The Outlook for Energy: A View to 2040

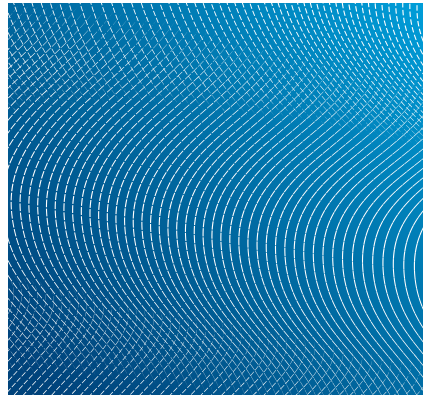
U.S. Edition

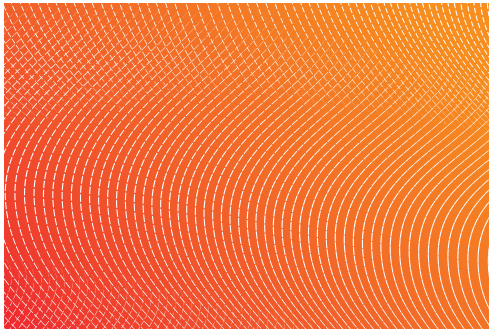
2015

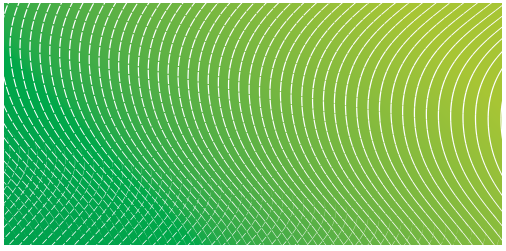
ExxonMobil

Energy lives here™


6:30







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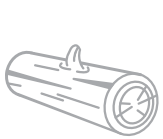
U.S. Edition

Modern energy for modern living

Gains in living standards over the past two centuries have been enabled in large part by a transition to modern energy sources.

One element driving this transition is the "energy density" of various energy types. Fuels high in energy content use less space and are often the easiest to transport for various uses. This helps explain why gasoline is prevalent as a transportation fuel and why people in high-rise buildings do not rely on wood for heating and cooking.

To help compare energy content, we've converted some sources of energy used today to one of mankind's earliest forms of energy: wood logs used as fuel for fire.



5 logs
(3.5 inch diameter, 16 inch length)

=

1 gallon gasoline

=

13,000 AA batteries

34 logs
Daily U.S. energy demand per person in 2010

=

7 logs
Household use

+

6 logs
Personal transportation

+

Comfort and security

Fire was the first form of light and heat, providing safety, comfort and security after dark.

Kerosene and other petroleum products became widely used for their low cost and versatility versus solid fuels.

Lighting for cities is provided by one of the most convenient energy types — electricity.

Then — Now

Personal mobility

It used to take 25 days to travel 2,000 miles by stagecoach.

By the 1860s, the trip could be made in 2 weeks by steam locomotive.

The same distance can now be traveled by a gasoline-powered car in just 3 days.

Then — Now

Energy fit for modern purposes

When selecting a type of energy for a particular need, many factors are considered including practicality, convenience and cost. Energy content is often "lost" in burning a log or charging a battery, and logs of wood can't easily power a car nonstop for 300 miles. Gasoline has advantages on the road, but doesn't compete well with batteries for powering a smartphone.

Technology and energy work together to provide practical solutions. This is what makes modern living standards possible and why we use a diversity of fuels.

6 logs
Commercial buildings

+

4 logs
Commercial transportation

+

11 logs
Industrial use

Productive workspaces

Before the late 19th century, office buildings generally did not exceed five stories because of construction costs and the lack of elevators.

Steel frame construction, elevators, electric lighting and air conditioning enabled taller buildings, which maximized real estate.

Modern insulation, lighting and temperature control have greatly improved commercial building energy-efficiency.

Then — Now

Travel and trade

With the use of wind power in 1620, the Mayflower took 66 days to cross the Atlantic.

The invention of steam-powered ships allowed the same trip to be made in two weeks.

Modern aircraft and jet fuel make flights across the Atlantic faster, taking less than 8 hours.

Then — Now

Modern manufacturing

Prior to the Industrial Revolution, factory locations were near fast-flowing streams to use water power.

The invention of the steam engine helped accelerate the Industrial Revolution and the demand for coal.

Modern manufacturing equipment now requires energy dense fuels like natural gas and electricity.

Then — Now

A sea change in U.S. energy

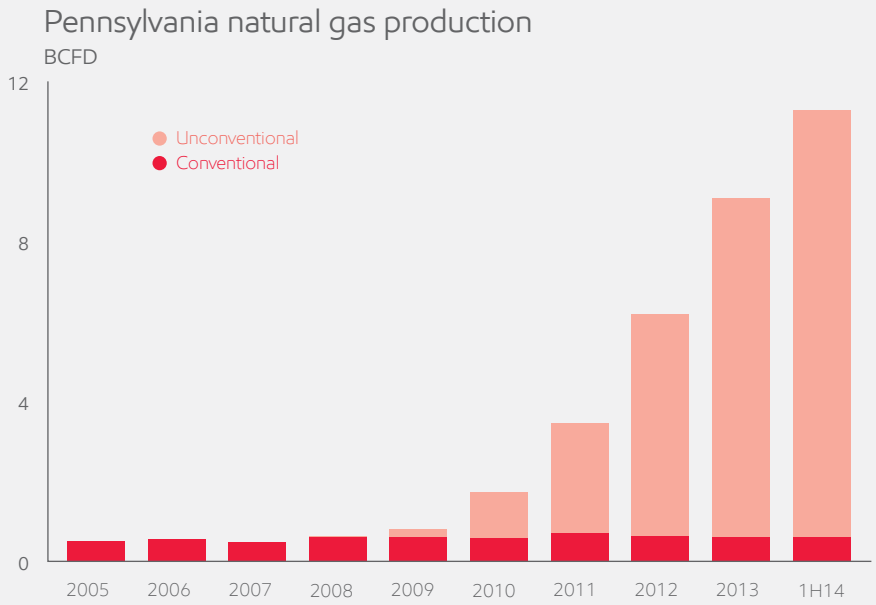
Ten years ago, the United States was importing close to 60 percent of its oil, and making plans to import significant amounts of natural gas for the first time in history. Today, the prevailing conversation in the United States is not about a scarcity of energy supply, but rather an abundance.

Advances in technology have unlocked oil and natural gas from shale and other tight rock formations in states across the country, including Pennsylvania, Texas and North Dakota. With the addition of other new sources, such as Canadian oil sands and production from the deepwater Gulf of Mexico, there has been a dramatic increase in U.S. energy supply, and further growth is projected.

But while supply is rising, America's energy demand is not. U.S. petroleum demand actually is falling because the country is using energy more efficiently in its cars and elsewhere. The country can grow its economy and maintain living standards with less energy.

As a result, North America is on track to become a net energy exporter for the first time in recent history, with the United States making a significant contribution. U.S. imports of oil are expected to drop to about one-tenth the level of 10 years ago. And the country has the opportunity to meet its own needs and export significant amounts of liquefied natural gas (LNG) to help meet rising global demand for the clean-burning fuel.

This special edition of *The Outlook for Energy* takes a closer look at these sea changes in U.S. energy, and what it means for the United States and the world from now through 2040.



Source: Pennsylvania Department of Environmental Protection

Technology advances have enabled a rapid rise in oil and gas production in states across the U.S.

30%

Rise in U.S. unconventional gas production from 2010 to 2013

The U.S. energy future

By now, many Americans have heard about the renaissance in U.S. energy production. But what can be difficult to appreciate is the speed and scale of this transformation. After falling for decades, U.S. production of crude oil and other liquid fuels has risen by over 50 percent in just the past five years, to a rate of more than 11 million barrels per day (MBD). Natural gas production has risen by 40 percent since 2005, and is now at a record high. According to U.S. Energy Information Administration (EIA) estimates, the United States has passed Russia and Saudi Arabia to become the world's largest oil and natural gas producer.

This new era of American energy abundance has had far-reaching positive impacts on the U.S. economy and global energy landscape.

Rising energy production has helped the U.S. economy, creating millions of new jobs and revitalizing communities. Rising production has also contributed billions in taxes and other government revenue. Increased domestic energy supplies have also saved U.S. consumers money on energy costs — more than $1,200 per household in 2012, according to an IHS study.

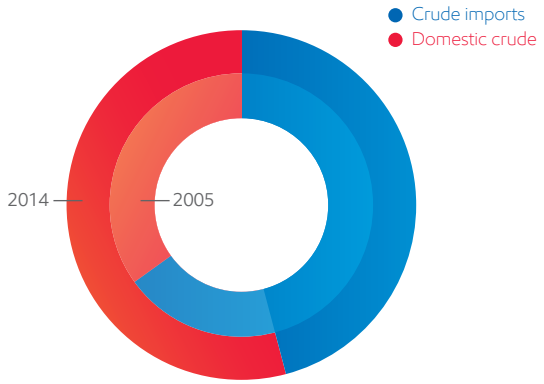
U.S. manufacturing has been revived. Energy intensive U.S. industries have been boosted by the influx of abundant, affordable energy. The chemicals industry has seen a double benefit, since it uses natural gas and liquids both as a fuel and as a feedstock for plastics and other petrochemicals. Five years ago, the United States was on the verge of becoming a net importer of chemicals. Today, chemicals are once again America's single biggest export — larger than agriculture, automobiles and aerospace.

As the United States produces more of its own oil, it's importing a lot less. The share of U.S. liquid fuels consumption met by net imports fell to an average of 33 percent in 2013, down from more than 60 percent in 2005. The EIA expects that share to hit 20 percent in 2016 – the lowest level since 1968.

The Outlook projects that this energy renaissance will continue for years to come.

U.S. refining crude supply

Percent



Rising domestic oil production has reduced U.S. crude imports

Source: U.S. EIA, through Aug 2014

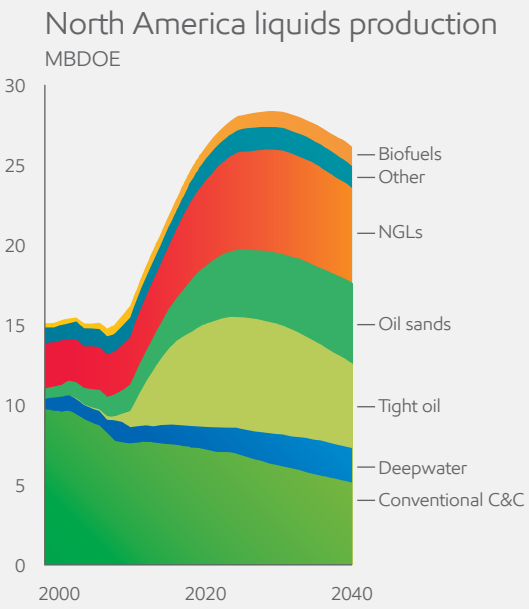
By 2040, U.S. production of crude and other liquids is projected to rise to over 15 MBD — about a 70 percent increase from 2010. North America as a whole will see a similar growth rate through 2040, reaching 26 MBD — more than twice the current production of Saudi Arabia. Given the integration of energy infrastructure and trade between the U.S., Canada and Mexico, North America is often considered as a single energy production region.

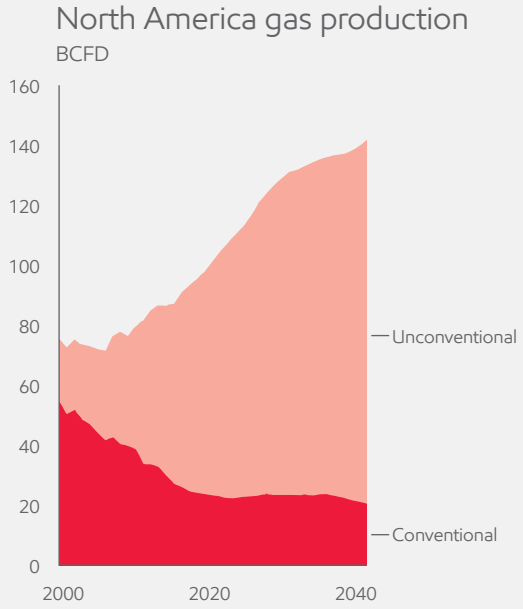
Similar growth rates are expected for natural gas. North American natural gas production is projected to rise by about 75 percent, to over 140 billion cubic feet per day (BCFD) by 2040.

Roots of a renaissance

Shale energy got its start in Texas in the 1980s, when an American innovator named George Mitchell worked to combine two existing production technologies — hydraulic fracturing and horizontal drilling — and began to safely and economically extract the vast quantities of natural gas that were known to exist in shale rock.

As it turned out, those same technologies can be used to extract oil from shale and other tight rock formations. Other nations are exploring the use of shale technology, but for now, the United States and Canada are the only countries in the world with meaningful shale production.





Combined oil and natural gas production is expected to grow through 2040, as shale gas and tight oil combine with other "unconventional" sources.

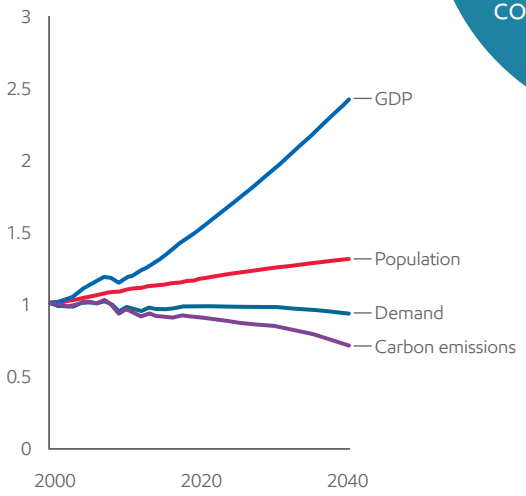
All of the growth in North American oil and gas production will come from "emerging" sources — energy that technology has only recently made possible to produce economically. These include shale gas and its associated natural gas liquids (NGLs), tight oil, deepwater Gulf of Mexico, and Canadian oil sands. By 2040, emerging sources are projected to account for 80 percent of North America's liquids production, and 85 percent of its natural gas.

55%

Less energy demand per dollar of U.S. GDP in 2040, compared to 2010

U.S. energy trends

Indexed to 2000



While U.S. energy production is rising, its energy consumption is declining as improvements to energy efficiency outpace underlying demand growth. The United States led the world in energy demand growth throughout the past century. But like many developed economies, the United States has reached a watershed moment, where energy use is already so pervasive that big increases in energy demand are no longer needed to sustain population growth and economic expansion.

For example, home and vehicle ownership rates tend to rise as countries grow more prosperous, driving up energy demand. But there is a practical limit to how many homes and cars people can have. The United States already has more than 75 cars for every 100 people. By contrast, in China today, there are about 10 cars for every 100 people.

Improvements to energy efficiency are likely to produce a net decline in U.S. energy demand for the first time in history. From 2010 to 2040, the U.S. population will grow moderately, its economy will double but its energy demand is expected to decline slightly, by about 5 percent.

Efficiency improvements are expected to reduce energy consumption in each of the four main demand sectors.

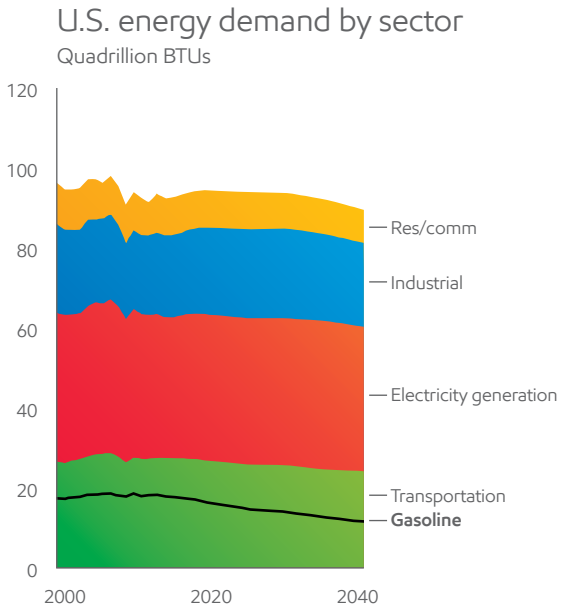
- The most dramatic efficiency impacts are seen in the Transportation sector, where U.S. demand for gasoline is falling as passenger cars become more fuel-efficient. The average new U.S. car in 2040 is expected to get 47 on-road miles per gallon, compared to 25 mpg today, mostly because of projected growth in hybrid vehicles. Commercial transportation needs will continue to grow despite efficiency gains, and will drive up U.S. demand for diesel and jet fuel.

- Demand in the residential/commercial and industrial sectors will fall due to efficiency gains such as improved insulation and lighting for buildings and the further use of advanced manufacturing technologies and processes.

- In the largest energy-demand sector, electricity generation, U.S. demand for electricity will continue to grow, but the energy required to produce that electricity should decrease as the use of cleaner, more efficient fuels like natural gas make a greater contribution.

In the electricity generation sector, utilities and other power generators are shifting away from coal in favor of low- or no-emissions fuels such as natural gas, renewables and nuclear. This shift is expected to accelerate as U.S. environmental policies raise the effective "cost of carbon" for various fuels. In 2000, 50 percent of America's electricity was produced from coal; by 2040, it will likely be about 10 percent.

As a result of this shift toward cleaner fuels, plus ongoing gains in efficiency, U.S. energy-related carbon dioxide emissions are expected to decline by more than 25 percent through 2040, reversing decades of steady increases.



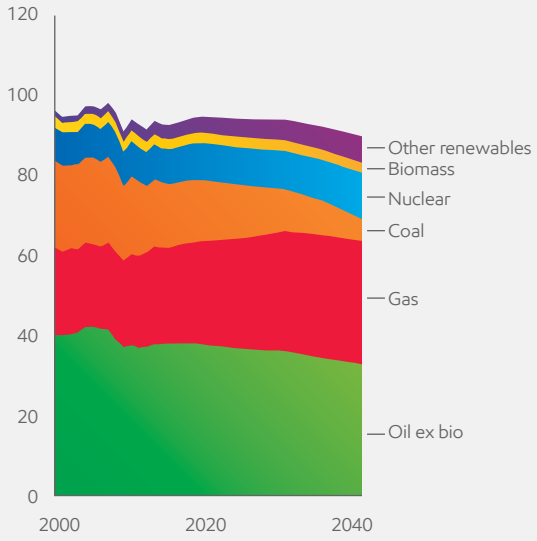
It is important to note that trends in the United States and other well-developed economies are different from trends in the rest of the world, where energy demand and emissions continue to rise. While energy demand in the United States and other developed nations is projected to fall by about 5 percent from 2010 to 2040, demand in developing nations (where 80 percent of the world's population lives) should rise by nearly 70 percent. Globally, demand is expected to rise by 35 percent.

"Energy is a critical part of boosting prosperity and eradicating poverty."

— Jim Yong Kim, President, World Bank Group

U.S. energy supply by fuel

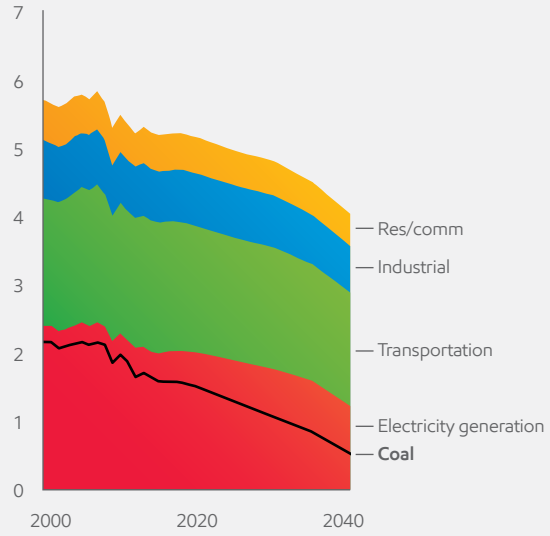
Quadrillion BTUs



Overall U.S. energy demand declines but natural gas, renewables and nuclear should take a greater share

U.S. energy-related CO_2 emissions by sector

Billion tonnes



Anticipated declining coal usage is the biggest factor behind an expected sharp drop in U.S. CO_2 emissions

North America's new trade opportunity

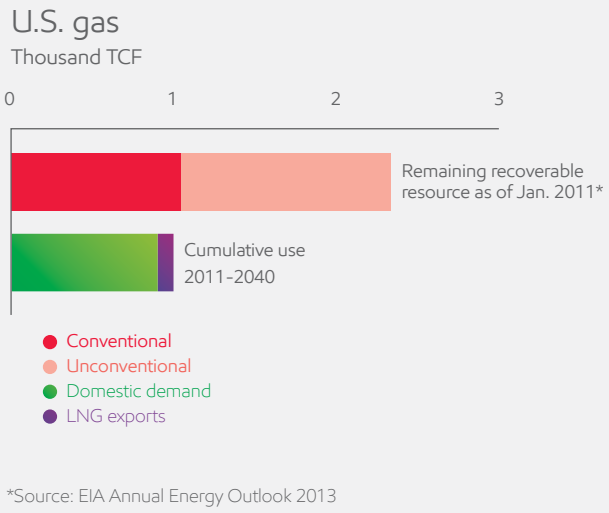
With its production rising and demand falling, North America is on track to become a net exporter of energy by about 2020, and the United States could be a significant contributor to those expanding trade opportunities.

Becoming an energy exporter would mean a new economic opportunity for the United States, and a changed role for the nation on the world energy stage. The United States will still want to integrate with global energy markets for certain types of energy to meets its needs – creating an interdependence as well as energy security.

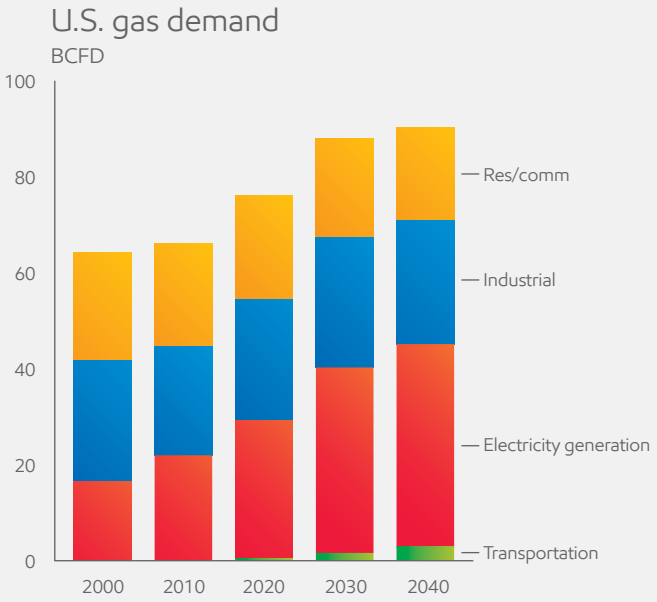
The export opportunities are largest for natural gas. Most of the markets for this gas are overseas – in places such as Japan and South Korea, which have high gas demand but little indigenous resource. As a result, most of America's gas exports will be in the form of LNG, which is natural gas that is liquefied for transport by ship, rather than by pipeline.

A study commissioned by the U.S. Department of Energy (DOE) investigated U.S. LNG exports in the range of 6 to 12 BCFD. The study concluded that the higher the level of LNG exports, the more the U.S. economy would benefit.

The DOE is currently studying LNG export levels ranging from 12 to 20 BCFD. Exports at these levels would represent only a small fraction of U.S. natural gas demand over *The Outlook* period, and an even smaller share of the estimated remaining U.S. natural gas resource.



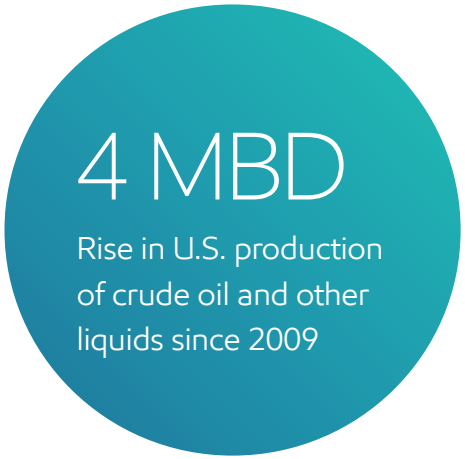
*Source: EIA Annual Energy Outlook 2013



U.S. natural gas resources are far greater than projected consumption plus LNG exports

We believe that, in time, U.S. LNG exports are likely to be in the higher range currently being studied by DOE due to the scale of global demand for natural gas. In Europe and Asia Pacific, imports are projected to account for over half of gas demand by 2040. As an example, even at the high end of the DOE study range, cumulative LNG exports through 2040 would still be only 5 percent of the EIA estimate of America's remaining recoverable gas resources.

Rising production will create new trading opportunities for oil, too. North America should shift to a net liquids exporter, as production is lifted by growth in U.S. tight oil, Canadian oil sands and other supplies such as NGLs. By 2040, North American production is expected to exceed liquids demand by approximately 15 percent.



In the United States, imports should continue to decline. U.S. net imports of liquid supplies are projected to fall to under 2 MBD by 2040, about one-tenth the levels seen just 10 years ago. The growth in U.S. tight oil has been rapid as evidenced by the surge in production from places like Texas and North Dakota. Every year producers increase their drilling effectiveness while estimates of the size of the resource steadily increase. In fact, North Dakota just recently surpassed 1 MBD of oil production.

The trading picture for crude is more complex than for natural gas, because unlike natural gas, there are different grades of crude oil.

The nation's 140 refineries use crude as feedstock to make a range of products, including gasoline, diesel fuel and asphalt. But each refinery can process only so much of each grade before running into bottlenecks.

"Total U.S. net imports of energy as a share of energy consumption fell to their lowest level in 29 years for the first six months of 2014."

— U.S. EIA

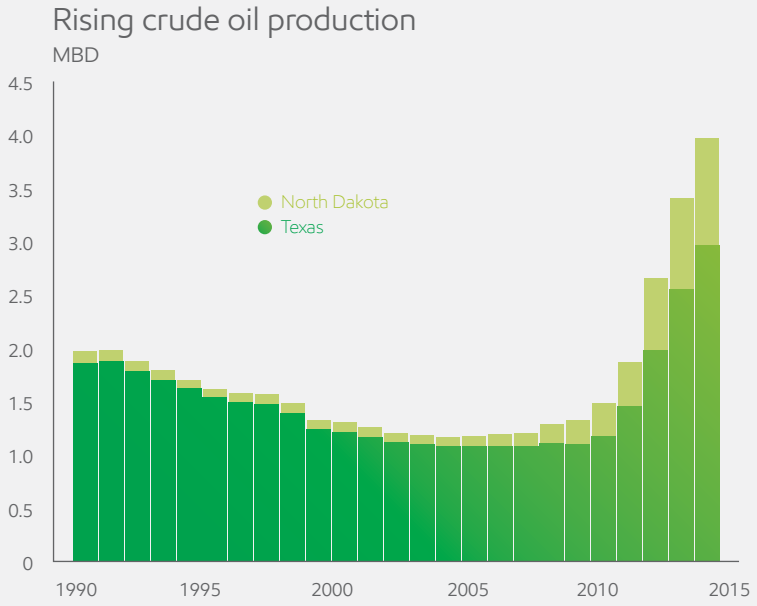
As a result, to most effectively meet the needs of U.S. energy consumers, the United States could export certain types of crude, while importing others. These balances can and will change with market conditions.

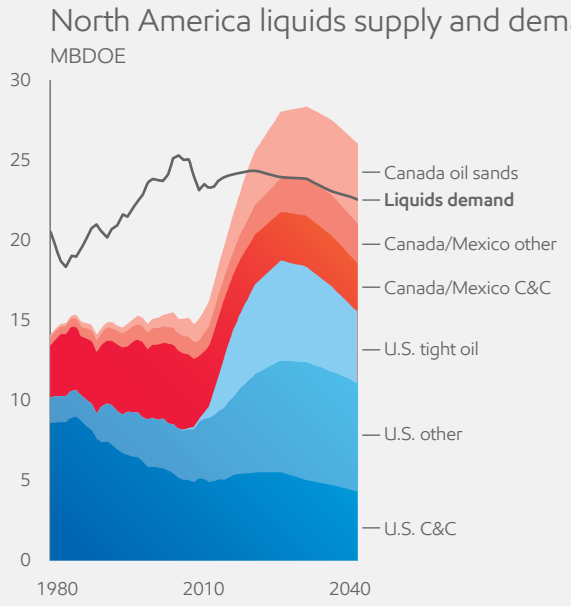
When considered as a region, North America is expected to be a significant energy exporter by 2040. Other energy forecasters have reached similar conclusions.

Just as the United States benefits from exporting agricultural products, cars and computer parts, it also can benefit from exporting energy.

In fact, as production continues to grow, the United States will need to export its surplus production or else risk forcing production to be curtailed, along with the jobs and economic growth that come with it.

The sea changes in U.S. energy — rising production and falling demand — continue to provide new jobs and economic benefits to the nation. Informed consumer choices and effective government policies are needed to best meet the complex energy challenges and opportunities facing the U.S., North America and the world.





As production rises and demand declines, North America can become a net liquids exporter

Data

Energy demand (quadrillion BTUs) unless otherwise indicated						Average annual change			% change					
						2010	2025	2010	2010	2025	2010	Share of total		
Regions	1990	2000	2010	2025	2040	2025	2040	2040	2025	2040	2040	2010	2025	2040
United States														
Primary	81	96	94	94	90	0.0%	-0.3%	-0.2%	0%	-5%	-5%	100%	100%	100%
Oil	35	40	38	37	33	-0.2%	-0.7%	-0.5%	-3%	-10%	-13%	40%	39%	37%
Gas	17	22	22	28	31	1.4%	0.7%	1.0%	24%	10%	36%	24%	29%	34%
Coal	19	22	20	13	6	-2.8%	-5.4%	-4.1%	-34%	-57%	-72%	21%	14%	6%
Nuclear	6	8	9	9	12	0.6%	1.4%	1.0%	9%	23%	34%	9%	10%	13%
Biomass/waste	2	3	3	3	2	0.2%	-0.4%	-0.1%	3%	-6%	-4%	3%	3%	3%
Hydro	1	1	1	1	1	0.9%	0.7%	0.8%	14%	11%	26%	1%	1%	1%
Other renewables	1	1	2	3	5	4.1%	3.0%	3.5%	83%	55%	183%	2%	4%	6%
End-use demand (including electricity)														
Total end-use	62	72	70	72	70	0.2%	-0.2%	0.0%	3%	-3%	0%	100%	100%	100%
Residential/commercial	15	18	19	19	19	0.0%	0.0%	0.0%	0%	0%	0%	27%	27%	27%
Transportation	22	27	27	26	24	-0.4%	-0.4%	-0.4%	-6%	-6%	-12%	39%	36%	34%
Industrial	24	27	24	27	27	0.9%	-0.1%	0.4%	15%	-1%	14%	34%	38%	38%
Memo: electricity demand	9	12	13	15	17	0.7%	0.8%	0.7%	11%	12%	24%	19%	20%	23%
Power generation fuel[1]	29	37	37	37	36	-0.1%	-0.1%	-0.1%	-2%	-1%	-3%	40%	39%	40%
North America														
Primary	95	114	113	118	115	0.3%	-0.2%	0.0%	4%	-3%	1%	100%	100%	100%
Oil	42	49	47	47	44	0.1%	-0.5%	-0.2%	1%	-7%	-6%	41%	40%	38%
Gas	21	26	28	36	40	1.7%	0.6%	1.2%	29%	10%	42%	25%	31%	34%
Coal	20	23	21	14	6	-2.6%	-5.3%	-3.9%	-32%	-56%	-70%	19%	12%	5%
Nuclear	7	9	10	10	13	0.3%	1.4%	0.9%	5%	23%	30%	9%	9%	11%
Biomass/waste	3	4	3	3	3	0.1%	-0.7%	-0.3%	2%	-10%	-8%	3%	3%	3%
Hydro	2	2	2	2	3	0.7%	0.4%	0.6%	12%	6%	18%	2%	2%	2%
Other renewables	1	1	2	4	7	4.5%	3.2%	3.8%	93%	60%	209%	2%	4%	6%
End-use demand (including electricity)														
Total end-use	73	86	87	93	92	0.4%	0.0%	0.2%	7%	-1%	6%	100%	100%	100%
Residential/commercial	18	22	23	23	23	0.2%	0.0%	0.1%	2%	0%	3%	26%	25%	25%
Transportation	25	31	32	32	31	-0.2%	-0.2%	-0.2%	-2%	-3%	-6%	37%	34%	33%
Industrial	30	34	32	38	38	1.2%	0.1%	0.6%	19%	1%	21%	36%	41%	41%
Memo: electricity demand	11	15	16	18	20	0.9%	0.8%	0.8%	14%	13%	29%	18%	20%	22%
Power generation fuel[1]	33	42	43	44	44	0.1%	0.0%	0.1%	2%	0%	2%	38%	37%	38%
World														
Primary	360	418	526	662	717	1.6%	0.5%	1.0%	26%	8%	36%	100%	100%	100%
Oil	137	157	178	212	228	1.2%	0.5%	0.8%	19%	7%	28%	34%	32%	32%
Gas	72	89	116	158	189	2.1%	1.2%	1.6%	37%	19%	63%	22%	24%	26%
Coal	86	93	135	164	138	1.3%	-1.1%	0.1%	22%	-16%	2%	26%	25%	19%
Nuclear	21	27	29	38	56	1.9%	2.7%	2.3%	32%	49%	97%	5%	6%	8%
Biomass/waste	36	41	49	56	56	0.9%	0.0%	0.5%	14%	1%	15%	9%	8%	8%
Hydro	7	9	12	16	20	2.3%	1.3%	1.8%	40%	21%	70%	2%	2%	3%
Other renewables	1	3	7	18	29	6.3%	3.4%	4.8%	149%	65%	311%	1%	3%	4%
End-use demand (including electricity)														
Total end-use	291	330	409	511	556	1.5%	0.6%	1.0%	25%	9%	36%	100%	100%	100%
Residential/commercial	87	98	115	135	147	1.1%	0.5%	0.8%	17%	9%	27%	28%	26%	26%
Transportation	65	81	100	122	140	1.3%	0.9%	1.1%	22%	15%	40%	24%	24%	25%
Industrial	139	151	193	254	269	1.8%	0.4%	1.1%	31%	6%	39%	47%	50%	48%
Memo: electricity demand	35	45	63	94	119	2.6%	1.6%	2.1%	48%	27%	87%	15%	18%	21%
Power generation fuel[1]	118	144	192	258	291	2.0%	0.8%	1.4%	34%	13%	51%	37%	39%	41%
Energy-related CO_2 emissions (billion tonnes)														
World	21.3	23.9	30.7	37.4	36.9	1.3%	-0.1%	0.6%	22%	-2%	20%	100%	100%	100%
North America	5.6	6.6	6.5	6.2	5.2	-0.3%	-1.1%	-0.7%	-4%	-16%	-19%	21%	17%	14%
United States	4.9	5.7	5.5	5.0	4.0	-0.7%	-1.4%	-1.0%	-10%	-19%	-26%	18%	13%	11%

[1]Share based on total primary energy

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