SHALE 3.0

THE REVOLUTION RESHAPING AMERICA AND THE WORLD

EXECUTIVE SUMMARY

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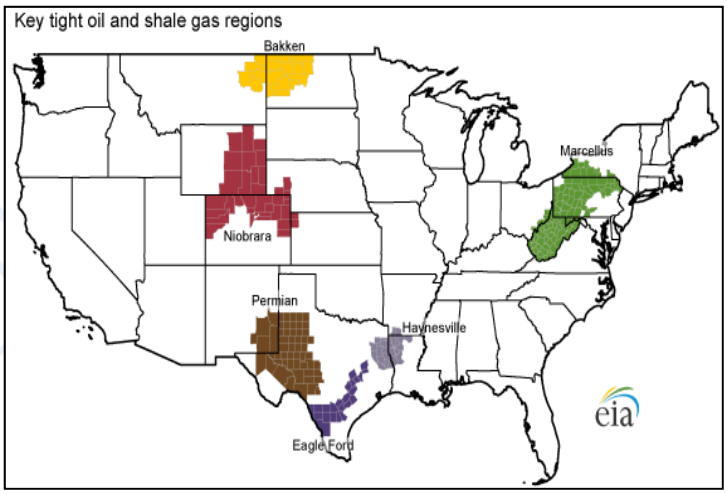
EXECUTIVE SUMMARY

**All charts used in this Executive Summary are sourced to the Energy Information Administration.*

ORIGINS OF THE SHALE REVOLUTION

The world has long known of the existence of a virtual ocean of underground oil and gas deposits imprisoned in "tight," low-permeable shale rock formations. Until recently, however, it was convinced there was no profitable extract them. Through the stubborn, decades-long persistence of a Texas oilman, and a committed effort by the U.S. government to invest hundreds of millions of dollars into "unconventional" oil and gas research, in 1998 Mitchell Energy CEO George Mitchell discovered the right combination of water, sand, and chemicals to extract natural gas from a shale formation using a hydraulically-fractured horizontal well.

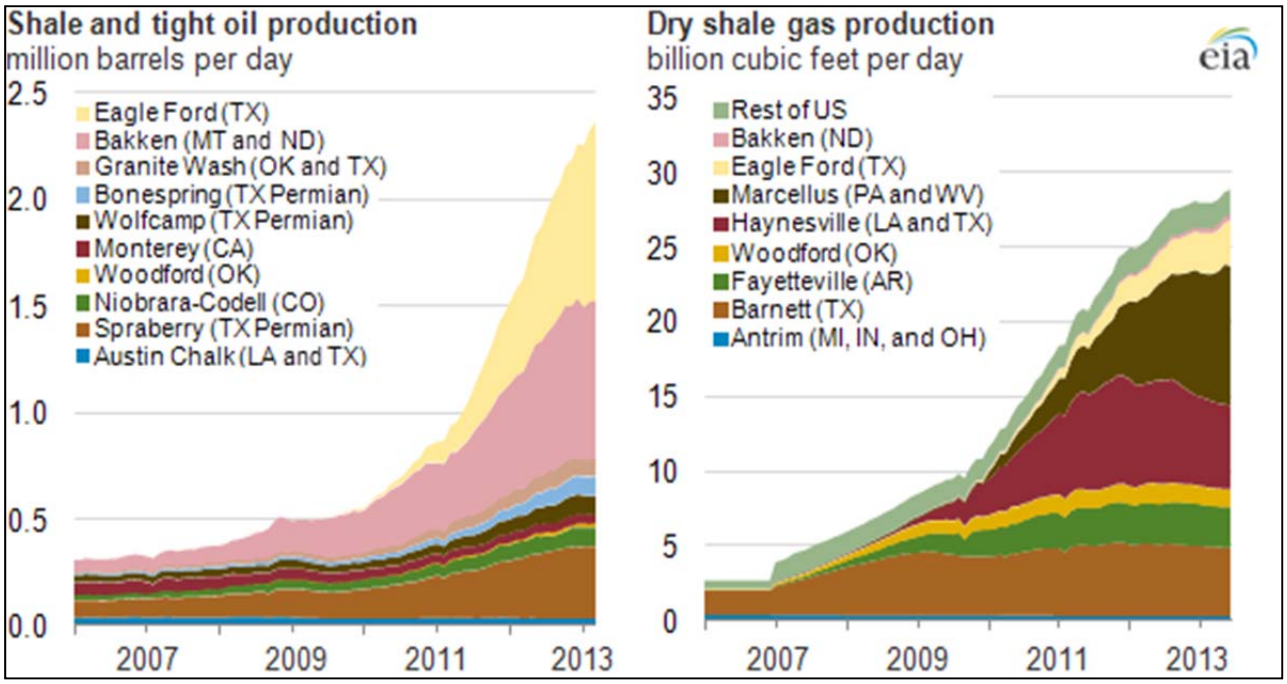
- **Shale 1.0: Research and Development Phase: 1970-1998**
- **Shale 2.0: Exploratory Phase 1999-2011**
- **Shale 3.0: Production Phase 2012-2016**



The efforts of Mitchell Energy and the Department of Energy were not nearly enough, however. The Shale Revolution owes its existence to:

- **The work of thousands of researchers, engineers, oil rig operators, chemists, geologists.**
- **A U.S. stock (2,000) of advanced drilling rigs; more than the rest of the world combined.**
- **Abundant water resources (shale wells require an average of 5.1 million gallons per well).**
- **World–class research institutes and world-class labor markets.**
- **A unique system of property rights granting underground mineral rights to landowners.**
- **Deep and liquid capital markets, and advanced technology like 3-D seismic imaging.**
- **Government incentives and regulations promoting research, development and production.**

Even with the benefits of America's "uniquely favorable ecosystem," the Shale Revolution was incomplete: with average "break-even" prices above $60bbl, the Shale Revolution remained stillborn amid the $20-25 oil prices of the 1990s and early 2000s. Only when the technology advances in 1998 were paired with the high oil prices of 2008-2014 was Shale 3.0 possible, transforming the U.S. into a 21st Century energy powerhouse.



The Shale Revolution required such a perfect storm of conditions it has yet to be replicated on a fraction of the scale anywhere else, despite an abundance of shale oil and gas reserves across the globe. Martin Houston says "the pace and scale…will not and probably cannot be replicated anywhere else."[1] The Energy Information Administration (EIA) predicts only Canada and Russia will be producing more than 1mbd of crude oil from shale reserves in 2040.

Table 2. Top 10 countries with technically recoverable shale oil resources

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	U.S.[1]	58	(48)
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Australia	18	
7	Venezuela	13	
8	Mexico	13	
9	Pakistan	9	
10	Canada	9	
	World Total	**345**	**(335)**

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

Table 3. Top 10 countries with technically recoverable shale gas resources

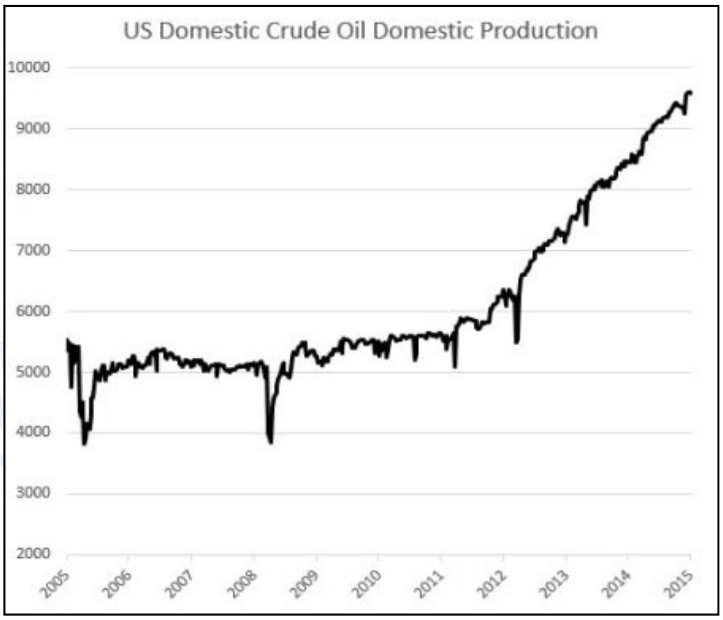
Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S.[1]	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	**7,299**	**(7,795)**

[1] EIA estimates used for ranking order. ARI estimates in parentheses.

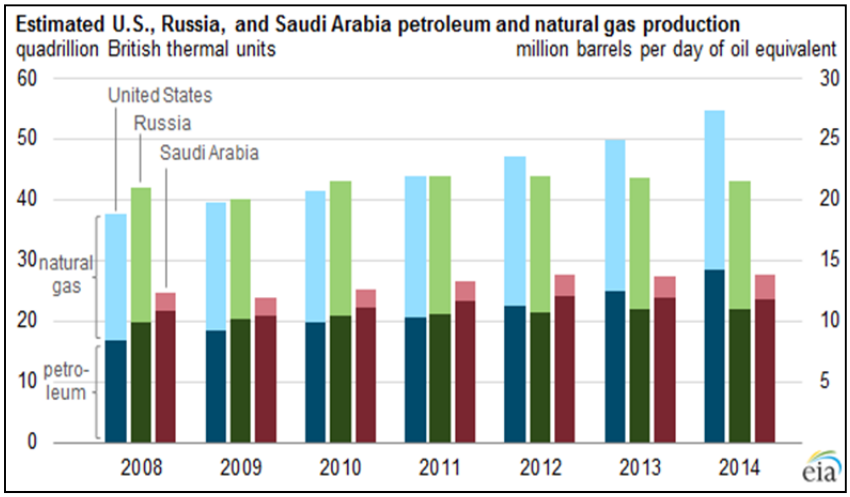
SHALE 3.0 (2012-2015) BY THE NUMBERS

Some 40-years in the making, Shale 3.0 needed only four years to create "an unexpected, technology-driven 'petrostate' of a type never seen before."[2] From 2012 to 2015 U.S. oil production surged by 50%, peaking at 9.6mbd in June 2015--the highest U.S. output in 40 years. America now accounts for 75% of the growth in world oil production.[3] Shale natural gas production, meanwhile, expanded by 700% from 2.1tcf to 13.4tcf between 2008 and 2014, helping total U.S. natural gas production hit an all-time record of 25.7tcf in 2014.

Production from shale plays now account for 49% of U.S. oil production and 56% of natural gas production. As late as 2006 the U.S. was importing record amounts of crude oil: 13.7mbd. By 2014, crude oil imports had shrunk by two-thirds and net natural gas imports reached their lowest level in 30 years. What's more, the Shale Revolution has:



- Contributed $43 billion per year to U.S. GDP, added 2.7 million American jobs-half the total job growth since 2005,[4] according to the Harvard Business School.
- Doubled American proved oil and gas reserves over 2008 estimates, from 20billion barrels to 40bb of oil, and adding 200tcf to U.S. proved natural gas reserves, now at 388.8tcf.
- Made the U.S. the leading producer of petroleum (crude oil and refined products) and natural gas in the world, overtaking Russia in natural gas production in 2011 and Saudi Arabia in total petroleum production in 2012.
- Shrank America's natural gas import bill from $8 billion in 2012 to $650 million in 2015.
- Helped shave an average 1.9md from America's oil import bill between 2010 and 2014, saving U.S. taxpayers some $60 billion in the process.



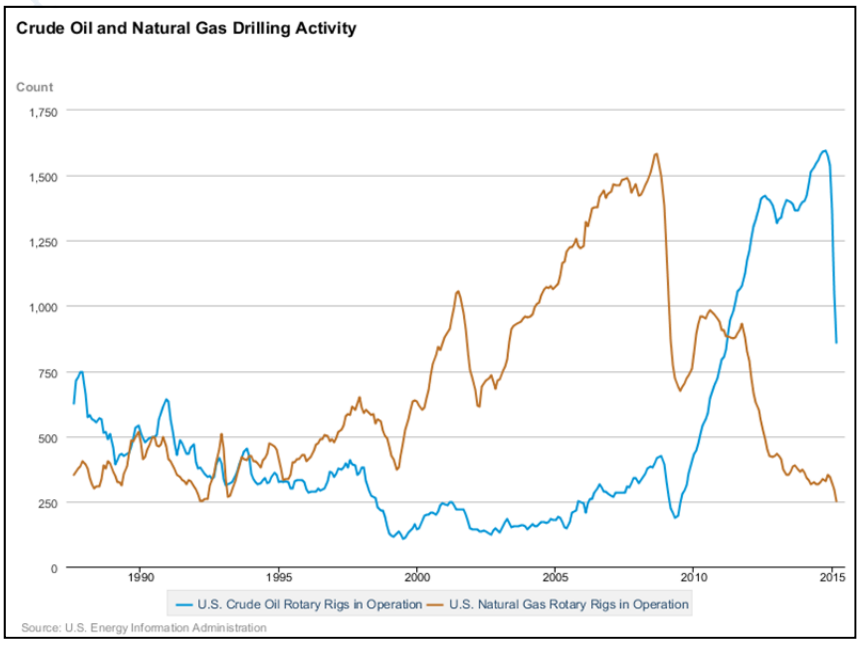
GREAT COLLAPSE

High oil prices sparked by the 1973 Arab Oil Embargo prompted the U.S. government to invest billions in unconventional oil and gas research. The high oil prices of 2008-2014 prompted the U.S. energy industry to invest equally impressive sums in U.S. shale oil and gas production. Today, however, the Shale Revolution faces an existential threat from a collapse in oil prices.

Late 2014 witnessed a market-driven cyclical downturn prompted in part by weaker Chinese growth and energy consumption: from 2010 to 2014 Chinese oil and natural gas demand growth fell from 11% to 1.6%, and from 20% to 5%, respectively.u8 As prices fell Saudi Arabia, the world's key swing producer, made a strategic decision: rather than cut production to stabilize prices, it "opted instead to flood the market and drive out rivals, boosting their own output to 10.6mbd into the teeth of the downturn."[5] Fearing loss of market share other oil producers followed suit. The price of a barrel of Brent crude halved between August 2014 and January 2015 ($98 to $48), reaching as low as $36 by December 2015.

SAUDI DECISION

- Many U.S. shale plays are believed to have a "break-even" price of $60: with oil selling below $60 they are no longer profitable. The Saudis believed cheap oil could undermine new rivals.
- Battle for market share: in the 1980s, Saudi production cuts (from 10mbd to 3.6mbd) to support falling prices resulted in a "dramatic loss of market share" while oil prices continued to drop.
- Saudi Oil Minister: "high efficiency producing countries are the ones that deserve markets share," while unconventional producers "will be greatly harmed before we feel any pain."[6]
- Saudi production costs per barrel of oil-$9.90 / U.S. production costs per barrel-$36.20.



FALLOUT FROM LOW OIL PRICES

- In early 2015, U.S. energy firms announced some 91,000 energy-related job cuts.[7]
- Shale investments were down by more than 20% in 2015.[8]
- From Oct. 2014 to June 2015 U.S. oil rigs in operation dropped 60% from 1,609 to 640.[9]
- Output from U.S. shale oil is expected to fall from 4.2mbd in 2014 to 3.9mbd in 2016.[10]
- Total U.S. oil production is expected to fall 5% in 2016 from 9.3mbd in 2015 to 8.8mbd.[11]
- Gazprom CEO Alexey Miller: "the shale revolution has fallen to a desolated underground."[12]
- The U.S. needs to drill 6,000 new wells per year ($35 billion) to maintain current production.[13]
- Total U.S. natural gas output is expected to decline slightly in 2016.
- Additional challenges from the rapid decline rates associated with shale extraction, which experience a 72% drop in production in the first 12 months, and 82% in the first two years.[14]

THE RESILIENCE OF SHALE

Despite failed to account for the adaptability and endurance of the shale industry and its stunning productivity gains. "If [Saudi Arabia] intended to strangle American shale producers, its plan has backfired, instead pushing frackers to become more efficient."[15] The shale industry is far more flexible and "price sensitive" than the conventional oil industry. Unlike the hundreds of millions of dollars and years or decades of investment typical of offshore conventional drillings, shale wells can be brought online in a matter of weeks for a few million dollars. When oil prices do rebound, thousands of dormant rigs can come back online with unprecedented speed. For many U.S. producers, "the question is no longer at what price [do they] go bankrupt, but at what point they start drilling again."[16]

- Drilling costs are down 50% and could drop another 30%.[17]
- "Break-even" prices for shale wells declined by some 25% in 2015,[18] while many "core" U.S. shale plays are now profitable at prices below $40bbl.[19]
- 2015 Saudi Central Bank report: shale "not as responsive to low oil prices as had been thought."
- Re-fracking wells now "can squeeze up to 40% more oil out of it. Wells that had been considered tapped are able to produce more oil than when they were first drilled."
- US drillers produce 33% more gas today with 280 rigs than they did in 2009 with 1,200 rigs."[20]
- U.S. has a "massive volume of stored oil and 3,000 to 5,000 wells drilled but awaiting fracking."
- The Saudis "can do nothing about the vast amount of shale and how quickly it can be extracted and brought to the market."[21]

A NEW SWING PRODUCER, A NEW NORMAL?

The Shale Revolution has fundamentally reshaped global oil markets, applying long-term downward pressure on oil prices not only with new supply, but new supply that can be brought to market more quickly than other conventional producers. It has also created a new buffer of spare capacity to guard against oil price spikes. Leonardo Maugeri now estimates global production capacity at 101mbd, nearly 10% more than expected demand in 2016.[22]

- U.S. oil production is expected to grow by 43% over the next decade.[23] PWC estimates shale oil production could top 14mbd by 2035, 12% of world supply, reducing prices by 25-40%.[24]
- BNY Mellon expects "more price stability, as no one cartel will have the ability to constrict supply." Kathleen White says that "for the first time in 50 years, world oil markets are beginning to hover around the U.S. rather than OPEC."
- Goldman Sachs now believes oil could fall to $20bbl[25] while BP chief executive Bob Dudley expects prices to be "lower for longer."[26]
- If "low" oil prices are here to stay, it would merely represent a return to normal. Between 1946 and 2015, the average, inflation-adjusted price of a barrel of crude oil was $40.08. On December 1, 2015, it was $40.58.

THE SAUDI GAMBLE

Geopolitics also partly explain the Saudi decision to keep oil prices suppressed. The Sunni-majority country's decades-old rivalry with Shi'ite-majority Iran has grown sharper in recent years, with the two waging proxy battles along various sectarian fault lines in the Middle East. Moscow's intervention in the Syrian Civil War has also soured relations Russia-Saudi relations. Riyadh believes low oil prices bleed the finances of Saudi rivals long before it feels any pain.

SAUDI ADVANTAGES

- 2014 Cost of production per barrel of oil—Saudi Arabia: $9.90. Iran: $12.60. Russia: $17.20.[27]
- 2014 Foreign exchange reserves—Saudi Arabia $732B. Iran: $109B. Russia: $385B.[28]

SAUDIS UNDER DURESS

- Despite low production costs, Saudis have one of the highest fiscal "break-even" prices, or price needed to balance federal budget.[29] Saudi: $105.60. Russia: $105. Iran: $87.20. Iraq: $81.
- In Russia oil trade=21.3% of GDP. Iran=29.6%. Saudi Arabia=56% (80% of federal revenue).[30]
- With oil at $115bbl, Saudi Arabia earns $360B per year.[31] With oil at $40bbl it earns $118B.
- December 2015 Saudi fiscal deficit: 13.9% of GDP. Iran: 2.9% of GDP.[32]
- Saudi Arabia's foreign exchange reserves depleting by roughly $100B per year.

OPEC DISUNITY

- OPEC was never a functional cartel: since imposing production quotas in 1982 it's "been utterly unable to constrain members' production."[33] They've "overproduced 96% of the time."
- OPEC has been pumping above its 30mbd nominal quota for 18 months.
- December 2015 OPEC meeting saw the cartel in disarray. No production ceilings were set.
- OPEC "all but abandoned price support for crude through production cutting" with members "readying for new battles for share in a market with record stockpiles."[34]
- Ironically, Saudis may actually *want* the Shale Revolution over long term. Its real rivals aren't high-cost oil producers, but renewable energy that could displace global oil demand.

WINNERS AND LOSERS

Outside the U.S., the greatest impact of Shale 3.0 has been the downward pressure it has exerted on global oil gas prices, directly from the additional supply and spare capacity, and indirectly from the pressure it has applied to traditional exporters to increase production to retain market share. The winners and losers from shale oil revolution are the winners and losers from low oil prices, which impose concentrated costs on net energy exporters and broad benefits to net importers and the global economy and global consumers more broadly.

If the world is producing roughly 100mbd, at $120 per barrel the oil trade is worth $12B per day and $4.4 trillion per year. At $30 per barrel, producers earn $3B per day and $1.1 trillion per year: a veritable transfer of wealth from oil producers to consumers worth $3.3 trillion. The IMF estimates each 10% drop in oil prices represents a 0.2% boost to global GDP.[35]

TOP OIL EXPORTERS 2014	DOLLAR VALUE OF EXPORTS	OIL EXPORTS AS A % OF GDP	OIL EXPORTS AS A % OF THE FEDERAL BUDGET
Saudi Arabia	$321 Billion	42.9%	89.5%
Russia	$292 Billion	13.5%	50.2%
Venezuela	$76 Billion	36.4%	47%
Nigeria	$65 Billion	12.5%	63.7%
Norway	$50 Billion	9.8%	29.3%

TOP OIL IMPORTERS 2014	DOLLAR VALUE OF IMPORTS	IMPORTS AS % OF GDP
Eurozone	$406 Billion	3.0%
China	$270 Billion	2.8%
Japan	$236 Billion	5.1%
United States	$199 Billion	1.2%
Turkey	$50 Billion	6.2%

NEW WINNERS

- Developing countries: 80% are net oil importers. Helps to reduce expensive fuel subsidies, which cost developing economies $550 billion per year.
- Airlines and transportation industries.
- Agriculture industry. It's five-times more energy intensive than manufacturing.
- High-inflation countries. Low oil prices exert downward pressure on inflation.
- India: it has a huge agriculture industry and suffers high inflation, and expensive fuel subsidies. Indian Inflation down from 10.4% in 2009 to 3.7% in 2015. Eliminated $10B diesel subsidy.

An analysis by Bloomberg New Energy Finance[36] (with oil prices around $50) assessed annual wins and losses of lower oil prices to the following countries and regions:

COUNTY/REGION	NET ANNUAL GAINS/LOSSES FROM CHEAPER OIL
Asia	+393 Billion
Europe	+$300 Billion
US	+$180 Billion
Canada	-$40 Billion
Norway	-$53 Billion
Latin America	-$60 Billion
North Africa	-$62 Billion
Sub Saharan Africa	-$89 Billion
Russia and Central Asia	-$218 Billion
Middle East	-$ 357 Billion

NEW LOSERS

- Low inflation countries like Japan and Europe. In Japan inflation fell to 0.92% in 2015 and in the Eurozone inflation reached *negative* 0.2% in December 2015, threatening a recession.
- Oil companies: since the Great Collapse of oil prices, the oil industry has cut around 200,000 jobs worldwide.[37] The U.S. shale industry has accumulated $260B in debt.[38]
- Alternative energy: the low cost of fossil fuels stunts efforts to combat climate change by increasing consumption and scaring off investments in costlier renewable energy sources.
- Sub-Saharan Africa producers: Many produce the same variety of light, sweet crude emerging from U.S. shale industry. U.S. imports from Nigeria down 90%.
- Other "high-cost" unconventional oil producers: Canadian tar sands projects have break-even prices as high as $90, twice that of U.S. shale plays. "The paradox of growing U.S. oil security is that it risks negatively impacting traditionally safe Western Hemisphere exporters."[39]

GEOPOLITICAL IMPACT

- Prospect of U.S. oil and natural gas exported encouraged Europe/Japan to join TTIP/TPP.
- Global glut of crude oil "played a key role in convincing China, South Korea, India and other buyers of Iranian crude that alternative supplies were plentiful."[40]
- Shale 3.0 "forced harsher choices between guns and butter on countries like Russia+ Iran."[41]
- Has raised anxiety about America's security commitment to the Middle East.
- Has changed perceptions of power, influence, and dependency relationships.
- Strengthened American partnerships with the U.S. sharing fracking technology with countries like Poland, Argentina, and others.
- Less fierce competition for energy resources globally benefits international peace and security.

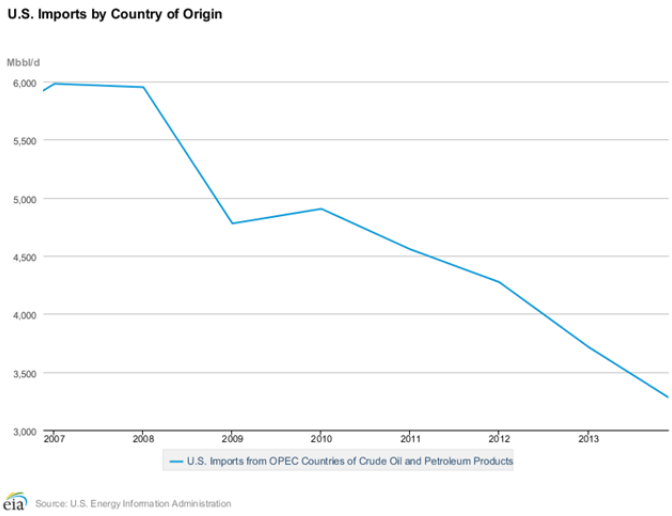
U.S. OIL EXPORTS

America's transformation into the world's leading producer of petroleum has raised the prospect of the U.S. becoming a major crude oil exporter. In December 2015 the U.S. Congress moved to end a 40-year-old ban on crude oil exports. Supporters argue this will reduce American dependence on Middle Eastern oil, lower U.S. gasoline prices, address a mismatch in U.S. refining capacity, and improve the energy security of American partners and allies while stripping American adversaries of financial resources and geopolitical leverage.

The *New York Times* says U.S. oil exports send "a telling message to President Vladimir V. Putin of Russia that the U.S. can push for stronger sanctions against Russian oil without jeopardizing the economies of countries that buy its oil… if Iran does not comply with its nuclear agreement and sanctions are snapped back, Iranian customers like India and Japan can look to the U.S. as an important new oil source."[42]

- U.S. oil imports represented 60% of consumption in 2006. That fell to 40% in 2012 and 20% in 2015.[43] Meanwhile, crude oil imports have fallen by 4.3mbd since 2007, with two-thirds of the reduction coming from OPEC countries.
- Saudi exports only 1.5mbd to U.S. of the nearly 20mbd it consumes; has been steady for 20 years.
- BP: U.S. energy consumption will grow by 1% over the next 20 years, despite 17% pop. growth.
- U.S. exports of refined petroleum products (gasoline, kerosene, etc) nearly quadrupled between 2005 and 2015, from 1.23mbd 4.4mbd.[44] The U.S. is now the world's largest producer of refined petroleum products; a "titan of unprecedented proportions."[45]

U.S. IMPORTS FROM OPEC COUNTRIES



The American Petroleum Institute says U.S.. crude oil exports could: reduce U.S. consumer fuel costs by as much as $5.8 billion per year between 2015-2035; spurn an additional $15-70 billion in investments by 2020; boost U.S. oil production output by as much as 500,000 barrels per day; add as many as 300,000 net jobs; contribute an additional $38.1 billion to U.S. GDP; reduce the U.S. trade deficit by $22.3 billion; and increase government revenues by $13.5 billion. Others are more agnostic, arguing the impact will be modest, especially given the U.S. is still a net importer of crude oil. However, some tangible benefits include:

MISTMATCHED REFINING CAPACITY

Most of America's refineries are configured to process heavy sour crude; U.S. shale fields produce light sweet crude, creating a backlog at U.S. refineries forcing producers to discount prices. Lifting the export ban allows producers to export crude oil to refineries abroad configured for light sweet crude while importing heavy crude fit for U.S. Gulf Coast refineries.

THE WTI/BRENT SPREAD

The U.S.-based WTI oil index has been trading at a discount to the Europe-based Brent crude index (by as much as $25bbl in 2010). Yet, U.S. gasoline prices are today set by the Brent benchmark: by exporting more oil and bringing down the price of global and Brent crude, U.S. oil exports should reduce U.S. gasoline prices. Experts believe the effect will be modest (nine cents per gallon by one estimate) or negligible if the WTI/Brent spread shrinks, as it has in 2015.

GEOPOLITICAL BENEFITS

Former U.S. Defense Secretary Leon Panetta has called U.S. oil exports a "powerful, nonlethal tool" to help spread democracy abroad.[46] The European Commission has pressed the Obama administration to lift the crude export ban "in the name of energy security." Michelle Flournoy says "U.S. oil exports would strengthen our geopolitical influence, leadership and leverage with allies and adversaries alike."[47]

U.S. LNG EXPORTS

Shale 3.0 had the *intended* effect of increasing U.S. natural gas production and proven reserves, lowering domestic gas prices, and shrinking America's natural gas import bill. Less known at the outset of the Shale Revolution was how it would combine with fundamental changes in the international market for Liquefied Natural Gas (LNG) to position the U.S. to become a major player in a new global LNG market and fundamentally restructure the way that market operates.

Less than a decade ago, analysts were predicting the U.S. would be the largest LNG *import* market by 2015 and as late as the mid-2000s U.S. companies were constructing new, multi-billion dollar LNG import terminals. Today, LNG imports have slowed to a trickle while U.S. partners from India to Japan, desperate for more diverse and secure sources of energy, are pleading with Washington to open the LNG floodgates for export.

COUNTY/REGION	NET ANNUAL NATURAL GAS SURPLUS/DEFICIT
Former Soviet Union	+4.6tcf
Africa	+3.9tcf
The Middle East	+3.8tcf
Southeast Asia	+2.9tcf
Canada	+2.8tcf
Korea and Japan	-4.8tcf
Europe	-9.7tcf

GLOBAL LNG MARKET

The table above demonstrates those regions of the world with significant excess supply of natural gas, and those that face massive annual deficits. Europe is connected by land (and an elaborate network of pipelines) to Russia, a natural gas titan. Korea and Japan are less fortunate: the latter surrounded on all sides by ocean and the former separated from continental Asia by a totalitarian regime to its north.

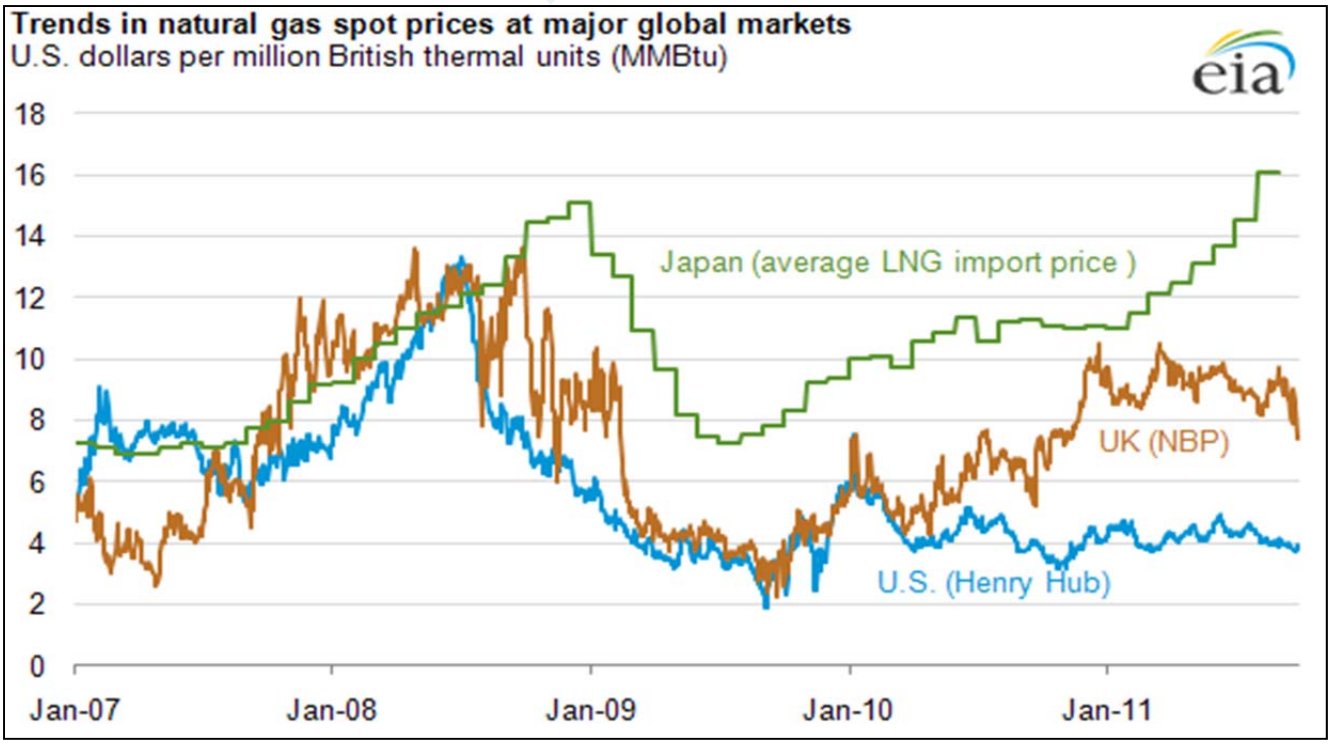
- Liquefying natural gas is not a new process: the U.S. began doing it in 1918 and built its first LNG processing plant in 1940. Yet, the LNG trade traditionally limited to niche Asian markets.
- Treating and transporting LNG is a costly endeavor: Congressional Research Service says LNG processing facilities cost $6B- $10B while export terminals cost up to $20B.[48]
- Yet today LNG is the fastest-growing source of natural gas supply—7% annual growth since 2000, and representing 10% of global gas demand in 2013.[49]

- 19 countries are now exporting LNG and 29 countries are now LNG importers.
- Jordan, Egypt, Pakistan, and Poland joining global LNG trade in 2015-16.
- Japan, ROK, and Taiwan are still the top global importers of LNG. Asia accounts for 75% LNG demand. China and India accounted for 70% of demand growth in 2014 (14% of global LNG).
- Qatar top LNG exporter worldwide. Australia, Malaysia, and Indonesia among top five.[50]

FRAGMENTED MARKET

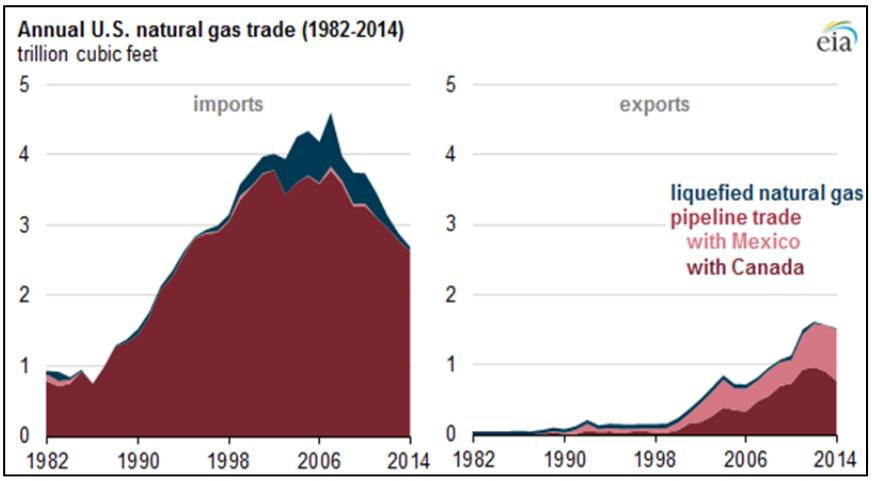
The U.S. is still a net importer of LNG (imports in 2014 were 59.2bcf while exports were 16.3bcf). Indeed, the U.S. was exporting more LNG in the 1990s than it is today. Yet imports are falling fast (down 39% in 2014) and production is growing rapidly. More important, interest in U.S. LNG exports lies in the fragmented structure of the global LNG market. The *Washington Post* says, "there is no global price for gas; rather, there are four or five, and they often differ greatly. Japan and South Korea buy gas…[at] nearly twice the rate paid in Europe and four times the current rate in the U.S."[51]

- 2012 average domestic LNG prices—Japan: $16.75/mmbtu. UK: $9.46. US: $2.76.
- Price U.S. companies can fetch for U.S. LNG exports grew with oil prices. Price in 2007: $5.56/mmbtu. In 2010: $13.19/mmbtu. In January 2015: $17.39/mmbtu.
- EIA says LNG exports could surpass imports in 2016.[52]
- In Asia natural gas prices are traditionally tied to the price of oil and contracts are longer-term; in the U.S. they are set at liquid trading hubs and function more like a true market.



PROSPECTS FOR U.S. LNG EXPORTS

- No government ban on the export of natural gas as there was with crude oil.
- Obama admin. approved 5 LNG export terminals in recent years. All to be completed by 2019.
- $18 billion Sabine Pass facility in Louisiana to begin exporting LNG in 2016.
- Less restrictions on LNG exports to Free Trade Agreement (FTA) countries. Encouraged Japan and Europe to join TTP and TTIP free trade negotiations.
- By January 2015, USG received 48 applications to export a total of 38.07 bcf/day of LNG, (63% of total U.S. production). 5.74 bcf/day exports have already been approved.[53]



ENVIRONMENTAL OPPOSITION

- Environmentalists oppose LNG exports as they promoting more gas production/consumption.
- Growing body of evidence suggests rather than harming the climate, the shale gas revolution has indirectly been a significant contributor to the preservation of the environment.
- Transition to natural gas from carbon-intensive coal in electricity and transportation sectors has been a major driver behind a substantial reduction in greenhouse emissions since 2005.[54]
- The Manhattan Institute estimates that while "solar power is responsible for 1 percent of the decline in U.S. carbon-dioxide emissions; natural gas is responsible for nearly 20 percent."[55]
- The Obama administration's Energy Secretary, Ernest Moniz, admits that "about half" of the progress made on greenhouse gas emission reductions "is from the natural-gas boom."[56]

POLITICAL OPPOSITION

- Opponents of U.S. LNG exports argue they would raise domestic natural gas prices.
- Broad consensus LNG exports would raise prices modestly but also boost GDP modestly.
- Most studies conclude net economic benefit would outweigh the net cost, with residential gas price rises of 2%-5% and a boost to U.S. GDP of between $895M and $3.05B.[57]

MARKET FORCES

- U.S. LNG looked especially attractive to Asian buyers with prices at or near $10bbl. However, with oil trading at or under $50bbl the market is decidedly less hospitable.
- Moody's: Great Collapse in oil prices " wiped out the price advantage of U.S. LNG projects."[58]
- Price of U.S. LNG exports: January 2015: $17.39/mmbtu. April: $10.53. December: $7.17.
- Asian LNG prices down from $19.75/mmbtu in March 2013 to $6.78/mmbtu in October 2015.
- EIA: "growing concern that weak oil prices, disappointing world economic growth and a

global gas glut have turned the economics of U.S. exports on their head."[59]

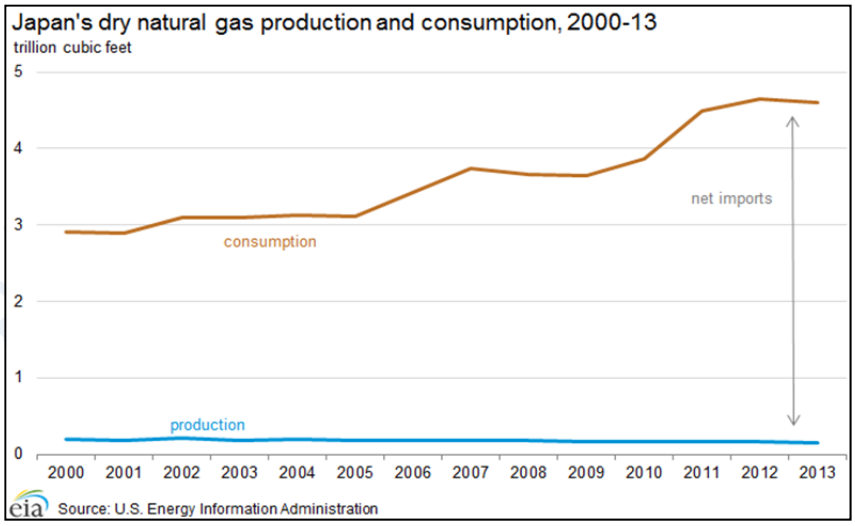
- Global Supply Glut: "liquefaction capacity is projected to rise by almost 50% by 2020 while many non-U.S. projects are much further along than the U.S. projects."[60]
- Nearly 30 proposals to export LNG likely to be canceled. LNG firms cutting capital budgets.[61]

LONG-TERM PROSPECTS

- EIA estimates U.S. will be a net LNG exporter in 2016, with exports reaching 3.5tcf in 2030.[62]
- U.S. shale gas production expected to double from 10tcf in 2012 to just under 20tcf in 2040.
- By 2020 China's LNG imports are expected to balloon to 3.7tcf.
- IEA expects natural gas demand to grow 1.6% annually over the mid-term.
- U.S. brownfield advantage: cheaper to convert existing import terminals to export terminals.
- Massive investments give U.S. important "first-mover" advantage if and when prices do rise.

QUICK VIEW: JAPAN'S DILEMMA

Japan is the fourth-highest energy consuming nation in the world yet the island-nation is poorly endowed with natural resources and, like South Korea, is almost 100% reliant on imported oil and natural gas. Indeed, Japan is the largest importer of LNG in the world, as well as the second-largest coal importer, and the third-largest net oil importer.[63]

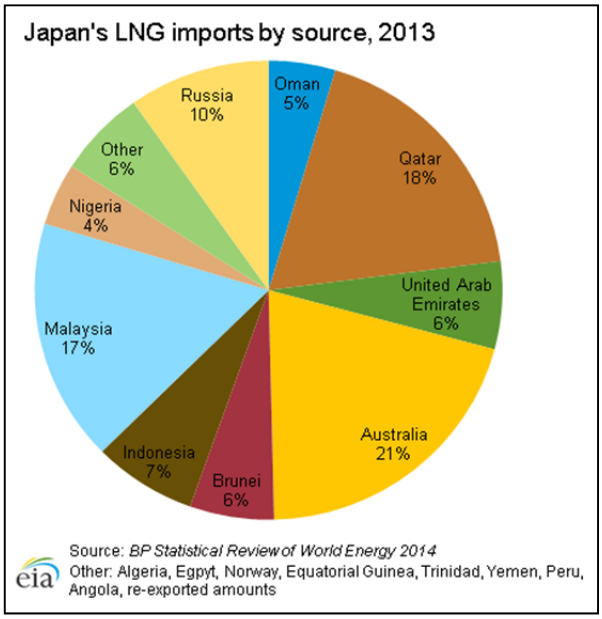


Japan used to be the third-largest generator of nuclear power, accounting for 26% of Japan's electricity generation as late as 2010. Yet, a meltdown at the Fukushima Daiichi Nuclear Power Plant in March 2011 following a tsunami generated by one of the most powerful earthquakes in recorded history forced Japan to take all 24 of its nuclear reactors offline for safety reasons. The gaping void in energy generation left by Fukushima has been filled principally by LNG, which jumped from 27% of Japan's electricity generation in 2010 to 48% in 2013. Japan now accounts for more than one-third of all global LNG demand;[64] as a result, its trade deficit has ballooned.[65]

- In 2013 Tokyo announced $11B in credit guarantees for Japanese investments in U.S. shale gas.[66]
- Japanese companies have invested in 4 of 5 U.S. LNG export terminals under construction, securing up to 1,000bcf per year of U.S. LNG by 2020,[67] making the U.S. Japan's top supplier.
- Yet, the Great Collapse in oil prices has begun to dampen optimism about U.S. LNG exports.
- Japan intends to bring its 24 nuclear reactors back online in the coming years, and after 2020, Japan's demand may begin to "flatten."

NATIONAL SECURITY TRUMPS ECONOMICS

For Japan, LNG imports are not merely a question of economics, but of national security. Japan's top suppliers of LNG are Australia, Qatar, and Malaysia. LNG from the Middle East must traverse two of the world's most congested global chokepoints: the Strait of Malacca and the Strait of Hormuz (the same is true for Japan's oil imports, 80% of which come from the Middle East). And while Japanese LNG imports from Australia and Malaysia can bypass those straits, their LNG tankers still cross the contested South China Sea. For a country crippled by an oil embargo during its last war, this represents a significant geopolitical vulnerability.



That vulnerability has grown more pronounced since 2013, when Japan's geopolitical rival, China, began consolidating control over the disputed South China Sea. China has now constructed seven artificial islands atop various rocks and low-tide elevations in the Spratly archipelago. American LNG and oil exports are thus uniquely attractive to Japan, as they would arrive from the safety of the vast Pacific Ocean to the east, bypassing the Straits of Malacca and Hormuz, and the South China Sea altogether. The widening of the Panama Canal, expected to be complete in 2016, will facilitate LNG tankers shipping to Asia from the Gulf and East Coasts. Shoichi Itoh of the Japanese Institute for International Economics says[68]:

> We still want as much [U.S. LNG] as we can get. By the 2020s were hoping to increase America's share to 20% of our imported LNG. We want to develop new supply chains from political allies. U.S. must seriously consider the geopolitical merits of exporting oil as well as LNG.

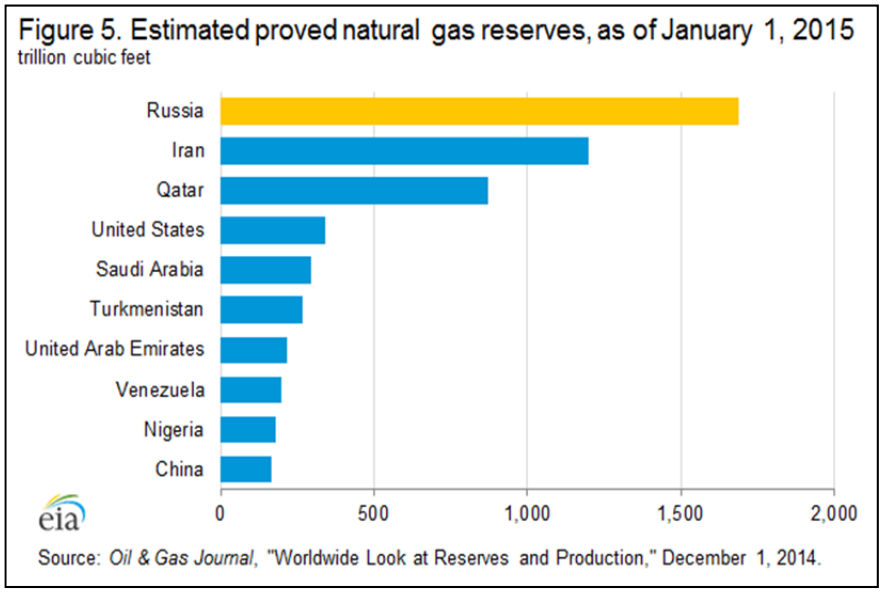
RUSSIA AND EUROPE CASE STUDY

Russia is, by any definition, a conventional oil and natural gas powerhouse. According to the EIA,[69] Russia hosts the largest natural gas reserves in the world (1,688tcf) and in 2015 was the second-largest producer of dry natural gas (22.1tcf), just behind the U.S. (24.3tcf). In 2014 Russia was the largest producer of crude oil (over 10.1mbd), and is the holder of the eighth-largest proved oil reserves on the globe, at some 80bb.[70]

In 2014 Russia consumed roughly 16.3tcf of the 22.1tcf it produced,[71] leaving it a nearly 6tcf surplus for export. Meanwhile, Russia only consumes around 3.5mbd of the crude oil it produces, leaving it with nearly 6mbd of petroleum products to export (including over 5mbd of crude oil). Notably, production and exports oil were both rising in 2015, with output hitting a post-Soviet record in October 2015 at 10.77mbd.

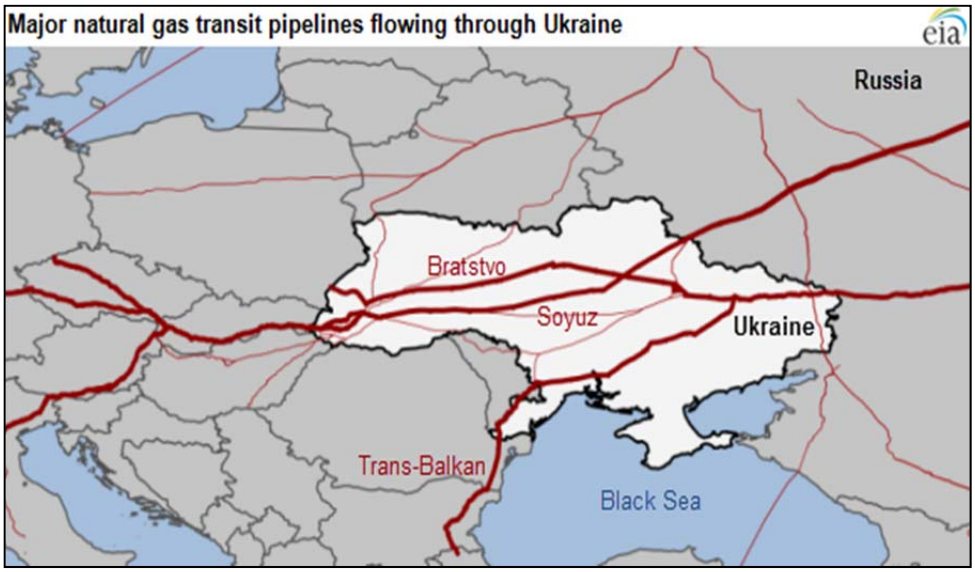
Russia accounts for roughly one-third of the EU's crude oil imports (3.5mbd of 10mbd in 2014) and one-third of the EU's natural gas imports (5.2tcf of 16.2tcf in 2014).[72] Yet Russia is arguably more dependent on the EU than vice-versa: the latter accounted for 72% of Russian crude oil exports and 90% of its natural gas exports in 2014. Half of Russia's federal budget revenue comes from its Mineral Extraction Tax and export duties on oil and gas. 54% of that sum derives from crude oil exports($270 billion), and 14% from natural gas exports($55B).[73]

While the politicization of the energy trade is a global phenomenon, it is arguably in Russia (and Russia's relationship with Europe) where the phenomenon has been the most extreme, visible, and consequential. Russian President Vladimir Putin, authored his 200-page 1997 PhD dissertation on Russian strategies to exploit natural resources for political gain.[74] In Europe Russia has leveraged its virtual monopoly on pipeline natural gas exports to apply pressure on various EU countries to advance its strategic objectives—most recently its territorial ambitions in Ukraine.



Russia's tactics include: raising commodity prices, cutting off supplies, or canceling energy deals and contracts to punish unfriendly regimes; lowering prices and dangling lucrative contracts for capitals compliant with Moscow's demands; and waging subversive political campaigns to advance Russian objectives and undermine EU efforts to limit or roll back Moscow's virtual gas monopoly over the continent. Over the course of several decades, these tactics have proven largely successful at stymying efforts to build consensus on initiatives to diversify Europe's sources of energy and reduce Russia's commanding share of the natural gas import market.

However, a strategic miscalculation by Moscow has begun to change this dynamic. Three Russia-Ukraine gas crises that unfolded in 2006, 2009, and 2014, and Russia's subsequent invasion of parts of Ukraine, have galvanize EU member states to support a new initiative to reform the EU energy sector and impose punitive sanctions on Moscow's energy industry. Whereas many capitals in Western Europe have little direct exposure to Russian natural gas (or ample storage capacity and supply alternatives), in many capitals in the Baltics and Southeastern Europe, Russia has long provided nearly 100% of their natural gas needs.



EU SHALE PROSPECTS

Europe is host to what could best be described as modest shale oil and gas reserves, though with the industry still in its infancy across the continent, reserve estimates are tentative and vary considerably. The EU's Joint Research Centre puts Europe's technically recoverable (TR) unconventional gas reserves lower, at 38.4tcf, about one-tenth of America's.[75] France, the most well-endowed, hosts 4.7bb of TR shale oil reserves, as compared to America's nearly 80bb.

Country	TR Shale Gas Reserves (tcf)	TR Shale Oil Reserves (bb)
Bulgaria	16.6	0.2
Lithuania/Kalningrad	2.4	1.4
Poland	145.8	1.8
Romania	50.7	0.3
Denmark	31.7	0.0
Turkey	23.6	4.7
Ukraine	127.9	1.1
France	136.7	4.7
Germany	17.0	0.7
Netherlands	25.9	2.0
Norway	0.0	0.0
Spain	8.4	0.1
Sweden	9.8	0.0
UK	25.8	0.7

Natural gas reserves are more substantial in Poland, Romania, France, and Ukraine, yet EU member states face significant obstacles to exploiting shale reserves, lacking several of the advantageous conditions enjoyed by the shale extraction industry in the U.S., including:

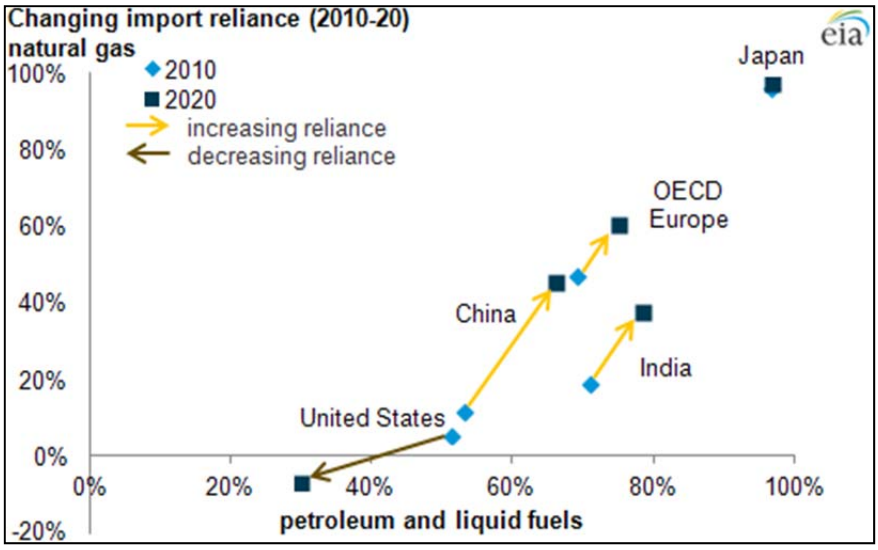
- A regime that grants underground mineral resource rights to the government rather than private landowners, as is the case in the United States.
- EU "unconventional gas basins tend to be smaller, tectonically more complex, and geological units seem to be more compartmentalized" as well as "deeper, hotter and more pressurized…with generally more clay content."[76] In many countries the share of "proved reserves" is likely to be a fraction of the technically recoverable totals in the table above.
- EU countries tend to be more sensitive to environmental concerns, and grassroots political opposition to fracking tends to be more organized and influential. Bulgaria, Czech Republic,

the Netherlands, Luxembourg, France have banned fracking.

- ❖ It's widely believed Russia has provided resources to numerous environmental groups campaigning against fracking in an attempt to undermine EU efforts at shale oil and gas extraction.[77]

Poland, potentially the largest holder of shale gas reserves in the EU, has been the most aggressive, granted over 100 concessions to energy firms in 2007. By 2014, 64 exploratory wells were drilled, but the results were "disappointing." Seven of 11 global energy firms have since pulled out. Poland recently cut estimates of shale gas reserves by 90% to 12.2tcf-27.1tcf.

IHS, an energy consultancy, expects that by 2020 European shale production will reach only be 0.14tcf per year, compared with over 2.5tcf in America today. Meanwhile, conventional gas production in Europe could drop by a factor of 10 over that period.[78] Meanwhile, the EU is growing *more* dependent on Russian energy. While EU gas consumption is down 13.7% since 2000, production has fallen 42.5%.[79] Since 2003, EU energy production overall has dropped 15% while its import dependence has grown 13.3% for natural gas and 9.9% for oil.[80] By 2030 the EU may be importing some 70% of its gas needs.[81]



PIPELINE RELIEF?

Options for substituting Russian gas with new natural gas pipelines from energy rich petro-states in the Caucasus and Central Asia remain limited in the near-term. Several mega-projects have been stuck in deadlocked negotiations for over a decade (Nabucco, TAPI).

Meanwhile, the Oxford Institute for Energy Studies notes EU countries are "contractually obligated to import at least 115bcm[4.1tcf] per year of Russian gas" through the mid-2020s and the contracts are "legally binding and subject to international arbitration." Moreover, there are "significant limitations on the options to reduce the volumes…or to terminate the contracts before expiry."[82] New pipeline imports are not expected increase substantially before 2030 and actually "may decline." Azerbaijan is the "only country which will substantially

increase its exports of pipeline gas to Europe prior to 2030, with 30 bcm [1.1 tcf] becoming available by that date, only half of which will progress beyond Turkey to the rest of Europe."

LNG

The EU is already one of the largest LNG importers in the world, commanding 20% of the global market, second only to Japan which imports 37%.[83] LNG imports account for 15-20% of European natural gas imports, versus 80-85% from pipeline. The continent already has substantial LNG infrastructure in place, including 28 LNG import terminals, 8 more under construction, and 26 in planning stages. However, infrastructure is skewed toward the developed west, where the need to diversify natural gas imports is the lowest.

Lithuania, hitherto dependent on Russia for 100% of its natural gas imports and paying the highest price for Russian gas of all 28 EU member states,[84] opened its first LNG facility at the port of Klaipeda in 2014. The regasification capacity of the *Independence*, 0.14tcf-0.18tcf, is twice Lithuania's gas demand and nearly enough to meet the demand of all three Baltic states (including Latvia and Estonia), now 0.19tcf annually.[85] The mere presence of the *Independence* has already helped Lithuania negotiate a 23% reduction in prices from Gazprom.[86]

Poland opened its first LNG import facility in October 2015 at the Baltic port of Swinoujscie. The capacity of the terminal, 0.17tcf, amounts to half of Poland's annual imports from Russia (30% of Polish natural gas consumption).[87] In December 2015, Polish Prime Minister Kopacz said he was considering nearly doubling the capacity of the terminal, to 0.27tcf.

LNG in in the EU still must compete with Russian natural gas on price: no easy feat. Yet by late 2014, LNG prices in the EU had begun challenging—and even undercutting—Russian pipeline exports, despite a 40% decline in Russian natural gas prices in 2015.[88] By one estimate, Russian pipeline exports to Europe in 2015 will average $6.64/mmbtu while the average spot price of LNG mid-year 2015 was $6.50/mmbtu.[89]

Yet Gazprom can likely compete with LNG on price in any feasible scenario, though it may come at significant cost to Gazprom and the Russian state. By some estimates Gazprom's *most expensive* gas, from the Yamal fields in Siberia, can still earn a profit at price of $7.50/mmbtu.[90] James Henderson says "the Russians are quietly confident that Europe will not find alternatives, and they have openly stated that if U.S. LNG arrives in Europe, they will compete with it. And there is no doubt they could undercut U.S. LNG in Europe.[91]

RUSSIA FEELS THE PAIN

Yet not all is well in Russia. The collapse in global oil prices hit Russia, the top exporter of crude oil in 2015, particularly hard: Moscow spent $90B in foreign exchange reserves trying to prop up its economy in late 2014 before allowing the ruble to float freely. Russia's currency lost almost half of its value immediately.

- Russia's economy entered recession in late 2014 and is expected to contract by 4% in 2015.
- Russia's "inflation rate is up 12.5-13.0 percent, and foreign trade dropped by 35-40 percent" and it witnessed "a 10 percent decrease in real wages and 5-6 percent drop in individual income."[92]
- Deloitte says Russia suffered from "capital flight of around $134 billion in 2014," citing predictions by the Russian Central Bank of "further capital outflows of $120 billion in 2015, $75 billion in 2016 and $55 billion in 2017."[93]
- Russian banks and companies are now said to be indebted to foreigners to the tune of $600B.[94]
- A Russian Foreign Ministry advisor as saying Russia loses about $2 billion in revenue for every dollar fall in the oil price. *The Economist* estimates Russia needs $110 oil to balance its budget.[95]

As the Russian economy has been battered by the Great Collapse, it has been hit a wave of potent Western sanctions levied on Moscow for its invasion of Ukraine targeting Russia's energy sector. The sanctions restrict U.S. banks from lending to Russian energy firms, and prohibit American companies from selling Russia fracking technology and "goods, services, or technology in support of deep-water, Arctic offshore, or shale projects."[96] At a time Russia's legacy oil and natural gas fields are facing declining production and it desperately needs Western capital and technology to exploit new and more challenging energy reserves.

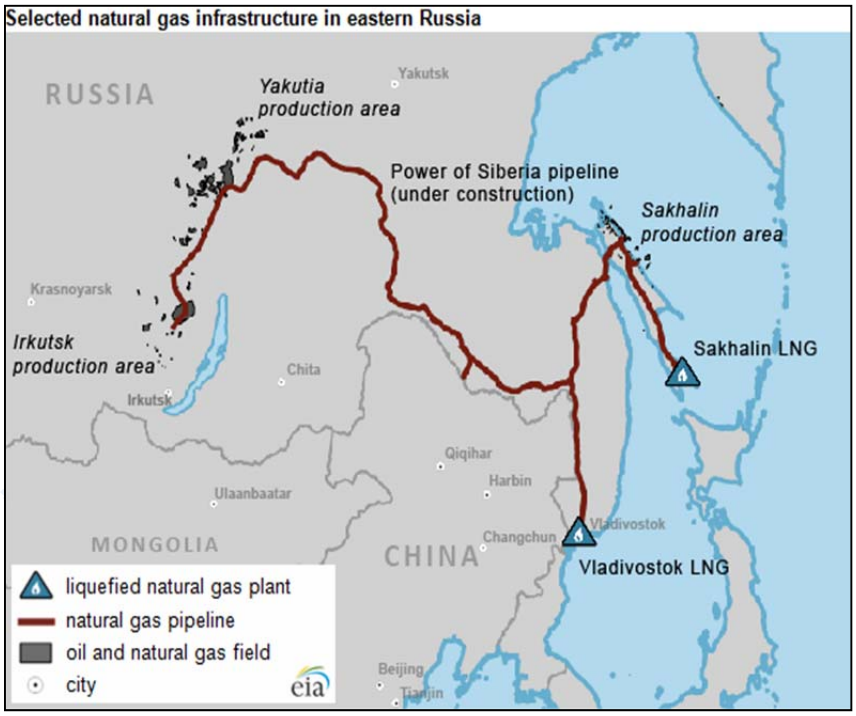
- Since 2014 "virtually all involvement in Artic offshore and shale projects by Western companies has ceased following the sanctions."[97]
- By one estimate this has resulted in "the loss of $300 billion to $500 billion in previously projected direct investment from western oil firms…a major blow to Russia's oil industry."[98]
- Russian natural gas giant Gazprom, which generates 8% of Russia's GDP, saw an 86% fall in net income in 2014.[99] The company's market capitalization, $350B in 2009, is $80B today.[100]
- Western companies "account for about half of the technology used in hard-to-recover oil projects and more than 80 per cent of the technology used offshore."[101]
- "25 per cent of Russian oil production involved fracking and relied on western service companies"[102] "Next year, many believe, [Russia's] oil production will fall … the start of what many expect will be a long-term decline."[103]
- Russia's energy ministry admits oil wells are depleting rapidly and Russian production could

fall by more than 20% by 2020, from 10.1mbd to 7.7mbd.[104]

- Gazprom is predicting a 25% drop in natural gas production "from existing conventional sources" by 2020, and 75% by 2030.[105]

RUSSIA LOOKS TO ASIA

Russia has made selling more natural gas to Asia a major strategic priority. An expansion of gas exports to Asia was a core plank of the Russian energy strategy published in 2009, and in 2014 Russia released a document, *Energy Strategy to 2035*. The Ukraine crisis seems to have galvanized momentum behind Eastern strategy and during a May 2014 trip to China, President Putin pushed Gazprom to reach a deal with Beijing on a massive new natural gas pipeline, the Power of Siberia. The 30-year deal is reportedly worth $400 billion, though the pricing and terms have not been disclosed. The pipeline is expected to cost Russia $55 billion to construct and Gazprom says it will be complete by 2019.[106] Russia is hoping through three new pipelines natural gas exports to China can reach 100bcm per year (versus 146bcm to Europe in 2014).[107] They include:



- Power of Siberia "Eastern Route"
  - 38bcm capacity. Irkutsk-Vladivostok. Signed May 2014.
- Power of Siberia 2/Altai Pipeline "Western Route"
  - 30bcm capacity. Western Siberia–Northwest China. First MOU signed March 2006. Second MOU signed September 2015. No final agreement yet signed. May be "delayed indefinitely."
- Sakhalin-Vladivostik Pipeline "Eastern Gas Program"
  - Approved in 2007. In operation since 2011. September 2015 Russia-China signed MoU to extend gas line to China. Studies yet to be conducted on volume and route.

However, Russia's Eastern Strategy may be in trouble thanks to weakening Chinese demand and surplus of natural gas supplies worsened by the U.S. Shale Revolution. China's natural gas demand was down 15% in 2015 from 2014.[108] The pricing terms of the Power of Siberia deal have not been revealed, but one Russian source suggested it was $350/bcm. Since the Great Collapse, natural gas prices have fallen precipitously: gas exports to Europe fell from $357/tcm in mid-2014 to $251/tcm in mid-2015.[109] And the natural gas being extracted from new fields in Siberia is of a higher cost. Dalan McEndree says "the Power of Siberia agreement may not achieve the volumes, prices, and therefore the revenues the Russian government expects.[110]

RUSSIAN SHALE

If there is a bright side for Russia to the Shale Revolution, it's that the country is extremely well-endowed with shale oil and gas reserves. The EIA's latest assessment sees Russian proved shale gas reserves at 284.6tcf, ninth-most in the world, while its proved shale oil reserves are 74.6bb, just behind America's 78.2bb.[111] Shale has effectively doubled Russia's (depleting) conventional oil reserves, estimated at 67bb.[112] Its shale oil reserves may be worth as much as $8.2 trillion.[113]

- Soviets were exploring ways to extract oil and gas from shale formations decades ago. The USSR had an experimental program to extract energy from tight rock using nuclear weapons.[114]
- Charles Kennedy: "Russia alone has the technology, infrastructure, [plentiful water resources]and political will to be the next revolutionary shale venue — not to mention a lot of sparsely populated space in which to drill without public backlash."[115]
- Russia's shale formations "lie in parts of Russia that have been producing oil for decades…the necessary pipelines, storage, and processing facilities are already there."
- "Shale development in Russia is unlikely to witness the degree of environmental backlash that has hampered shale exploration programs [elsewhere]."[116]
- Russia also has a great deal of experience with fracking, registering 1.1m horsepower of pumps to blast water, third behind China's 3.1m horsepower and America's 19.7m horsepower.[117]

BAZHENOV

After taking a disinterested approach to its shale reserves, Russia has shown more interest in recent years, especially in the massive Bazhenov formation, "the world's largest shale oil resource."[118] Moscow has offered tax relief from Russia's Mineral Extraction Tax (MET) of between 50-100% depending on the permeability of the rock, a move that "significantly changes the economics of Russian shale oil.[119] According to one estimate Russian oil companies pay $78 in export duties and mineral taxes out of each $110 worth of crude they produce."[120]

- EIA estimates 74.6bb of TR shale oil reserves and 285tcf of TR shale gas reserves in Bazhenov,[121] ten times more than America's massive Bakken shale formation.[122]
- President Putin set a target of 450,000 b/d tight oil production by 2020.[123] Now seems unlikely.
- Break-even price for Russian shale estimated at $60--80, on par with higher-priced U.S. shale.[124]
- Bazhenov may have less favorable geology than U.S. shale plays. Limited testing to date.
- Bloomberg: "Russia will require Western companies to provide the modern drilling and production gear -- and techniques such as hydraulic fracturing -- that are essential to unlocking its $8.2 trillion worth of [tight oil] still underground."[125] Sanctions preventing that cooperation.

ENERGY SECURITY IN 2015

- In February 2015, the European Commission released a Framework Strategy for a Resilient Energy Union to create "an integrated continent-wide energy system where energy flows freely across borders, based on competition and best possible use of resources."[126]
- In July 2015, 15 EU countries "endorsed an action plan to improve energy infrastructure and ultimately to ensure each of them maintains three separate sources of supply."[127]
- The plans envision a network of new pipelines and as many as 14 new interconnectors in Eastern Europe, new LNG terminals and storage capacity, and the upgrading of existing natural gas pipelines to handle "reverse gas flows."
- In 2016 the EU plans to unveil a comprehensive LNG strategy and new legislation to "bind together proposals on gas-related supply security."[128]
- However, in June 2015, several EU energy companies joined with Gazprom to promote a $10 billion-plus plan to double the capacity of Russia's Nord Stream pipeline, which bypasses Ukraine to bring Russian gas to Germany via the Baltic Sea. It will allow Russia more leeway to manage the flow of natural gas into Ukraine without affecting Western Europe.
- Keith Johnson argues the deal "underscores the way commercial considerations —not grand strategy—underpin Europe's approach to meeting its energy needs despite years of hand-wringing in Brussels over Europe's huge and growing dependence on imported fuels."[129]

KEY AREAS AND VARIABLES TO WATCH

- The possibility of the U.S. overtaking Saudi Arabia as the new "swing producer" in international oil markets.
- The growth of global spare capacity margins and their effect on price spikes.
- The effect of the Great Collapse on future LNG investments in the U.S. and abroad.
- The impact of the revocation of the U.S. crude oil export ban. Do volumes increase and where do they go?
- The long-term impact of the Great Collapse on U.S. shale production and investments.
- Natural gas and crude oil demand growth in Asia, especially in China and India
- The effect of the Panama Canal expansion on U.S. oil and LNG export costs and volume.
- The impact of U.S. crude oil exports on domestic gasoline prices and U.S. GDP.
- The impact of LNG exports on domestic natural gas prices and U.S. GDP.
- OPEC production levels, production targets, and overall cartel cohesion.
- The price-sensitivity of shale oil and natural gas. How quickly does production increase when prices rise; how much farther will it fall in response to global oil prices.
- The pace of technological, efficiency and productivity gains in U.S. oil and gas fields.
- The WTI/BRENT spread and its implications for U.S. oil exports.
- The degree to which the Great Collapse has further stunted the development and growth of other shale industries abroad, particularly in Russia.
- The degree to which the global LNG market begins operating like a true market with prices untethered from crude, contracts increasingly short-term, and regional price differences diminished.
- America's security commitment to the Middle East, perceptions of America's security commitment to the Middle East, and the degree to which other countries like China and Russia seek to fill a perceived void.
- Whether Japanese and European interest in in U.S. oil and LNG exports diminishes from the Great Collapse or continues on the strength of geopolitical and national security merits.
- The evolution of the EU Energy action plan and the growth of LNG infrastructure in Eastern Europe.
- The price and volume of Russian natural gas exports to China.

[1] "BG: Shale Gas Revolution in North America Will Be Difficult to Replicate," *LNG World News,* October 13, 2013. http://www.lngworldnews.com/bg-shale-gas-revolution-in-north-america-will-be-difficult-to-replicate/
[2] John M. Golden and Hannah J. Wiseman, "The Fracking Revolution: Shale Gas as a Case Study in Innovation," *Emory Law Journal* 64 (2015), http://law.emory.edu/elj/content/volume-64/issue-4/articles/fracking-revolution-study-innovation-policy.html
[3] Kathleen Hartnett White, "Have faith in the shale gale," *The Hill,* July 14, 2015. http://thehill.com/blogs/pundits-blog/energy-environment/247695-have-faith-in-the-shale-gale
[4] Michael E. Porter, David S. Gee, Gregory J. Pope," AMERICA'S UNCONVENTIONAL ENERGY OPPORTUNITY," *The Boston Consulting Group,* June, 2015. http://www.hbs.edu/competitiveness/Documents/america-unconventional-energy-opportunity.pdf
[5] Ambrose Evans-Prichard, "Saudi Arabia may go broke before the US oil industry buckles," *The Telegraph,* August 5, 2015. http://www.telegraph.co.uk/finance/oilprices/11768136/Saudi-Arabia-may-go-broke-before-the-US-oil-industry-buckles.html
[6] Raval, Anjili. "Opec leader vows not to cut oil output even if price hits $20," *Financial Times*, December 22, 2014.
[7] Verrastro, Frank. "The Impact of Low Oil Prices on North America," *NBR*, May 14, 2015. http://www.nbr.org/research/activity.aspx?id=560
[8] Katy Barnato, Stephen Sedgwick, "Oil prices may go even lower in 2016: IEA's Birol," *CNBC,* December 9, 2015. http://www.cnbc.com/2015/12/09/oil-prices-may-go-even-lower-in-2016-ieas-birol.html
[9] Yep, Eric. Oil prices fall on strong shale supply. *Market Watch*, July 3, 2015. http://www.marketwatch.com/story/oil-prices-fall-as-us-shale-shows-resilience-2015-07-03
[10] Rascouet, Angelina. "IEA Sees U.S. Shale Oil Shrinking in 2015 on Price Slump," *Bloomberg Business*, September 11, 2015. http://www.bloomberg.com/news/articles/2015-09-11/iea-sees-u-s-shale-oil-output-shrinking-in-2016-on-price-slump
[11] Ailworth, Erin. *Low oil prices put squeeze on US Shale Producers.* The Australian, 2015.
[12] " Gazprom CEO: "Shale revolution" Fell to Desolated Underground," *Oil & Gas Eurasia,* October 6, 2015. https://www.oilandgaseurasia.com/en/news/gazprom-ceo-shale-revolution-fell-desolated-underground
[13] Loder, Asjylyn. "U.S. Shale-Oil Boom May Not Last as Fracking Wells Lack Staying Power," *Bloomberg Business*, October 10, 2013. http://www.bloomberg.com/bw/articles/2013-10-10/u-dot-s-dot-shale-oil-boom-may-not-last-as-fracking-wells-lack-staying-power#p1
[14] Leonid Bershidsky, "Saudis Are Winning the War on Shale," *Bloomberg View,* September 11, 2015. http://www.bloombergview.com/articles/2015-09-11/saudis-are-winning-the-war-on-shale
[15] "Negative interest rates: Bankers v mattresses," *The Economist*, November 28, 2015. http://www.economist.com/category/web-sections/finance/o
[16] Blas, "Shale is 'Here to Stay'".
[17] Evans-Pritchard, Ambrose. "Saudi Arabia may go broke before the US oil industry buckles," *The Telegraph*, August 5 2015. http://www.telegraph.co.uk/finance/oilprices/11768136/Saudi-Arabia-may-go-broke-before-the-US-oil-industry-buckles.html
[18] "Core part of the Eagle Ford in the money even at the oil price below $40," Rystad Energy, November 2015. http://www.rystadenergy.com/AboutUs/NewsCenter/Newsletters/UsArchive/shale-newsletter-november-2015
[19] "Core part of the Eagle Ford in the money even at the oil price below $40," Rystad Energy, November 2015. http://www.rystadenergy.com/AboutUs/NewsCenter/Newsletters/UsArchive/shale-newsletter-november-2015
[20] Ambrose Evans-Pritchard, "US to launch blitz of gas exports, eyes global energy dominance," *The Telegraph,* April 26, 2015. http://www.telegraph.co.uk/finance/newsbysector/energy/11563761/US-to-launch-blitz-of-gas-exports-eyes-global-energy-dominance.html
[21] Bourgeault, Gary. "Why I Don't Care about Not Stinkin' Oil Rig Counts," *Seeking Alpha*, October 3, 2015. http://seekingalpha.com/article/3549316-why-i-dont-care-about-no-stinkin-oil-rig-counts
[22] Ian Talley, "Get Used to Cheap Oil. Why Lower Prices May Stick Around," *Real Time Economics,* January 21, 2015. http://blogs.wsj.com/economics/2015/01/21/get-used-to-cheap-oil-why-lower-prices-may-stick-around/
[23] BP. 5 *Points on How the U.S. Will Soon Become a Net Energy Exporter*. Talking Points Memo, 2015.
[24] "Shale oil: the next energy revolution," *PWC,* February, 2013. https://www.pwc.com/gx/en/oil-gas-energy/publications/pdfs/pwc-shale-oil.pdf
[25] Barani Krishnan, "Oil down 1 percent after hitting 2009 lows," *Reuters,* December 8, 2015. http://finance.yahoo.com/news/u-crude-oil-prices-remain-004835177.html

[26] Ailworth, Erin. *Low oil prices put squeeze on US Shale Producers.* The Australian, 2015. http://www.theaustralian.com.au/business/wall-street-journal/low-oil-prices-put-squeeze-on-us-shale-producers/story-fnay3ubk-1227618652619
[27] Alanna Petroff, Tal Yellin, "Rystad Energy on CNN Money," *Rystad Energy,* November 23, 2015. http://www.rystadenergy.com/AboutUs/NewsCenter/PressReleases/rystad-energy-on-cnn-money
[28] "COUNTRY COMPARISON :: RESERVES OF FOREIGN EXCHANGE AND GOLD," *Central Intelligence Agency,* December 31, 2014. https://www.cia.gov/library/publications/the-world-factbook/rankorder/2188rank.html
[29] Dalan McEndree, "Saudi Oil Strategy: Brilliant Or Suicide?," *oilprice.com,* August 11, 2015 http://oilprice.com/Energy/Oil-Prices/Saudi-Oil-Strategy-Brilliant-or-Suicide.html
[30] Fahad Nazer, "How Saudi Arabia Will Avert an Oil Economy Collapse," *Foreign Affairs,* December 1, 2015. https://www.foreignaffairs.com/articles/saudi-arabia/2015-12-01/down-not-out
[31] "Winners and losers," *The Economist,* October 23, 2014. http://www.economist.com/news/international/21627642-america-and-its-friends-benefit-falling-oil-prices-its-most-strident-critics
[32] Mark Fahey, "Oil prices and budgets:The OPEC countries most at risk," *CNBC,* December 3, 2015. http://www.cnbc.com/2015/12/03/oil-prices-and-budgetsthe-opec-countries-most-at-risk.html
[33] Jeff Colgan, "How OPEC Lost Its Bite: The Oil Cartel That Behaves Like a Club," *Foreign Affairs,* December 3, 2015. https://www.foreignaffairs.com/articles/persian-gulf/2015-12-03/how-opec-lost-its-bite
[34] Barani Krishnan, "Oil down 1 percent after hitting 2009 lows," *Reuters,* December 8, 2015. http://finance.yahoo.com/news/u-crude-oil-prices-remain-004835177.html
[35] "Here Are The Big Winners And Losers Of Low Oil Prices," *The Economist,* October 26, 2014. http://www.businessinsider.com/here-are-the-big-winners-and-losers-of-low-oil-prices-2014-10
[36] Tom Randall, "Cheap oil's Winners and Losers in One Giant Map," *Bloomberg Business,* April 15, 2015, http://www.bloomberg.com/news/articles/2015-04-15/cheap-oil-s-winners-and-losers-in-one-giant-map.
[37] Julia Mitusova, "Oil Prices: The Winners, the Losers, and Geopolitical Drivers of Change," *Emergent Risk International,* October 19, 2015. https://www.linkedin.com/pulse/oil-prices-winners-losers-geopolitical-drivers-change-mitusova-mba?trkSplashRedir=true&forceNoSplash=true
[38] Hassan Bashir, "Crude Awakening The impact of plummeting crude oil prices on company finances," *Deloitte,* 2015. http://www2.deloitte.com/uk/en/pages/energy-and-resources/articles/crude-awakening.htm
[39] Leonardo Maugeri, "THE SHALE OIL BOOM: A U.S. PHENOMENON," *The Geopolitics of Energy Project,* June, 2013.http://belfercenter.ksg.harvard.edu/files/The%20US%20Shale%20Oil%20Boom%20Web.pdf
[40] Herman Wang, "How the shale boom strengthens US diplomatic clout: Fuel for Thought," *The Barrel,* November 2, 2015. http://blogs.platts.com/2015/11/02/shale-boom-us-diplomatic-clout-fuel-for-thought/
[41] Herman Wang, "How the shale boom strengthens US diplomatic clout: Fuel for Thought," *The Barrel,* November 2, 2015. http://blogs.platts.com/2015/11/02/shale-boom-us-diplomatic-clout-fuel-for-thought/
[42] Clifford Krauss, Diane Cardwell, "Expected Repeal of Oil Export Ban Unlikely to Have Immediate Impact," *The New York Times,* December 16, 2015. http://www.nytimes.com/2015/12/17/business/energy-environment/expected-repeal-of-oil-export-ban-unlikely-to-have-immediate-impact.html
[43] Verrastro, Frank. "The Impact of Low Oil Prices on North America." *NBR*, May 15, 2015. http://www.nbr.org/research/activity.aspx?id=560
[44] "A Graphical Look at Some of Export-Import Trends of the U.S. Oil Market," *Global Institute,* McGraw Hill Financial. 2015. https://www.mhfi.com/mhfi-global-institute/articles-and-reports/export-import-trends-of-the-US-oil-market.html
[45] Nick Cunningham, "IEA: U.S. Soon To Be 'Titan' of Refined Petroleum Products," *oilprice.com,* June 17, 2014. http://oilprice.com/Energy/Energy-General/IEA-U.S.-Soon-To-Be-Titan-of-Refined-Petroleum-Products.html
[46] Panetta, Leon. "The Oil-Export Ban Harms National Security," *The Wall Street Journal,* May 19, 2015. http://www.wsj.com/articles/the-oil-export-ban-harms-national-security-1432076440
[47] Flournoy, Michele. *Congressional Testimony: United States Crude Export Policy*. Senate Committee on Banking, Housing, and Urban Affairs, July 28, 2015. Http://www.banking.senate.gov/public/_cache/files/585c8bdf-db2f-4ac7-9513-49a2c773e8f4/33A699FF535D59925B69836A6E068FD0.flournoytestimony72815.pdf
[48] Michael Ratner, et al. *U.S. Natural Gas Exports: New Opportunities, Uncertain Outcomes,* Congressional Research Service, 2015, https://www.fas.org/sgp/crs/misc/R42074.pdf.

[49] Tim Boersma, Charles K. Ebinger, and Heather L. Greenley, *An Assessment of U.S. Natural Gas Exports*, Brookings Institute, 2015, http://www.brookings.edu/~/media/research/files/papers/2015/07/us-natural-gas-exports/lng_markets.pdf.
[50] Ibid.
[51] Chico Harlan, "Asia wants a piece of U.S. shale gas boom; Japan, South Korea seek lower-cost LNG," *The Washington Post*, October 13, 2013, https://www.washingtonpost.com/world/asia-wants-a-piece-of-us-shale-gas-boom-japan-south-korea-seek-lower-cost-lng/2013/10/15/ac161cb8-359e-11e3-89db-8002ba99b894_story.html . https://www.washingtonpost.com/world/asia-wants-a-piece-of-us-shale-gas-boom-japan-south-korea-seek-lower-cost-lng/2013/10/15/ac161cb8-359e-11e3-89db-8002ba99b894_story.html
[52] "Annual Energy Outlook," *Analysis & Projections, 2015.* U.S. Energy Information Administration, 2015, http://www.eia.gov/forecasts/aeo/mt_naturalgas.cfm.
[53] Ratner, Parfomak, et al. *U.S. Natural Gas Exports: New Opportunities, Uncertain Outcomes.*
[54] Valerie Volcovici, "U.S. greenhouse gas emissions fall 10 percent since 2015: EPA." *Reuters*, April 15, 2014, http://www.reuters.com/article/2014/04/15/us-usa-climate-carbon-idUSBREA3E1XD20140415.
[55] Oren Cass, *Issues 2016: Fracking, Not Solar Power, is Reducing U.S. Carbon-Dioxide Emissions (*New York: Manhattan Institute, 2015), https://www.manhattan-institute.org/html/issues-2016-reality-check-fracking-not-solar-power-reducing-us-carbon-dioxide-emissions-8004.
[56] Ben German, "Energy Secretary: Natural gas helps battle climate change – for now," *The Hill*, August 1, 2013, http://thehill.com/policy/energy-environment/315009-energy-secretary-natural-gas-helps-battle-climate-change-for-now?utm_campaign=E2Wire&utm_source=twitterfeed&utm_medium=twitter.
[57] "Effect of Increased Levels of Liquefied Natural Gas Exports on U.S. Energy Markets," *Analysis & Projections,* U.S. Energy Information Administration, October 29, 2014, https://www.eia.gov/analysis/requests/fe/.
[58] Joe Fisher,"Moddy's Forecasts Cancellation of Many U.S. LNG Export Projects," *NGI's Daily Gas Price Index*, April 7, 2015, http://www.naturalgasintel.com/articles/101902-moodys-forecasts-cancellation-of-many-us-lng-export-projects.
[59] Mandel, "For U.S. LNG is the window half open or half closed?".
[60] Ratner, Parfomak, et al. *U.S. Natural Gas Exports: New Opportunities, Uncertain Outcomes.*
[61] Joe Fisher,"Moddy's Forecasts Cancellation of Many U.S. LNG Export Projects," *NGI's Daily Gas Price Index*, April 7, 2015, http://www.naturalgasintel.com/articles/101902-moodys-forecasts-cancellation-of-many-us-lng-export-projects.
[62] *Annual Energy Outlook 2015* (Washington D.C.: U.S. Energy Information Administration, 2015, http://www.eia.gov/forecasts/aeo/mt_naturalgas.cfm.
[63] Tom Cutler, "The Trans-Pacific Partnership as a Pathway for U.S. Energy Exports to Japan," *NBR Energy Security Program*, November 7, 2014, http://www.nbr.org/downloads/pdfs/eta/ES_essay_cutler_012815.pdf.
[64] Ibid.
[65] Ibid.
[66] Tony Daltorio, "Why Japan's Desperately Seeking U.S. LNG," *Money Morning*, March 25, 2013, http://moneymorning.com/2013/03/25/why-japans-desperately-seeking-u-s-lng/.
[67] *Japan: International energy data and analysis* (Washington, DC: U.S. Department of Energy, 2015), https://www.eia.gov/beta/international/analysis.cfm?iso=JPN.
[68] Interview with Author May 1, 2015 in Toyko Japan.
[69] "Russia: International energy data and analysis," *U.S. Energy Information Administration*, July 28, 2015. https://www.eia.gov/beta/international/analysis.cfm?iso=RUS
https://www.eia.gov/beta/international/analysis.cfm?iso=RUS
[70] Ibid.
[71] Ibid.
[72] *The Economist,* April 3, 2014 http://www.economist.com/news/briefing/21600111-reducing-europes-dependence-russian-gas-possiblebut-it-will-take-time-money-and-sustained
[73] "Russia: International energy data and analysis," *U.S. Energy Information Administration*, July 28, 2015. https://www.eia.gov/beta/international/analysis.cfm?iso=RUS
[74] Jude Clemente, "How Much Energy Does Russia Have Anyways?," *Forbes,* March 25, 2015. http://www.forbes.com/sites/judeclemente/2015/03/25/how-much-energy-does-russia-have-anyways/
[75] *The Economist,* April 3, 2014 http://www.economist.com/news/briefing/21600111-reducing-europes-dependence-russian-gas-possiblebut-it-will-take-time-money-and-sustained

[76]David Buchan, "Can shale gas transform Europe's energy landscape?," July, 2013. http://www.cer.org.uk/sites/default/files/publications/attachments/pdf/2013/pbrief_buchan_shale_10july13-7645.pdf
[77] Dalibor Rohac, "Time to end Europe's Dependence on Russian energy," *Financial Times,* May 5, 2015. http://blogs.ft.com/beyond-brics/2015/05/05/time-to-end-europes-dependence-on-russian-energy/
[78] *The Economist,* April 3, 2014 http://www.economist.com/news/briefing/21600111-reducing-europes-dependence-russian-gas-possiblebut-it-will-take-time-money-and-sustained
[79] Alex Benjamin Wilson, "Liquefied Natural Gas in Europe," *European Parliament Research Service,* November 2015. http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/571314/EPRS_BRI(2015)571314_EN.pdf
[80] Ralf Dickel, Elham Hassanzadeh, James Henderson, Anouk Honoré, Laura El-Katiri, Simon Pirani, Howard Rogers, Jonathan Stern & Katja Yafimava, " Reducing European Dependence on Russian Gas: distinguishing natural gas security from geopolitics," *The Oxford Institute for Energy Studies,* October, 2014. http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/10/NG-92.pdf
[81] The Conference on "Security and Energy Implications for the South Caucasus after Ukraine," The Kennan Institute, the Woodrow Wilson Center, January 28, 2015.
[82] Ralf Dickel, Elham Hassanzadeh, James Henderson, Anouk Honoré, Laura El-Katiri, Simon Pirani, Howard Rogers, Jonathan Stern & Katja Yafimava, " Reducing European Dependence on Russian Gas: distinguishing natural gas security from geopolitics," *The Oxford Institute for Energy Studies,* October, 2014. http://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/10/NG-92.pdf
[83] Bill White, "Buyers and sellers debate LNG pricing change at Tokyo conference," *Alaska Natural Gas Transportation Projects,* September 11, 2013 http://www.arcticgas.gov/buyers-and-sellers-debate-lng-pricing-change-tokyo-conference
[84] Milda Seputyte, "Lithuania Grabs LNG in Effort to Curb Russian Dominance," *Bloomberg Business,* October 27, 2014. http://www.bloomberg.com/news/articles/2014-10-27/lithuania-grabs-lng-in-effort-to-curb-russian-dominance
[85] Kjetil Malkenes Hovland, "Gas Terminal Plans Helped Lithuania Negotiate Lower Price From Gazprom," *The Wall Street Journal,* May 28, 2014. http://www.wsj.com/articles/gas-terminal-plans-helped-lithuania-negotiate-lower-price-from-gazprom-1401188154
[86] Milda Seputyte, "Lithuania Grabs LNG in Effort to Curb Russian Dominance," *Bloomberg Business,* October 27, 2014. http://www.bloomberg.com/news/articles/2014-10-27/lithuania-grabs-lng-in-effort-to-curb-russian-dominance
[87] Mark Strzelecki, "Poland Opens LNG Terminal, Pledges to End Russian Dependence," *Bloomberg Business,* October 12, 2015. http://www.bloomberg.com/news/articles/2015-10-12/poland-opens-lng-terminal-pledges-to-end-russian-gas-dependence
[88] Anna Shiryaevskaya, "Cheap Russian Gas Tempts EU Buyers as LNG Import Growth Stalls," *Bloomberg Business,* September 9, 2015. http://www.bloomberg.com/news/articles/2015-09-09/cheap-russian-gas-tempts-eu-buyers-as-lng-import-growth-stalls
[89] "Cedigaz: European LNG net imports drop," *LNG World News,* October 23, 2015. http://www.lngworldnews.com/cedigaz-european-lng-net-imports-drop/
[90] "THE RUSSIAN GAS MATRIX: HOW MARKETS ARE DRIVING CHANGE," *The Brookings Institute,* May 27, 2014. http://www.brookings.edu/~/media/events/2014/5/27-russian-gas-matrix/20140527_russia_gas_matrix_transcript.pdf
[91] "THE RUSSIAN GAS MATRIX: HOW MARKETS ARE DRIVING CHANGE," *The Brookings Institute,* May 27, 2014. http://www.brookings.edu/~/media/events/2014/5/27-russian-gas-matrix/20140527_russia_gas_matrix_transcript.pdf
[92] Dymitry Dokuchaev. "What helped Russia's economy survive in 2015?" Russia Direct. Decemebr 29, 2015. http://www.russia-direct.org/analysis/what-helped-russias-economy-survive-2015
[93] Hassan Bashir, "Crude Awakening The impact of plummeting crude oil prices on company finances," *Deloitte,* 2015. http://www2.deloitte.com/uk/en/pages/energy-and-resources/articles/crude-awakening.htm
[94] Michael J. Halloran, "Cheap Oil – What Is It Good For?," *Investment Strategy Group,* December 18, 2014. http://www.janney.com/File%20Library/Insights/ISG_Cheap-Oil---what-is-it-good-for.pdf
[95] Joe Parson, "Russia shale-acked on oil price fall and sanctions," *bne Intellinews,* October 14, 2014. http://www.intellinews.com/russia-shale-acked-on-oil-price-fall-and-sanctions-500432371/?archive=bne

[96] "Russia: International energy data and analysis," *U.S. Energy Information Administration*, July 28, 2015. https://www.eia.gov/beta/international/analysis.cfm?iso=RUS
[97] Ibid.
[98] Adam Galas. "Russia Sanctions: 5 Dividend Stocks That Might Be Affected" The Motley Fool. October 22, 2014. http://www.fool.com/investing/general/2014/10/22/russia-sanctions-5-dividend-stocks-that-might-be-a.aspx
[99] Vladimir Soldatkin, "Gazprom net income plunges 86 pct on oil price drop, rouble," *Reuters,* April 29, 2015. http://uk.reuters.com/article/us-gazprom-results-idUKKBN0NK1XP20150429
[100] Donald N. Jensen, "The Kremlin Tries to Roll Back the 'Shale Revolution'," *Institute of Modern Russia,* August 1, 2013. http://imrussia.org/en/economy/524-the-kremlin-tries-to-roll-back-the-shale-revolution
[101] Jack Farchy, "Russian oil: Between a rock and a hard place," *Financial Times,* October 29, 2014. http://www.ft.com/intl/cms/s/2/fc354a6a-5dcb-11e4-b7a2-00144feabdc0.html#axzz3vCW8Pkug
[102] Jack Farchy, "Russian oil: Between a rock and a hard place," *Financial Times,* October 29, 2014. http://www.ft.com/intl/cms/s/2/fc354a6a-5dcb-11e4-b7a2-00144feabdc0.html#axzz3vCW8Pkug
[103] Jack Farchy, "Russian oil: Between a rock and a hard place," *Financial Times,* October 29, 2014. http://www.ft.com/intl/cms/s/2/fc354a6a-5dcb-11e4-b7a2-00144feabdc0.html#axzz3vCW8Pkug
[104] Patrice Hill, "Siberian Shale find fuels Russia's fracking future," *The Washington Times,* February 18, 2014. http://www.washingtontimes.com/news/2014/feb/18/siberian-shale-find-fuels-russias-fracking-future/?page=all
[105] "Could hydraulic fracturing play a part in Russia's future?," *Shale Gas International,* June 25, 2015. http://www.shalegas.international/2015/06/25/could-hydraulic-fracturing-play-a-part-in-russias-future/
[106] Alexey Miller, "Message delivered by Alexey Miller at 5th St. Petersburg International Gas Forum," *Gazprom,* October 6, 2015. http://www.gazprom.com/press/miller-journal/399450/
[107] Duncan Brown, "Message delivered by Alexey Miller at 5th St. Petersburg International Gas Forum," *The Diplomat,* December 24, 2015. http://thediplomat.com/2015/12/energy-and-trade-in-russias-far-east-realignment/
[108] Elena Mazneva, "Gazprom Says China Supply Talks Looking Beyond Short-Term Demand," *Bloomberg Business,* September 29, 2015. http://www.bloomberg.com/news/articles/2015-09-29/gazprom-says-china-supply-talks-looking-beyond-short-term-demand
[109] Dalan McEndree, "Putin Is Taking A Big Risk With China Gas Deals," *oilprice.com,* November 1, 2015. http://oilprice.com/Energy/Natural-Gas/Putin-Is-Taking-A-Big-Risk-With-China-Gas-Deals.html
[110] Dalan McEndree, "Putin Is Taking A Big Risk With China Gas Deals," *oilprice.com,* November 1, 2015. http://oilprice.com/Energy/Natural-Gas/Putin-Is-Taking-A-Big-Risk-With-China-Gas-Deals.html
[111] "World Shale Resource Assessments" Energy Information Administration. Updated September 24, 2015. https://www.eia.gov/analysis/studies/worldshalegas/
[112] Andrew E. Kramer, "Russia Anticipates Boom in Oil Extracted From Shale," *The New York Times,* November 13, 2012. http://www.nytimes.com/2012/11/14/business/energy-environment/russia-anticipates-boom-in-oil-extracted-from-shale.html
[113] David Wethe, "Russian $8.2 Trillion Oil Trove Locked Without U.S. Tech," *Bloomberg Business,* June 17, 2014. http://www.bloomberg.com/news/articles/2014-06-16/russia-s-8-2-billion-oil-trove-locked-without-u-s-tech-energy
[114] Andrew E. Kramer, "Russia Anticipates Boom in Oil Extracted From Shale," *The New York Times,* November 13, 2012. http://www.nytimes.com/2012/11/14/business/energy-environment/russia-anticipates-boom-in-oil-extracted-from-shale.html
[115] Patrice Hill, "Siberian Shale find fuels Russia's fracking future," The Washington Times, February 18, 2014. http://www.washingtontimes.com/news/2014/feb/18/siberian-shale-find-fuels-russias-fracking-future/?page=all
[116] Arjun Sreekumar, "Why the Next Shale Oil Boom Could Be in Russia," *The Motley Fool,* January 19, 2014. http://www.fool.com/investing/general/2014/01/19/why-the-next-shale-oil-boom-could-be-in-russia.aspx
[117] David Wethe, "Russian $8.2 Trillion Oil Trove Locked Without U.S. Tech," *Bloomberg Business,* June 17, 2014. http://www.bloomberg.com/news/articles/2014-06-16/russia-s-8-2-billion-oil-trove-locked-without-u-s-tech-energy
[118] Melissa Akin, "Insight: Russia's Bazhenov - a long, slow shale oil revolution," *Reuters,* April 3, 2013.http://www.reuters.com/article/us-russia-shale-insight-idUSBRE9320JW20130403
[119] Patrice Hill, "Siberian Shale find fuels Russia's fracking future," The Washington Times, February 18, 2014. http://www.washingtontimes.com/news/2014/feb/18/siberian-shale-find-fuels-russias-fracking-future/?page=all
[120] Patrice Hill, "Siberian Shale find fuels Russia's fracking future," The Washington Times, February 18, 2014. http://www.washingtontimes.com/news/2014/feb/18/siberian-shale-find-fuels-russias-fracking-future/?page=all

[121] "Russia: International energy data and analysis," *U.S. Energy Information Administration*, July 28, 2015. https://www.eia.gov/beta/international/analysis.cfm?iso=RUS
[122] "USGS Releases New Oil and Gas Assessment for Bakken and Three Forks Formations" Department of the Interior Press Release. April 30, 2013. https://www.doi.gov/news/pressreleases/usgs-releases-new-oil-and-gas-assessment-for-bakken-and-three-forks-formations
[123] Jude Clemente, "How Much Energy Does Russia Have Anyways?," *Forbes,* March 25, 2015. http://www.forbes.com/sites/judeclemente/2015/03/25/how-much-energy-does-russia-have-anyways/
[124] Joe Parson, "Russia shale-acked on oil price fall and sanctions," *bne Intellinews,* October 14, 2014. http://www.intellinews.com/russia-shale-acked-on-oil-price-fall-and-sanctions-500432371/?archive=bne
[125] David Wethe, "Russian $8.2 Trillion Oil Trove Locked Without U.S. Tech," *Bloomberg Business,* June 17, 2014. http://www.bloomberg.com/news/articles/2014-06-16/russia-s-8-2-billion-oil-trove-locked-without-u-s-tech-energy
[126] Jozef Niemiec. "EU energy plans must include investment in 'energy transition' measures for workers" The Parliament Magazine. March 19, 2015. https://www.theparliamentmagazine.eu/articles/opinion/eu-energy-plans-must-include-investment-energy-transition-measures-workers
[127] Ewa Krukowska and Ladka Bauerova. "Gas Pipeline Web Sought to Cut Russia's Grip on EU Supplies." Bloomberg. July 10, 2015. http://www.bloomberg.com/news/articles/2015-07-10/gas-pipeline-web-sought-to-reduce-russia-s-grip-on-eu-supplies
[128] Frederic Simon "EU plans major offensive to diversify gas supplies." Euractiv. June 2, 2015 http://www.euractiv.com/sections/energy/eu-plans-major-offensive-diversify-gas-supplies-315019
[129] Keith Johnson. "Europe Doubles Down on Russian Gas. September 11, 2015. *Foreign Policy*. http://foreignpolicy.com/2015/09/11/europe-doubles-down-on-russian-gas-nord-stream-gazprom-putin/