 with 2 mb of high-sulfur heating oil to supply ten days of regional demand.[47]

Opponents raised the specter of the reserve being used at "inappropriate" times (to manipulate prices absent a real crisis), and the possibility that the NEHHOR would discourage the private sector from holding sufficient reserves themselves, and so the bar for release was raised. The NEHHOR's bespoke authorization requirements stated that the differential between crude and home heating oil prices would need to rise more than 60 percent above the five-year rolling average. That same year the 60 percent bar was reached, but only because crude prices fell, and the new reserve was not used. A proposed 2009 bill,

45 Bruce A. Beaubouef, *The Strategic Petroleum Reserve: US Energy Security and Oil Politics 1975-2005* (College Station: Texas A&M University Press, 2007).

46 "1998 Department of Energy Home Heating Oil Reserve Assessment Techline," US Department of Energy, Office of Fossil Energy, July 13, 1998, https://energy.gov/fe/listings/fe-press-releases-and-techlines.

47 "Northeast Home Heating Oil Reserve (NEHHOR) History," US Department of Energy, Office of Fossil Energy, accessed October 2017, https://energy.gov/fe/northeast-home-heating-oil-reserve-nehhor-history.

President Barack Obama delivers remarks on energy at the TransCanada Stillwater Pipe Yard near Cushing, Okla., March 22, 2012. The President highlighted the Administration's commitment to expanding domestic oil and gas production. (Official White House Photo by Pete Souza)

which was ultimately defeated, would have mandated NEHHOR release based on specific price triggers.[48]

In 2005, the Energy Policy Act[49] directed the secretary of energy to increase the SPR capacity to one billion barrels, a move that appeared prescient when Hurricane Katrina made landfall along the Gulf Coast less than three weeks after the bill's passage. Offshore crude oil production in the Gulf of Mexico was badly hit, and a quarter of national refining capacity was down, as well as import terminals and some pipelines. Amidst a tight global oil market and the perception of runaway Asian demand, then President George W. Bush authorized an emergency drawdown of the SPR on September 2 following requests from refiners and as part of a coordinated emergency response by the IEA.[50] Awards were made for 10.8 mb from the SPR, and deliveries began on September 26. The response to Katrina from the SPR and the wider IEA emergency regime was timely and generally seen as a success in global oil market management. Crude prices were kept down 3-4 percent off pre-storm prices through the month despite continuing offshore outages, fell over 20 percent in the three subsequent months, and remained below pre-Katrina levels well into 2006.[51] However, the response was ineffective at addressing the oil product price spikes and shortages that affected American consumers in the storm's wake.

The following year, a Government Accountability Office (GAO) study found that the ability of the SPR to mitigate economic damage could be impaired by a

48 US Senate Committee on Energy and Natural Resources, "Senate Hearing 111-67: Testimony on S.967 and S.283."

49 Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005).

50 "History of SPR Releases," US Department of Energy, Office of Fossil Energy, accessed October 2017, https://energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/releasing-oil-spr.

51 "Fact Sheet: Department of Energy Response to Katrina," US Department of Energy, Office of the Secretary, last updated September 2, 2005, https://energy.gov/downloads/department-energy-response-hurricane-katrina.





lack of refining capacity (due to damage or otherwise) or by transport bottlenecks to or from refineries.[52] Indeed, in the three weeks after Katrina, gasoline prices in the Gulf Coast spiked 38 percent and diesel 41 percent after twenty-one refineries had been shut down or seen capacity reduced, and as power outages had shut some pipelines in the affected areas. It took a week for the Colonial Pipeline to return to full capacity. Eventually a 25 percent increase in product imports brought those prices back down, but price hikes and physical shortages lasted much longer in some inland regions.

These conclusions came as the DOE was directed to expand the SPR. In a post-9/11 world with a huge new department for homeland security and increased emphasis on critical infrastructure protection, Katrina sparked a new concern about domestic oil product vulnerabilities. Like many other government security tools during this time, the SPR was starting to be seen as more than just a defensive weapon in an international oil "cold war," but also as a tool that could be used to mitigate threats to the homeland.

In 2008, Hurricanes Gustav and Ike delivered an arguably stronger blow to the Gulf Coast refinery complex. While the IEA did not implement an international coordinated emergency action due to prevailing global oil market realities, the DOE implemented an SPR exchange—a process meant principally to replace SPR oil, but one used in practice to address short-term disruptions under a lesser authority. The exchange in response to Gustav resulted in deliveries starting on September 9. Ike made landfall on September 13 with devastating effect, including on SPR facilities. After repairs, the SPR deliveries continued under a second exchange authority until mid-October, delivering a total of 5.39 mb to refiners between the two actions.[53] The double whammy of Gustav and Ike caused the familiar acute product shortages, sending regional gasoline prices up 22 percent and causing gas stations to go empty, until eventually a 30 percent increase in product imports slowly and unevenly began to normalize the situation once again, re-igniting the question of strategic product reserves.

A 2009 GAO report specifically about refined product reserves outlined some of the arguments for and against their establishment.[54] In addition to citing increased product import dependence and the Katrina experience of reduced refining capacity, the report discussed the bottlenecks and delays that could hamper seaborne product delivery in times of regional shortage. While some of that is related to transport times (a week minimum for European shipments to the Northeast, and longer for the Pacific coast and the Midwest), the report also cited bottlenecks at import terminals where ports were operating at capacity. After Katrina, some European oil product shipments to the Northeast were stuck in port for as long as two weeks. The arguments the report cited against such stocks included a surplus of European gasoline as the continent switched increasingly to diesel; higher storage costs for refined products (the NEHHOR had been halved in 2008 due to cost); reduced product fungibility as a result of "boutique blends"; and slowing US demand growth. Notably absent were the same arguments that had arisen surrounding the NEHHOR—particularly the risk of product reserves crowding out private storage investment, or hindering price signals from effectively incentivizing replacement shipments from Europe.

In 2009, Senator Jeff Bingaman (D-NM) and Senator Byron Dorgan (D-ND) introduced the S.967 Strategic Petroleum Reserve Modernization Act, which proposed amending the 1975 Energy Policy and Conservation Act to require that the SPR contain at least 30 mb of refined product. While the bill ultimately failed, the Senate Committee on Energy and Natural Resources hearings on the proposal yielded useful information.[55] Deputy Assistant Secretary for Petroleum Reserves David Johnson testified that markets "south of Virginia and north of Florida" had less access in 2005 and in 2008 to timely European product deliveries (some of which he claimed were freed as a result of the 2005 IEA joint action). He added that the Barack Obama administration had "not yet made a decision" on the issue of a refined product reserve, but noted that

> there are several areas in the United States that primarily receive their refined products through a single mode of transportation. For example, there are parts of the western United States that would be completely cut off from fuel supplies if

52 US Government Accountability Office, *Strategic Petroleum Reserve: Available Oil Can Provide Significant Benefits, But Many Factors Should Influence Future Decisions about Fill, Use, and Expansion*, August 3, 2006, http://www.gao.gov/assets/260/251209.pdf.

53 "History of SPR Releases: 2008 Gustav and Ike Exchanges," US Department of Energy, Office of Fossil Energy, accessed October 2017, https://energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/releasing-oil-spr#2008Exchange.

54 US Government Accountability Office, *Strategic Petroleum Reserve: Issues Regarding the Inclusion of Refined Petroleum Products as Part of the Strategic Petroleum Reserve*, May 12, 2009, http://www.gao.gov/assets/130/122513.pdf.

55 US Senate Committee on Energy and Natural Resources, "Senate Hearing 111-67, Testimony on S.967 and S.283."

Figure 9. Strategic Oil Product Infrastructure in the Northeast


*Source*: US Department of Energy, Long-Term Review of the US SPR, 19.

an earthquake or other disaster affected refinery or pipeline operations.[56]

The director for energy markets and security at the IEA noted that even with more expensive product stockholding, the low cost of crude SPR holdings (10 percent of costs elsewhere) would mean that total US strategic reserve costs per barrel would still be well below those of other IEA members. He pointed to the 2007 Emergency Preparedness Review of the United States in which "the IEA advised the United States Government to consider holding product stocks as part of any expansion of the Strategic Reserve and to consider a wider distribution of the reserve throughout the country." His testimony went further, asserting that "we encourage the US to procure additional SPR barrels in the form of product stocks, held in storage more geographically spread across the country."[57]

Likely as a response to clear congressional interest, in 2009 the DOE began commissioning a series of pre-feasibility studies from storage construction companies to build a refined oil product reserve (of gasoline and diesel) specifically to serve the Colonial and Plantation Pipeline complexes. While these studies are limited mostly to capital expenditure requirements for different types of tanks, caverns, and storage methods, they provide insight into DOE thinking ahead of Hurricane Sandy. The original 2009 vision was in line with the size requirements of the shelved S.967, and mirrored the DOE risk view outlined by Johnson. It analyzed the feasibility of a centralized product reserve of 20 to 50 mb in Mississippi, but subsequent iterations looked at more decentralized options, along the Colonial Pipeline in particular.[58]

Prior to Hurricane Sandy, those feasibility studies also examined scenarios to lease storage space (as is the case with the NEHHOR) full time or seasonally, rather than construct new government-owned caverns or tank farms. SPR expansion plans had been axed in 2011 and there was little appetite to fund the construction of large new facilities. The updated feasibility studies estimated that high utilization of existing commercial storage capacity would mean leasing rates in the upper range (at $6 or more per barrel per year plus premiums for logistical advantages) and envisioned five to seven sites of about 1 mb each containing mostly gasoline and located mostly in the "interior Southeast."[59]

These studies, along with Johnson's 2009 congressional testimony, show that the DOE perceived the major risks to oil product supply security after Katrina to be those risks exposed by the storm—specifically that Gulf Coast hurricanes could damage US refining capacity and major product pipelines, particularly the vital Colonial (and to a lesser degree Plantation) system, and moving product imports inland meant that the Southeast was the weak spot.

However, as is often the case when the government is busy fighting the last war, the next one can be violently thrust upon it. Hurricane Sandy wreaked havoc on the Eastern Seaboard and particularly on New York in October 2012, leaving more than forty terminals in New York Harbor inoperable and some New York gas stations without fuel for as many as thirty days. The local shortages caused by Sandy, however, would not have been alleviated by any of the options under consideration since 2009 to modify the SPR. Gasoline shortages were not due to a lack of product in local commercial inventories, but rather to power outages that impeded the ability to get product out of the tanks and into trucks. Sandy made clear that weaknesses in the supply system were a question of not only refining and mainline midstream vulnerabilities, but potential impacts at the point of distribution.

The impetus to address oil product vulnerabilities exposed by Sandy seemed stronger than the response to Katrina. Rather than years of feasibility studies, DOE officials have described discussions following the storm and into 2013 as "frenzied."[60] That is perhaps due to greater vested interest from the White House—the principal energy advisor on the National Security Council reported on the gasoline shortages after Sandy firsthand while back home.[61]

Whatever the cause, by May 2014 the DOE announced the creation of the Northeast Gasoline Supply Reserve. The NGSR holds 1 mb of gasoline in leased tanks at three locations: 100 kb at South Portland, Maine, 200 kb at Revere, Massachusetts, and 700 kb at New York Harbor. The region consumes 50 percent more than that each day,[62] and most commercial product storage sites installed independent power generation for their pumps after the storm. Thus, the NGSR is practically useful only in providing quick emergency response. The psychological effect of its existence may help keep product prices down, but those same effects would then arguably also have the adverse impacts on private sector investment and emergency allocation that critics of the NEHHOR originally raised.

In addition, unlike the NEHHOR, the NGSR was established by fiat rather than by legislation—likely for expediency in a deeply polarized political climate. As a result, it had to be rolled into the existing authorization clause of the original 1975 Energy Policy and Conservation Act governing the SPR, which expressly mandates release only in the case of nationwide economic impact.[63] Thus, absent some emergency legal fudge, the NGSR would not necessarily be available during precisely the type of crisis it is meant to address. Congress has taken note, and consistently complicates NGSR funding while making clear that any future oil product reserve would require legislative approval, appropriation, and significant advanced warning.

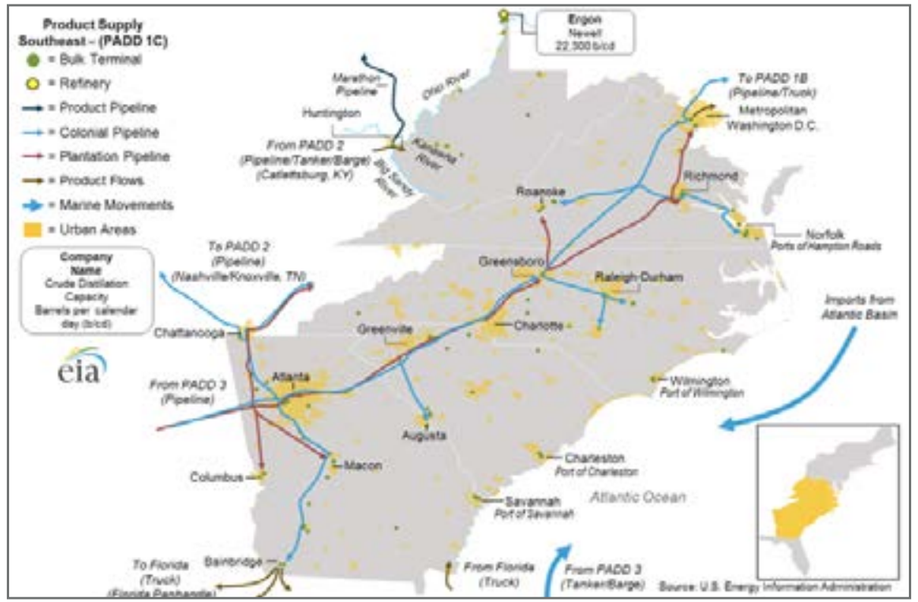
In the same 2014 press release[64] announcing the creation of the NGSR, the DOE heralded the upcoming launch of the first Quadrennial Energy Review (QER). This strategic posturing exercise was based on the Quadrennial Defense Reviews, which have underpinned Department of Defense policy and planning for decades. The release stated:

> The first installment of the QER review will focus on the United States' infrastructure for transmitting, storing and delivering energy. As part of this process, the Energy Department will conduct a series of regional fuel resiliency studies to analyze the specific challenges faced by different parts of the country that are vulnerable to a variety of weather-related natural disasters that could potentially affect energy supply infrastructure. Because of the interdependencies inherent to the U.S. energy infrastructure, even where regional refined product reserves may play a role in enhancing fuel resiliency, they will be but one part of a system intended to minimize potential disruptions in fuel distribution.

These regional fuel resiliency studies were undertaken to conduct precisely the risk analysis needed to inform cost-benefit decisions on further strategic oil product reserves—and to provide a methodical and coherent

56 Ibid.
57 Ibid.
58 Parsons Brinckerhoff, *Feasibility Study for a Refined Petroleum Product Reserve;* 2010.
59 Parsons Brinckerhoff, *Revised Conceptual Design Report for a Refined Petroleum Product Reserve; 2012*.
60 Per summer 2017 interviews the author conducted with DOE officials.
61 "How an Obama Insider Tackled New York's Meanest Hurricane, and Moved On," Greenwire and Environment and Energy Publishing, via Columbia University, School of International and Public Affairs (SIPA), Center on Global Energy Policy, last updated February 4, 2013, http://energypolicy.columbia.edu/newsmaker-how-obama-insider-tackled-new-yorks-meanest-hurricane-and-moved.
62 "Supply and Consumption of Gasoline in Northeastern United States from 2007 to 2011 with Projections through 2013 (in 1,000 barrels per day)," Statistica, accessed August 2017, https://www.statista.com/statistics/220405/supply-and-consumption-of-gasoline-in-northeastern-united-states/.
63 Energy Policy and Conservation Act of 1975, Pub. L. 94–163, 89 Stat. 871 (1975).
64 "Energy Department Announces First Regional Gasoline Reserve to Strengthen Fuel Resiliency," US Department of Energy, last updated May 2, 2014, https://energy.gov/articles/energy-department-announces-first-regional-gasoline-reserve-strengthen-fuel-resiliency.

Figure 10. East Coast and Gulf Coast Transportation Fuels Markets.




Source: US Energy Information Administration, February 13, 2016.

review of the legal and logistical parameters of those reserves to bring consistency to any subsequent product stockholding regime.

However, when the first installment of the QER was released, those studies were not included. Only PADD 5 (West Coast) analysis had been done in late 2014, and the document stated that the study process was ongoing.[65] However, as work progressed it seems that the complexity of modeling the various associated risks overwhelmed the initial methodology. Further analysis of the US Southeast in summer 2015 and other PADD 1 (East Coast) regions in 2016 caused internal debates about the methodology's value, and ultimately the work was shelved in the summer of 2016.

So, while the QER does contain an extensive discussion about updating the SPR itself (citing the new crude oil production and demand geography and changed global markets), discussion about regional petroleum product stocks (RPPRs as described by the QER) is necessarily limited by the lack of analysis, an issue that continues at the time of this writing.

## Risks

While conducting a quantitative site-by-site risk analysis is outside the scope of this study, general risks can be identified. Some have already been recognized by preliminary DOE analysis, comments from specialists in specific areas, and experience.

Risks are the product of relatively high vulnerabilities to various events, combined with a relative difficulty of addressing their effects in the event of disaster. Around the United States, the most concerning geographic areas are those that:

- are heavily dependent on one mode of oil product delivery (such as a single pipeline or road/rail corridor), particularly if that mode is subject to risk of closure;
- have little or no local refining capacity, or risk losing access to crude supply;
- do not have local accessible commercial product storage that is regularly sufficient to meet at least a week of local demand;

65 US Department of Energy, *Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure*, April 2015, https://energy.gov/sites/prod/files/2015/04/f22/QER-ALL%20FINAL_0.pdf.





Houston Hobby Airport flooded and closed due to Hurricane Harvey. August 27, 2017. Photo by Tony Dortie

- are prone themselves to natural events that may damage surrounding infrastructure (roads, power, refining assets, commercial fuel storage, ports, product pipelines);
- are not easily supplied in a timely manner by seaborne fuel shipments; and
- contain economic assets that are important for emergency response or daily needs and dependent on specific fuels (airports that need jet fuel, first responder hubs that need gasoline).

A major take-away is that pertinent risks facing oil product supply are the combination of multiple overlapping and interdependent events. In the Northeast, depleted commercial product stocks from hurricanes that shut Colonial Pipeline deliveries, combined with local power outages or road closures as a result of the same storm or independent weather events, could quickly result in shortages of gasoline, diesel, and jet fuel.

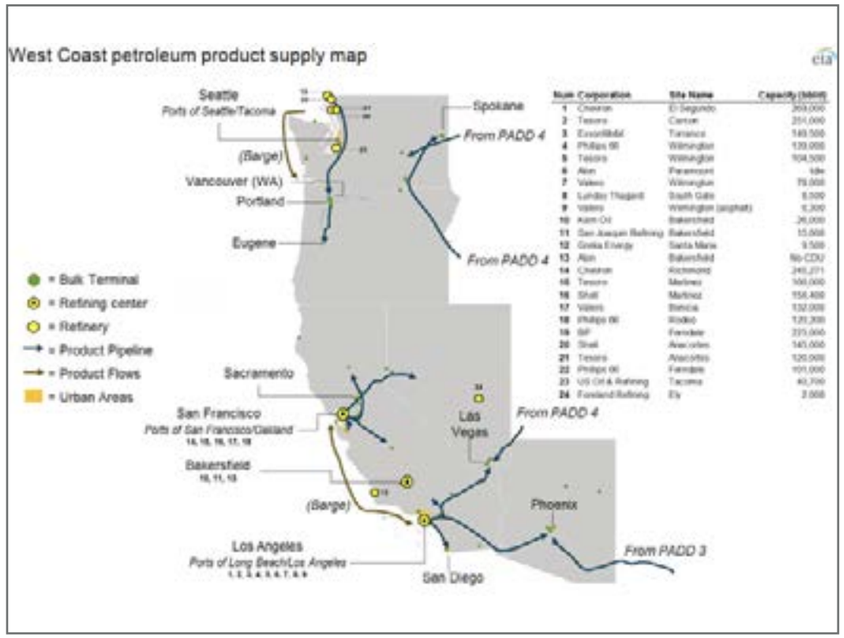
Indeed, double hurricanes are a major risk factor. That was the case during Gustav and Ike, when recovery efforts in the oil sector and commercial stock coverage were complicated by another storm a few days later. During such a scenario, industry stocks get low, and do not have sufficient time to replenish. That happened along the Colonial Pipeline in 2008, causing real product shortages that even threatened such major customers as jet fuelers at the Atlanta airport—the world's busiest.

As hurricanes become stronger and more frequent due to climate change, those risks are likely to increase.[66]

Risks can also result from failures of the existing system. In September 2016, a major leak along the Colonial Pipeline in Alabama forced a week-long closure of the line. Gasoline supplies were reduced

66 "Global Warming and Hurricanes: An Overview of Current Research Results," National Oceanic and Atmospheric Administration, Geophysical Fluid Dynamics Laboratory, last updated August 30, 2017, https://www.gfdl.noaa.gov/global-warming-and-hurricanes/. The link between global warming and hurricane risk is sufficiently convincing to realistically make that claim, whatever one may think about the causes of global warming.

Figure 11. West Coast petroleum product supply map




*Source*: "Today in Energy," US Energy Information Administration, February 27, 2015.

in Alabama, Georgia, Tennessee, and the Carolinas, sending pump prices up almost 20 percent in South Carolina and leaving many rural gas stations empty.[67] Waterborne shipments to the region increased by 58 percent (despite high costs as a result of the Jones Act), and eventually the line was repaired.[68] The incident revealed that even absent external events, systemic failure could have significant impact.

In a general sense, the inland Southeast continues to be the major risk point due to its ongoing reliance on domestic product deliveries from the Colonial Pipeline, the high risk posed to its own region and refining sector by catastrophic weather events, and the unique difficulties of supplying it by alternative means including seaborne imports. In short, oil production distribution in the inland Southeast suffers from both vulnerability and an acute lack of redundancy.

Another area of concern recognized by the DOE is in PADD 5, the isolated West Coast. The potential for earthquake damage in both Washington State and California can induce product shortages at points where large areas are served by only one oil transport link and could suffer road damage. The experience of Japan in 2011 should serve as a reminder of this risk.

Thanks to its sizable refining capacity and plentiful access to both crude and products from various sources, the Midwest is generally less prone to oil product shortages, particularly of a nature where very brief shortages could cause outsized damage. There is some evidence that propane could be at risk of possible shortage to some degree, but the duration and largely agricultural impact of any potential propane shortage is a clear example of where the market would be best placed to respond.[69]

67 Jeff Martin and Shameka Dudley-Lowe, "Pipeline Will Soon Reopen, Carrying Gasoline to 5 States," Associated Press, September 20, 2016, https://apnews.com/30a8d7f3b8af4123bae3a232cd440f12/alabama-governor-praises-pipeline-companys-response-leak.

68 Planet, "The Anatomy of a Pipeline Accident: The Colonial Pipeline Spill," A Medium Corporation, May 17, 2017, https://medium.com/planet-stories/the-anatomy-of-a-pipeline-accident-the-colonial-pipeline-spill-d30bb2a5941d.

69 In the winter of 2014 an acute propane shortage resulted in government measures to ease distribution of the fuel. In the wake of that shortage, the National Propane Gas Association sent the "Letter from the National Propane Gas Association to the Department of Energy, Comments on the Quadrennial Energy Review," via US Department of Energy, October 7, 2014, https://energy.gov/sites/prod/files/2015/04/f21/National%20Propane%20Gas%20Association%20QER%20Comments.pdf.



# MAKING US STRATEGIC OIL STORAGE FIT FOR PURPOSE:
## Lessons and Recommendations

Existing proposals for US strategic product reserves have met various criticisms. During the debate surrounding the Northeast Home Heating Oil Reserve (NEHHOR), those criticisms focused on private sector product storage displacement and a diminished incentive to arrange emergency import cargoes. In practice, however, the small size of both the NEHHOR and the Northeast Gasoline Supply Reserve (NGSR) that these risks never really materialized in the past, and subsequent studies failed to mention them.

Still, market distortions are a potential risk. The unanticipated introduction of new supply via an SPR release into a tight market could undermine industry profitability and potentially drive smaller players out of business. It is also true that the continuous churning in private inventory may be the cheapest way to keep gasoline or other products fresh. In the United States, refiners and blenders transport and sell dozens of individual "boutique blends" during the course of a year. Storing all these blends would require active management of significant inventories.

The variety of products to be held is also an issue, with about three-quarters of US refiners' runs in the form of light products. If gasoline comprises only about 55 to 60 percent of total product volumes, should a reserve contain other products? Logistically, storing the product reserve away from the Gulf Coast might come at the impractically high price of new supporting infrastructure. Pipeline pumping equipment shares a common vulnerability with refineries themselves—both need power. Even if strategic reserves were available in the immediate aftermath of a serious disruption, pipelines might prove inoperable.[70]

From a technical perspective, how should oil products be held? Given their need to function during emergencies, strategic storage sites clearly require a special degree of hardening. The most secure way to store oil is generally in underground caverns, doing away with a large surface footprint of storage tanks vulnerable to weather or attack, in favor of an eight-foot-diameter surface dome and protected underground pumping infrastructure. These are more capital intensive, however, and are generally viable only at volumes above 500 kb—requiring more centralized reserves and up-front capital outlays. Recent innovations such as smaller-volume silo caverns present new solutions, but trade-offs are persistent.[71]

All these problems with and arguments against potential forms of strategic product stockholding in the United States are legitimate, and lessons drawn from both foreign experience and American debates are worthwhile in considering how to move forward.

### Lessons

- **Risks, especially those to PADD 1 (East Coast) and PADD 3 (Gulf Coast), stem from multiple overlapping, interdependent events.** Power failures, floods, communications breakdowns, and other surrounding events can exacerbate potential catastrophes. In the case of the eastern and southern United States, double hurricanes like Gustav and Ike can knock out infrastructure and deplete storage, then hit again before repairs are complete or storage has been replenished. That was also the view among European partners like the Netherlands who, despite an otherwise secure, interconnected, and flexible refining and oil product system, recognized that weather threats could impact multiple systems at once.
- **Too-small reserves are a waste of money (beyond supporting first responders, which could otherwise be done more efficiently).** While the NGSR may have been useful under the specific circumstances posed by Hurricane Sandy in 2012, subsequent hardening of commercial storage facilities means that at this point it is useful only if commercial stocks in the same areas have depleted (which was not the case during Sandy). However, if that becomes the case, then less than half a day of demand will not do much good. There is a case, as described by one DOE official, to "go big or go home."[72]. It is of course impossible to go infinitely big – the key is optimization.

70 US Senate Committee on Energy and Natural Resources, "Senate Hearing 111-67: Testimony on S.967 and S.283."

71 Per discussions the author conducted with Michael Tritt of Lane Power & Energy Solutions, October 2017.

72 As per discussions with DOE officials in July 2017.

- **Sustained disruption to intra-regional transport for liquid fuels is unlikely.** Unlike international crude oil supply shortages that may squeeze markets and take several months to subside, regional shortages are primarily a question of impaired access to a specifically dependent area. As discussed during the Atlantic Council roundtable in Paris, it takes about ten days to restore fuel services after a major disaster or event. Any requirement for emergency product storage is only short term, before the market can allocate sufficient product.

- **There are clear examples where the market works, and the risks of stockholding to efficient market operations should be recognized.** The market will most efficiently allocate oil products, and government policy should not be meant to tip private sector production or storage decisions. Storage location and release authority should be mindful of dis-incentivizing private fuel storage or shipments, and crowding out the market. That said, emergency response is designed for those occasions when the market will (understandably) not bear the cost of low-probability events to ensure service continuity or public safety. Maximizing positive impact while minimizing adverse economic incentives requires clear and simple delineation of public and private assets, and clear definitions of emergencies and respective responsibilities.

- **All emergency fuel distribution plans should be as independent as possible of outside power, communications, or fuel dependency.** The lesson from Hurricane Sandy was not that commercial storage was insufficient, but that it was dependent on outside power. After Katrina, efforts to harden installations proved relatively successful by the time Gustav and Ike hit in 2008. However, by 2017 it was unclear whether new facilities built as a result of the shale revolution had incorporated those lessons.[73] Strategic product stocks are useful if they operate when normal infrastructure does not, and so storage, release, and distribution should be hardened, providing independence from outside needs.

- **Release authority should be reviewed, and future product reserves should seek tailored funding and authority from Congress.** New legislation is necessary to stipulate regional product storage release authority for the NGSR or any new reserve absent national SPR release conditions. NGSR funding outside the appropriations process puts the reserve at financial risk and also makes it a target for legislators. Therefore, any future efforts to acquire strategic product reserves should make the case to Congress and secure both appropriations funding and proper release authority.

- **The long view is uncertain due to major changes on the oil product demand side.** The effects of major unforeseen changes in the geography of American crude production over the past decade have led many to question the size, cost, and role of the SPR. While construction of the SPR lowered the marginal costs of storage, adapting large, capital-intensive, government-owned infrastructures to changing dynamics is expensive. Plus, experience has shown that the initial rationale for centralization was based on a specific industrial layout that was not as permanent as once thought. Today the coming change is on the demand side, and perhaps soon, suggesting that the United States should exercise caution before embarking on any large capital-intensive public oil storage projects. Technological disruption in transport from autonomous electric vehicles could happen much faster than predicted (especially in the Northeast and in California). Models for electric vehicle penetration vary, but the uncertainty that underpins that range is based around a few inflection points that will become much more apparent before the end of the decade, including policy uncertainty surrounding autonomous vehicles, battery improvements, and technology and social changes.

Ultimately, the trajectory of future demand is uncertain. Traditional forecasters remain conservative, with the IEA's Electric Vehicles Initiative target calling for twenty million electric vehicles (EVs) by 2020. The IEA's most aggressive forecasts are policy driven, seeing only 2 percent penetration in the United States by 2020.[74] Other observers, which emphasize the rates of technology and cost improvements, project more rapid adoption. Bloomberg New Energy Finance sees cost equivalency for electric vehicles and internal combustion engine (ICE) cars by 2026,[75] while the

73 Antoine Halff, *From Katrina to Harvey: Storm Resilience in the Age of Shale*, Columbia University, SIPA, Center for Global Energy Policy, August 2017, http://energypolicy.columbia.edu/sites/default/files/From%20Katrina%20to%20Harvey_Storm%20Resilience%20in%20the%20Age%20of%20Shale.pdf.

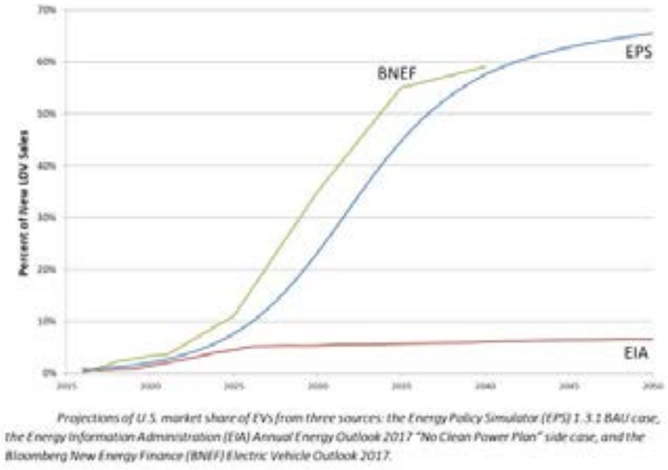
74 International Energy Agency, *Global EV Outlook 2016*, 2016, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf.

75 Bloomberg New Energy Finance 2016, as cited in International Energy Agency, *Global EV Outlook 2016*.





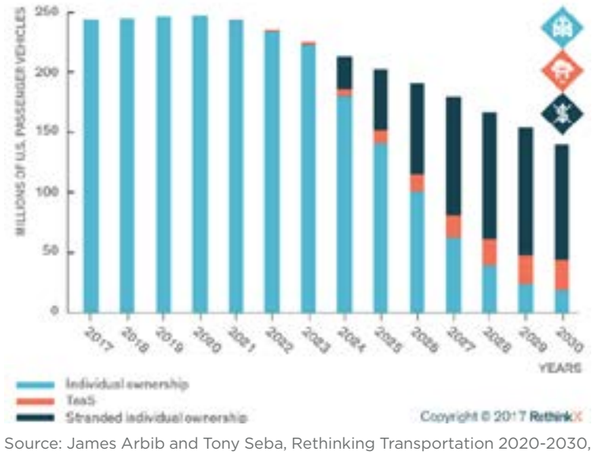
Figure 12. Projections of US market share of EVs from three sources




*Projections of U.S. market share of EVs from three sources: the Energy Policy Simulator (EPS) 1.3.1 BAU case, the Energy Information Administration (EIA) Annual Energy Outlook 2017 "No Clean Power Plan" side case, and the Bloomberg New Energy Finance (BNEF) Electric Vehicle Outlook 2017.*

Source: Jeffery Rissman, "Driving the Future: Electric Vehicles in the US," Energy Today, September 21, 2017.

Figure 13. Projected trends in fleet size composition




Source: James Arbib and Tony Seba, Rethinking Transportation 2020-2030, RethinkX, May 2017, 35.

most aggressive models (RethinkX) emphasize the cost differential of transport-as-a-service (TaaS, think Uber), predicting that TaaS could be two to four times cheaper than owning a vehicle by 2021, and that 95 percent of US passenger miles driven will be served by TaaS by 2030.[76] Fleet economics for EVs are much more favorable, and fleet renewal faster. If the case for strategic product storage is marginal, and if the possible inflection point away from ICE cars could be so soon and so sharp, there is incentive to hold off on expensive new-build product reserve facilities lest they become stranded assets.

## Recommendations

Based on these lessons, the following steps should be taken toward the establishment of a US strategic oil product reserve:

1. **The existing regional analysis created by the Department of Energy should be reviewed** and a simpler methodology chosen to reexamine regional oil product supply risks in the United States on a two-step basis.
    - Existing research should be used to the greatest extent possible and with minimal further cost to compile a preliminary list of vulnerable sites within one year. The initial list should focus on the inland Southeast and the West Coast, and sites should be identified in conjunction with local emergency agencies, local refiners, fuel providers, and major consuming entities.
    - In the second stage, a more detailed study of admittedly complex risk factors like hurricane frequency, earthquake risks, cyber threats, and other hazards should be conducted using a probabilistic risk analysis approach with as much input as possible from existing local engineering and critical infrastructure analysts.
2. **A "distributed model" for local government–owned stocks should initially focus on leasing storage for finished gasoline**, despite the higher cost, as well as a much lesser amount of jet fuel where the need is identified (for example at Atlanta's airport and other major hubs in the Southeast).
    - Transportation fuels are the most critical in the short term for first responders, evacuees, and a broad swath of the economy.
    - Sufficient gasoline storage should be leased directly and the product owned by the federal government (rather than in the form of tickets) at specific local points of vulnerability, with minimal new construction, on a long-term (five-year initial period) leasing basis that is less subject to temporary product storage market tightness.
    - Where possible, stockholding should use existing storage facilities at refineries, fuel distribution hubs, commercial tank farms, or large demand centers (like airports) and they should be commingled with existing private sector stocks to alleviate any need for government-managed rotation or issues with local boutique fuel blends.
    - The government would in effect be subsidizing greater storage within the existing refining logistics chain to cover ten to twelve days of supply within very small demand areas that have been marked for their vulnerability either due to experience or risk modeling.
3. **Government-owned stocks, on the basis of the leasing contract, should be stored in facilities with set requirements for hardening.** Where possible, small-scale underground storage solutions (recent "silo" cavern designs hold promise) should be encouraged to minimize vulnerabilities to above-ground weather or security risks. In addition, emergency distribution plans should be in place, optimally using multiple distribution methods with minimal requirement for outside power, communications, or fuel.
4. **Release authority should be decentralized** down from the president to the SPR administrator, but only on the basis of a declaration of emergency at the federal or state level. Sales should then be conducted directly to institutional customers (such as airports) or distributors on a localized basis to fulfill existing contracts.

76 RethinkX, *Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries*, May 2017, https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/591a2e4be6f2e1c13df930c5/1494888038959/RethinkX+Report_051517.pdf.



# CONCLUSION

The oil world has changed dramatically since the various IEA members came together to pool their strategic oil stocks in the 1970s. Like the Cold War, the idea of politically driven global "oil conflict" began to recede amid worldwide economic integration, increasingly complex overlapping national interests, and profound technological changes. Today, the concern is how to keep much more privatized and efficient systems from failing consumers or public interests in the face of more "mundane" threats. Across many IEA countries, those domestic concerns have driven the holding of more expensive oil products.

Despite having one of the most integrated, efficient, privatized, and complex oil sectors, US policy towards oil security is remarkably outdated. An all-crude, centralized SPR is increasingly less suited to the threats facing American energy security, and the time is right to seriously consider a more decentralized storage system attuned to the local risks brought on by hurricanes, earthquakes, or even low-level attacks. In discussing a more effective and responsive system, vital lessons can be learned from the experiences of foreign partners. While the US case is and will remain unique, it would be foolish to ignore international experience in the pursuit of American energy security.

This report recommends incremental implementation of strategic product reserves in a decentralized and limited fashion, avoiding large capital costs while sustaining higher per-barrel operating and leasing costs. While still responding to increasingly prevalent weather-related threats in a few regions, that approach offers time for more thorough regional risk analysis and to improve understanding of impending changes to oil consumption patterns on the horizon.

# ABOUT THE AUTHOR

**Phillip Cornell** is a nonresident senior fellow at the Atlantic Council's Global Energy Center. Prior to joining the Atlantic Council, Cornell was a senior corporate planning adviser to the chairman and chief executive officer of Saudi Aramco, where he provided market analysis and business development support to the executive management during the implementation of Saudi oil price strategy. In that capacity, he also provided advice to the Royal Court in the context of Saudi economic transition and foreign policy. From 2011 to 2014 he was special adviser to the executive director of the International Energy Agency (IEA) in Paris, responsible for strategic messaging and policy advice to the Executive Office of the IEA. In 2009-2010, he worked in the IEA department for strategic oil storage, and was responsible for organizing international exercises for strategic oil release. Before joining the IEA, Cornell served with NATO as the senior fellow and director of international programs at the NATO School (NSO) in Oberammergau, Germany, where his policy research focused on NATO and energy security. During that period, he also served on the secretary general's committee in Brussels to develop NATO policy in energy infrastructure security. Cornell has held research positions at the Naval Postgraduate School (Monterey), the Royal United Services Institute (London), and the Center for International Security and Cooperation (Stanford). He holds master's degrees with distinction in international economics (energy focus) and European studies (security focus) from the Johns Hopkins School of Advanced International Studies. He received his BA cum laude in international relations from Stanford University.

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