

NEBRASKA

Good Life. Great Energy.

NEBRASKA ENERGY OFFICE



Pete Ricketts, Governor

February 14, 2019

Patrick J. O'Donnell
Clerk of the Legislature
Room 2018, State Capitol
Lincoln, NE 68508

Dear Mr. O'Donnell:

Enclosed is the Nebraska Energy Office's Annual Report for Fiscal year 2017-2018 as required by Nebraska State Statutes, Section 81-1607, and (R.S. 2012). A copy of the Annual Report has also been posted at the agency's website at: http://www.neo.ne.gov/annual_rept/NEOAnnualReport.pdf.

Sincerely,

A handwritten signature in blue ink, appearing to read "Jim Macy".

Jim Macy,
Interim Director



NEBRASKA ENERGY OFFICE
Annual Report
2018

NEBRASKA
Good Life. Great Energy.

Letter from the Interim Director



Dear Citizens of Nebraska:

On August 1, 2018, Governor Ricketts appointed me Interim Director for the Nebraska Energy Office. I've found the Energy Office has a dedicated staff working together to help grow Nebraska.

The Nebraska Dollar and Energy Saving Loan Program began in 1990 and continues to be a long-running success story. Available to all Nebraskans at more than 900 locations across the state, more than 93.4 percent of all the energy efficiency projects financed with low-interest loans from the agency are for homes of Nebraskans. As of June 30, 2018, more than \$348.9 million have been loaned to Nebraskans for 29,298 energy efficiency improvement projects.

In addition, since the Weatherization Assistance Program began in 1977, \$208 million has been used to make energy efficiency improvements in 69,191 homes. In 2010, maximum household income levels were revised, making free home weatherization available to thousands more low-income and elderly Nebraskans than in prior years.

2018 success stories are:

- Completion of Access Ethanol Nebraska — a collaborative effort between federal and state organizations to install more flex fuel pumps at service stations across Nebraska to provide travelers with more ethanol fuel options.
- Collected and evaluated energy use at small community wastewater plants, analyzed plant energy efficiency and provided technical and financial assistance to the lowest performing plants, enabling an energy savings of 20 percent or more.
- The Energy Office employed University of Nebraska engineering students to record government building energy use which will be used to help develop recommendations for a "Benchmarking & Beyond" state building efficiency policy.

Details of the agency's loan efforts and other successes can be found in the Energy Office's *2018 Annual Report*. It is with great pleasure that I present this *Report* to you.

The Annual Report can also be found on the agency's website at:

http://www.neo.ne.gov/annual_rept/NEOAnnualReport.pdf

Sincerely,

Jim Macy,
Interim Director

Nebraska Energy Office



Table of Contents

The Programs

Weatherization Assistance Program	1
Dollar and Energy Saving Loans.....	4
State Energy Program Formula Grant	7
State Energy Program Competitive Funding	8
State Heating Oil and Propane Program	9
Oil Overcharge Funds.....	10
Financial Activity	10

Trends and Needs

State-wide Energy Need and Cost.....	11
Agricultural.....	13
Commercial.....	15
Residential	16
Industrial	18
Transportation.....	20
Electric Power.....	22
Status of Ongoing Studies.....	23



The vision of the Nebraska Energy Office is to provide leadership that maximizes the benefits of energy efficiency and renewable energy through communications, outreach, technology and partnerships.

The mission of the Nebraska Energy Office is to promote the efficient, economic and environmentally responsible use of energy. The agency's principles are that we value teamwork, are customer oriented and are committed to excellence, creativity and innovation.

The Energy Office accomplishes this mission by administering innovative programs, implementing projects and services that inform, educate and involve energy consumers and decision makers. The Energy Office also collects essential statistical energy data and is the State's lead Agency responsible for developing recommended responses during energy related emergencies.

Goals:

- ❖ Expand opportunities to implement energy efficient projects through partnerships and collaborations.
- ❖ Develop and administer programs that promote efficient uses of energy resources in everyday lives.
- ❖ Support economic development activities including sustainable existing state businesses and attracting new energy investment to the state.
- ❖ Support a broad energy portfolio that meets the state's energy needs in a reliable, clean, cost-effective manner and integrates renewable options.
- ❖ Continue the compilation and analysis of energy statistics and information that identify emerging trends related to energy supply, demand and conservation.
- ❖ Provide objective perspectives on energy policy to the public and elected officials.

The Programs

The Nebraska Energy Office operates several different annually-funded federal and state programs. These programs are:

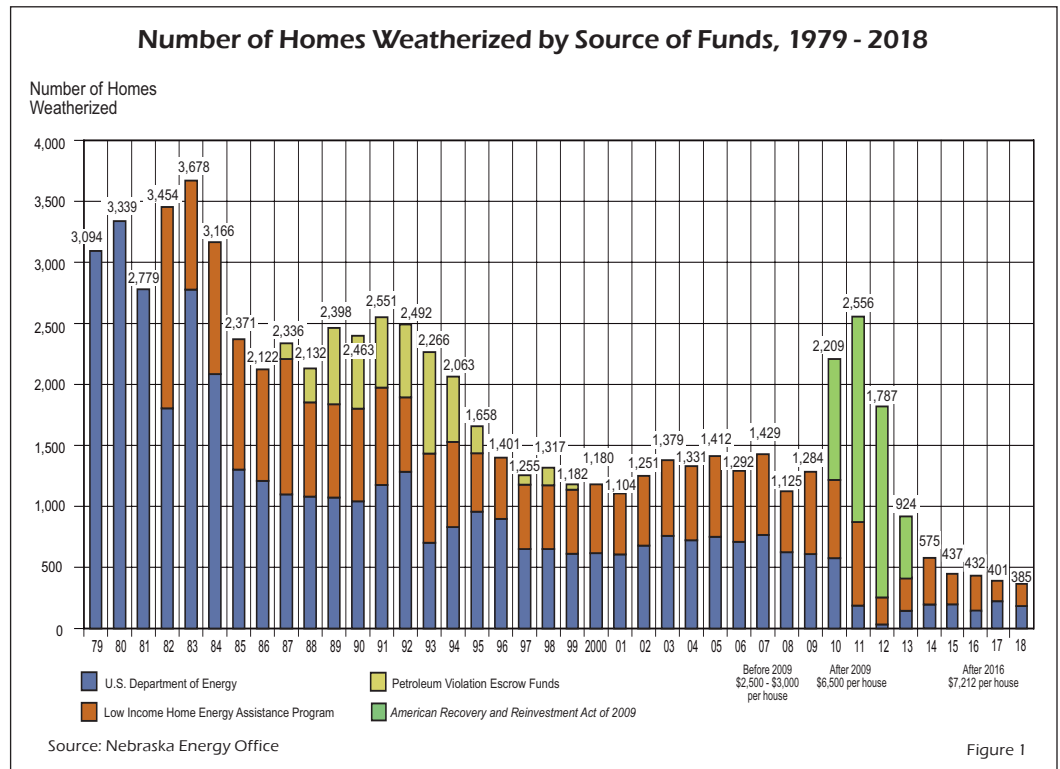
- ❖ Weatherization Assistance
- ❖ State Energy Program and special projects
- ❖ Dollar and Energy Saving Loans
- ❖ State Heating Oil and Propane Program
- ❖ Statutorily-required state activities such as data collection and reporting.

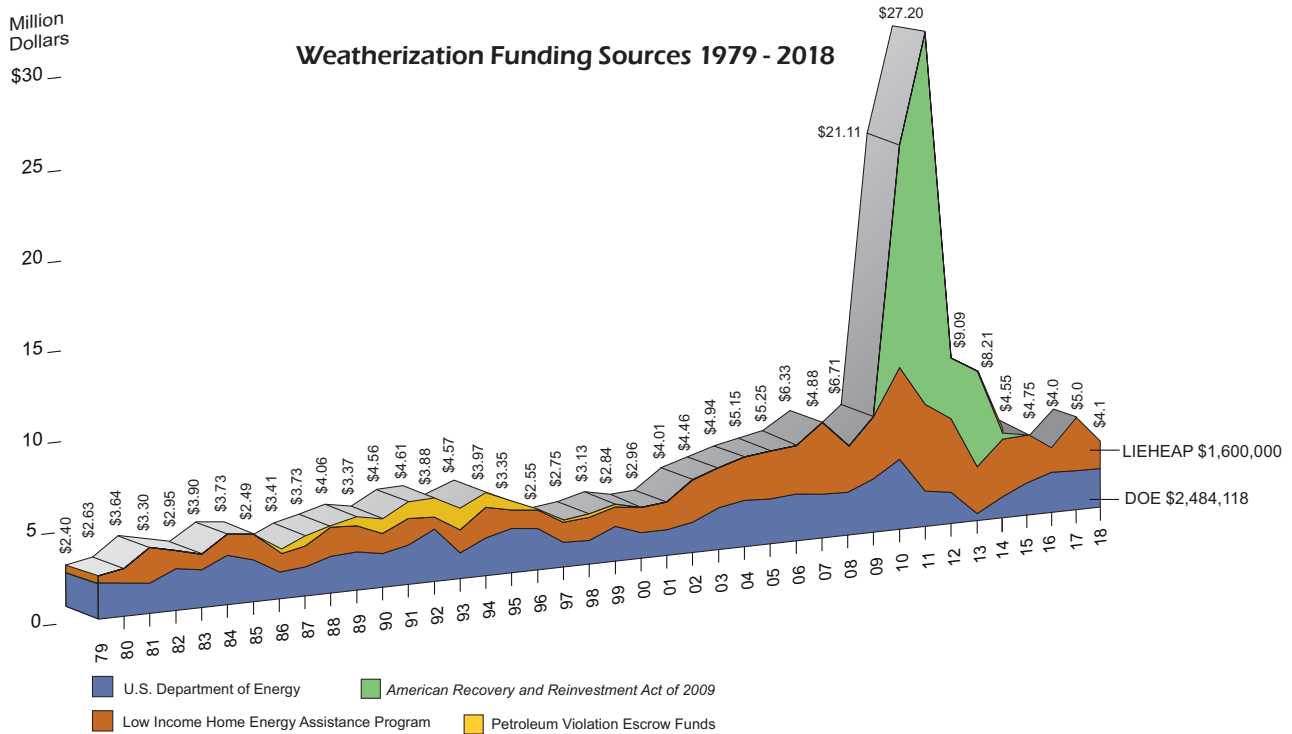
An overview of the 2017-2018 financial activity appears at the end of this section. The period covered is from July 1, 2017 to June 30, 2018, except where noted.

Weatherization Assistance Program

The Energy Office administers the federally-funded program for weatherizing homes to save energy and money for those with limited incomes. The agency is responsible for inspecting the homes that are weatherized

and for monitoring the sub-grantees, primarily community action agencies and one non-profit agency, that are responsible for the home weatherization improvements. Sub-grantee crews or private contractors are responsible for completing the work on the homes. The Energy Office staff inspects a minimum of 10-15 percent of all completed homes to ensure the quality of work performed.

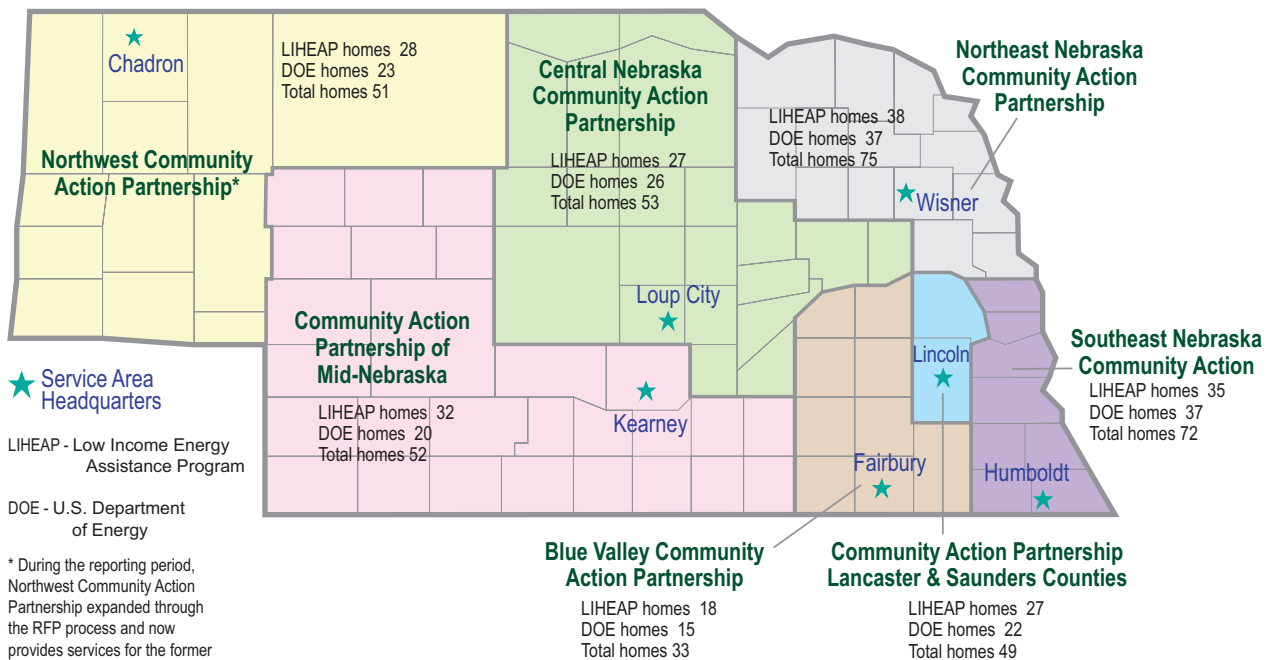




Source: Nebraska Energy Office

Figure 2

Total Nebraska Homes Weatherized by Area Provider July 2017 - June 2018



* During the reporting period, Northwest Community Action Partnership expanded through the RFP process and now provides services for the former Community Action Partnership of Western Nebraska.

Source: Nebraska Energy Office

Figure 3

The Weatherization Assistance Program received funding from two sources during the reporting period:

- \$1,600,000 from the Low-Income Home Energy Assistance Program. Annually, the Nebraska Department of Health and Human Services transfers a portion of the funds received to pay utility bills to the agency to weatherize homes so that the need for utility bill paying assistance is reduced or eliminated.
- \$2,484,118 from the U.S. Department of Energy's Weatherization Assistance Program.

More about how these funds have been spent throughout the state are in figure 3.

Between 2017-2018, 385 homes were weatherized with these funds as illustrated in figure 3.

The types of improvements may vary based on an analysis of the home and averages between \$4,000 and \$7,212 per home, excluding the cost of health and safety improvements such as furnace repairs. Prior to mid-2009, the average amount spent on homes ranged from \$2,500 to \$3,000. The average cost of a home is set by the U.S. Department of Energy. The kinds of improvements made to homes vary by the home type: frame, mobile or multi-family. In a frame home, the most common improvements generally are: adding insulation to attics and walls, insulating box sill areas and crawl spaces, replacing or repairing the furnace, and replacing a primary door. In mobile homes, the most frequent improvements

are: replacing a primary door, replacing a primary window, replacing or repairing the furnace, insulating the underbelly and replacing or repairing the water heater. In multi-family homes, the two most common improvements are: adding insulation to the attic and replacing a primary window. Most homes that are weatherized also receive low-cost improvements such as caulking, weatherstripping, pipe wrap and, in some instances, water heater jackets.

Since the Weatherization Assistance Program began in 1977, \$208 million has been spent to make energy efficiency improvements in 69,191 homes.

“In multi-family homes, the two most common improvements are adding insulation to the attic and replacing a primary window.”



Nebraska Energy Office Investment in the Weatherization Assistance Program October 2017 - September 2018	
NEO Investment (federal funds)	\$1,184,820
Energy Impacts	
Electric Dollar Savings (present discounted value)	\$124,225
Natural Gas Dollar Savings (present discounted value)	\$436,951
Annual Total Dollar Savings	\$561,176
Present Discount Value of Future Savings	\$561,633
Economic Impacts	
Output	\$857,005
Value-Added	\$565,272
Labor Income	\$527,360
Job-Years	15.19
Environmental Impacts (Pounds)	
Carbon Dioxide (CO2)	7,533,960
Sulfur Dioxide (SO2)	10,273
Nitrogen Oxide (NOX)	10,102
Particulate Matter < 2.5 micro-meters (PM2.5)	178.84
Volatile Organic Compounds (VOC)	395.11
Particulate Matter < 10 micro-meters (PM10)	286.79

Source: Nebraska Energy Office

Figure 4

In 2010, maximum household income levels were revised to 200 percent of the federal poverty guidelines, making free home weatherization available to thousands more Nebraskans than in prior years.

Energy savings resulting from the energy efficiency improvements made to homes typically last 20 years or longer and most have a one year payback. Conservatively, estimated energy savings for the 41 years total \$122 million.

In 2012, an extensive analysis quantified the energy, economic and environmental benefits of the Weatherization Assistance Program and these quantifiers are used today to determine the impact on the program. That analysis was based on a sample of the weatherization investments made over 12 months during 2009 and 2010. Since the actual investment for the 12 month period was \$8.9

million, the energy, economic and environmental impacts were 4.5 times larger than shown in the table figure 4.

Beginning in January 2014, data from Weatherization Assistance Program activities were entered into the NEO database. The energy, economic and environmental benefits from October 2017 through September 2018 are illustrated in figure 4.

Dollar and Energy Saving Loans

The Dollar and Energy Saving Loan program was initially capitalized with Oil Overcharge Funds, later augmented with *American Recovery and Reinvestment Act* funds and is continually re-charged with loan repayments from borrowers.

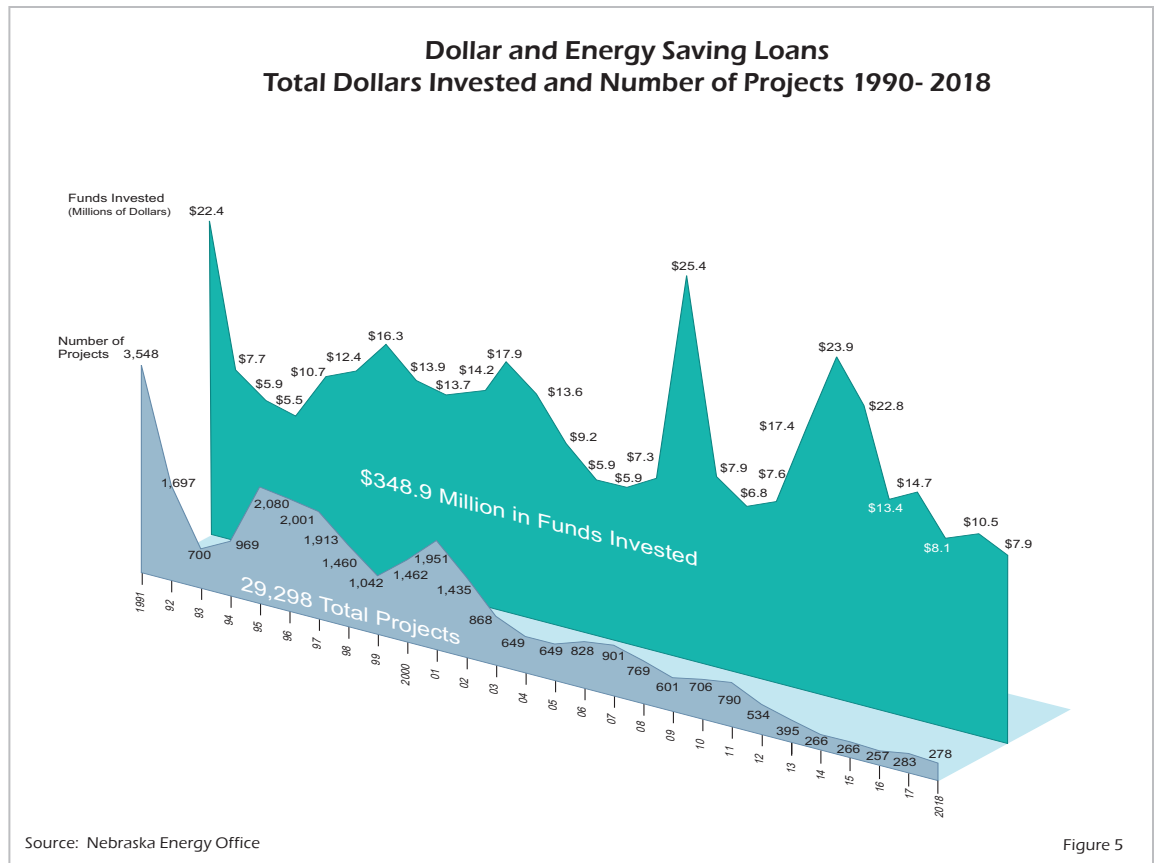


Figure 5

Loans have financed projects in all of the state’s 93 counties as illustrated in figure 6. Douglas County with 3,367 projects totaling \$47.8 million tops the list with the most projects. Lancaster County co-anchors the top spot with the most dollars invested at \$55.3 million, albeit on fewer projects — 2,190. Looking at a regional perspective, the Third Congressional District leads with 14,737 projects; First Congressional District with 10,331 projects and the Second Congressional District with 4,230 projects.

During this reporting period, 278 new projects totaling \$7.9 million were financed. The number of energy efficiency projects financed since 1990 are shown in figure 5 and total 29,298.

Figure 7 quantifies loans in five different areas:

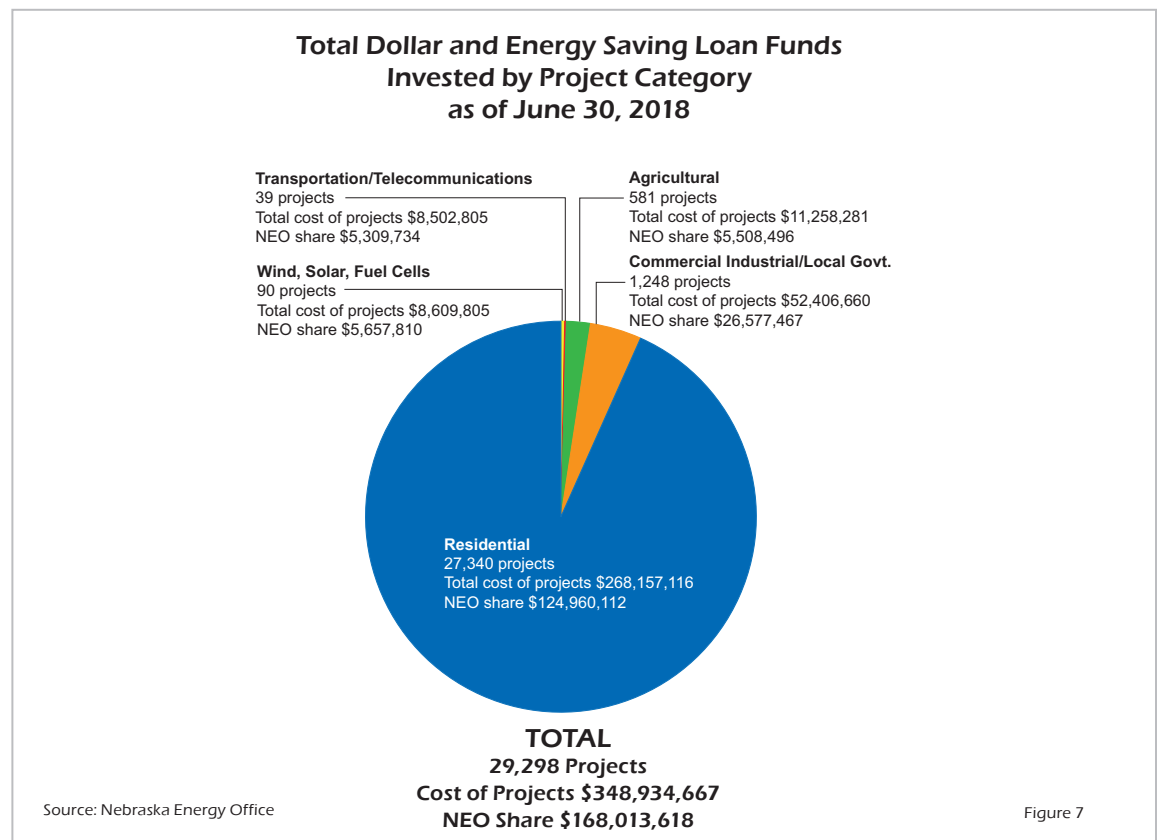
residential, commercial/industrial/local government, agricultural, transportation/telecommunications, wind, solar and fuel cells. The number of projects by category and the total cost in each category also appear in figure 7. Several of the largest categories are detailed as follows:

Residential

More than 93.3 percent of all the energy efficiency projects financed with loans from the agency are for homes of Nebraskans. More than 74.37 percent of NEO funds from all categories — \$124.96 million — has been used to finance residential energy saving improvements such as replacement of inefficient furnaces, air conditioners and heat pumps, replacement of windows and doors and insulation of walls and ceilings. New energy



“More than 93.3 percent of all the energy efficiency projects financed with loans from the agency are for homes of Nebraskans.”



efficient housing construction is also included in the category. Since 1990, 27,340 residential energy efficiency projects have been undertaken by Nebraskans using loan program funds.

Commercial/Industrial/Local Government

More than 15.02 percent of funds from all categories — \$52.41 million — has been used to make building and system improvements in 1,248 projects since 1990, ranking second-highest among all loan areas. Typical improvements in this category include replacement of heating and cooling equipment, installation of insulation, lighting upgrades and replacement of doors and windows.

Agricultural

Improvements in agricultural equipment and systems rank third in the use of low-interest financing. More than 3.30 percent of all improvement funding — \$11.26 million — has been used to finance projects such as low-pressure irrigation systems, replacement of irrigation pumps and motors, replacement of grain dryers and well modifications. Since 1990, 581 projects have been financed with \$5.51 million from the Energy Office, \$5.37 million from participating lenders and over \$383,000 from borrowers.

Energy, Economic and Environmental Impacts

In 2012, a study analyzing the energy, economic and environmental impacts of Residential Dollar and Energy Saving Loans was completed by the University of Nebraska - Lincoln. Beginning in January 2014, data from Residential Dollar and Energy Saving Loans has been entered into the

database. The energy, economic and environmental benefits of these loans from July 1, 2016 through June 30, 2018 are illustrated in figure 8.

State Energy Program Formula Grant

In 2017-2018, Nebraska received \$391,890 for this federally-funded effort and supplied \$78,378 in state funds from oil and natural gas severance taxes, as required 20 percent matching funds. These funds are used to provide energy efficiency services

Residential Dollar and Energy Saving Loans July, 2017 - June, 2018	
Investment	\$3,001,054
Residential Projects	243
Energy Impacts	
Electric Energy Savings (kWhs)	64,453
Natural Gas Energy Savings (therms)	40,574
Present Discount Value of Future Savings	\$803,595
Present Day Value Economic Impacts	
Output	\$2,773,738
Value-Added	\$1,666,453
Labor Income	\$1,235,384
Job-Years	31.85
Emissions Reductions (Pounds All Years)	
Carbon Dioxide (CO2)	11,089,585
Sulfur Dioxide (SO2)	6,279
Nitrogen Oxide (NOX)	11,378
Particulate Matter < 2.5 micro-meters (PM2.5)	109
Volatile Organic Compounds (VOC)	240
Particulate Matter < 10 micro-meters (PM10)	174
Total Present Discount Value of Environmental, Comfort, Health and Safety	\$696,735

Source: Nebraska Energy Office

Figure 8

to consumers and other small energy users, and include the publication of this *Annual Report* and the *Nebraska Energy Quarterly* as well as maintenance of the state's energy database (neo.ne.gov/statshtml/index3c.html) and agency website (neo.ne.gov).

These funds also provide program support for a wide array of activities that include energy supply shortage tracking and management and emergency preparedness, education and information, Dollar and Energy Saving Loan operations, support of renewable energy activities and residential and commercial building energy efficiency activities.

Residential Energy Codes Compliance Collaborative

In March 2013, the Energy Office established a Residential Energy Codes Compliance Collaborative, using existing agency funding. The Collaborative is a group of more than 25 members that represent state and local governments, homebuilders, utilities, architects, home energy raters, suppliers, banks, and advocacy groups including Midwest Energy Efficiency Alliance and the Nebraska League of Municipalities.

It's activities include:

- Collaboration with the Nebraska Energy Office on the state's Residential Field Study Energy Code Compliance Evaluation;
- Joint participation with the Nebraska Energy Office in the National Commercial Buildings Energy Code Field Study, and
- Collaboration with the Nebraska Energy Office's Baseline Study Project.

Nebraska Wind and Solar Conference

Since 2008, the Nebraska Energy Office has partnered with stakeholders interested in wind and solar energy to produce a state-wide Wind and Solar Conference. Agency staff members develop and execute communications for the conference

including news release development, and distribution and active social media promotion. They also help to develop conference content including selection of speakers and topics; host an educational booth about services provided by the agency, and assist with IT equipment and services. The October 2018 conference was held in Lincoln, Nebraska and hosted over 350 attendees.

National Association of State Energy Officials

Participation in National Association of State Energy Officials (NASEO) programs is also included under the State Energy Program. The agency also participates in NASEO webinars and conference calls, and attends national and regional NASEO meetings and conferences concerning energy issues.

Nebraska Energy Efficiency Partnership

The Nebraska Energy Office is a founding member of the Nebraska Energy Efficiency Partnership (NEEP), which includes representatives from Nebraska's three largest electric utilities: Omaha Public Power District, Nebraska Public Power District and Lincoln Electric System as well as the Nebraska Municipal Power Pool. The group meets to share knowledge, program ideas and other information including Demand Side Management programs for electric utility customers.

State Energy Program Competitive Funding

Energy Reduction at Municipal Waste Water Plants

The Energy Office is collaborating with the University of Nebraska-Lincoln and the Nebraska Department of Environmental Quality for this U.S. Department of Energy cooperative agreement to address energy efficiency in local government waste water treatment facilities. The U.S. Department of

“ Since 2008, the Nebraska Energy Office has partnered with stakeholders interested in wind and solar energy to produce a state-wide Wind and Solar Conference. ”



Energy awarded \$273,330 in December 2015 and it was matched with \$54,666 of state funds. The project was completed December 31, 2018.

Tasks for this award include:

- Collection and evaluation of energy use data from wastewater plants in communities with a population of 10,000 or less;
- Further analysis of 60 to 100 of the plants, including an on-site visit, and
- Technical and financial assistance to at least 24 of the lowest performing plants, enabling the achievement of 20 percent or better in savings.

Access Ethanol Nebraska

The U.S. Department of Agriculture awarded a \$2.285 million Biofuel Infrastructure Partnership grant to the Energy Office to establish a public-private partnership with the Nebraska Corn Board (Corn Board), Nebraska Ethanol Board (Ethanol Board) and Nebraska Department of Agriculture (NDA) to add 88 new blender pumps at 22 retail sites across the state of Nebraska, allowing greater access to ethanol for Nebraskans and out of state visitors. The grant required a dollar for dollar match from the state, private industry and foundations, and was fulfilled with funds from the Nebraska Corn Board through the state corn checkoff funds paid by Nebraska corn farmers. The Nebraska Environmental Trust approved funding of \$500,000 for each of the next two years. Matching funds came from Legislative Bill 581 (LB 581) passed by the Nebraska Unicameral in 2015, which allows for some ethanol infrastructure; contributions made by individual ethanol plants and “Prime the Pump;” a non-profit organized and funded by the ethanol industry to improve ethanol infrastructure.

Nebraska Initiative-Benchmarking & Beyond

The Energy Office is partnering with the University of Nebraska-Lincoln (UNL) and the University of Nebraska-Omaha (UNO) to benchmark Nebraska state government buildings. With the assistance of a \$300,000 cooperative agree-

ment awarded in December 2016 from the U.S. Department of Energy (USDOE) and matching state funds of \$122,012, the goal is to have as many Nebraska state government buildings as possible benchmarked in EPA's ENERGY STAR Portfolio Manager by 2020.

2018 tasks for this award included:

- Certified Energy Manager, Building Operator Certification and ECO 24/7 training for facilities managers;
- Building energy use data collection;
- Revision of NEO's Energy, Economic and Environmental Impact Tool to analyse public/commercial buildings by the UNL Bureau of Business Research;
- Completed two Benchmarking trainings for university interns and provided six training workshops for high school teachers to educate students in benchmarking public and commercial buildings in their communities and,
- Developing recommendations for a state benchmarking policy.

State Heating Oil and Propane Program

Between September 2017 and September 2018, the Energy Office began its 16th year of participation in the U.S. Department of Energy's State Heating Oil and Propane Program. This activity collects price information from a sampling of Nebraska suppliers selected by the Energy Information Administration from October through March which in turn, is shared with the Energy Information Administration and then posted on the agency's website (www.neo.ne.gov/statshtml/86.html and www.neo.ne.gov/statshtml/87.html).

U.S. Department of Energy provided a grant of \$6,144 for this activity which is required to be matched one-for-one using state cash funds. By the end of the reporting period, all funds were expended and the project was completed.



“The U.S. Department of Agriculture awarded a \$2.285 million Biofuel Infrastructure Partnership grant... to add 88 new blender pumps at 22 retail sites across the state of Nebraska...”

Oil Overcharge Funds

Beginning in 1982, Nebraska received oil overcharge — or petroleum violation escrow — funds as a result of several court actions against oil companies that overcharged their customers during the period of federal price controls from 1973 to 1981. Since direct restitution to injured consumers was not practical, the courts ordered the money be distributed to the states and used, within parameters established by the courts and a federal regulator, to fund energy assistance and efficiency programs. The final petroleum violation escrow payment from the U.S. Department of Energy to the Energy Office was received March 28, 2017.

The Legislature and the U.S. Department of Energy require the Energy Office to annually report on the disposition of these funds. A Nebraska Energy Settlement Fund Summary of activities and expenditures is detailed in figure 9.

Financial Activity

Total Energy office expenditures for the year were \$11,324,755, a decrease of 28.6 percent. Energy loans accounted for 39.9 percent of expenditures, aid payments accounted for 43.8 percent and the remaining 16.3 percent of expenditures were for salaries and operations.

Of the funding for these expenditures, 19.4 percent came from Oil Overcharge funds, 72.1 percent from federal funds, and 8.5 percent from state and other funds.

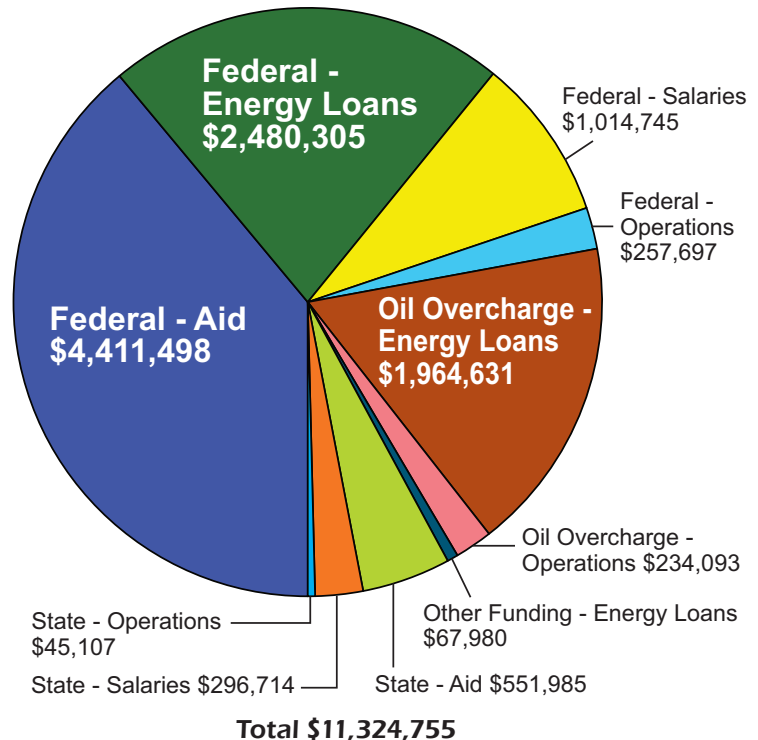
A complete listing of expenditures by funding source and category is illustrated in figure 10.

Nebraska Energy Settlement Fund Summary of Exxon, Stripper Well and Diamond Shamrock Oil Overcharge Funds as of June 30, 2018

	Exxon	Stripper Well	Diamond Shamrock	Total
Funds Received	\$15,504,944	\$15,680,564	\$359,172	\$31,544,680
Interest Earned and Miscellaneous Income	\$12,917,902	\$11,542,422	\$261,262	\$24,721,586
Total	\$28,422,846	\$27,222,986	\$620,434	\$56,266,266
Funds Budgeted	\$28,422,846	\$26,826,251	\$620,434	\$55,869,531
Low Income Designated	\$0	\$17,255	\$0	\$17,255
Uncommitted Balance	\$0	\$379,480	\$0	\$379,480

Figure 9

How Funds Were Spent by Source July 1, 2017 - June 30, 2018



Source: Nebraska Energy Office

Figure 10



Nebraska Revised Statutes 81-1607

(1) On or before February 15 of each year, the Director of the State Energy Office shall transmit to the Governor, Clerk of the Legislature and State Library Commission a comprehensive report designed to identify emerging trends related to energy supply, demand, and conservation and to specify the level of statewide energy need within the following sectors: Agricultural, commercial, residential, industrial, transportation, utilities, government, and any other sector that the director determines to be useful.

(2) The report shall include, but not be limited to:

(a) An assessment of the state's energy resources, including examination of the current energy supplies and any feasible alternative sources;

(b) The estimated reduction in annual energy consumption resulting from various energy conservation measures;

(c) The status of the office's ongoing studies;

(d) Recommendations to the Governor and the Legislature for administrative and legislative actions to accomplish the purposes of sections 70-625, 70-704, 81-161, 81-1602, 81-1606, and 81-1607; and

(e) The use of funds disbursed during the previous year under sections 81-1635 to 81-1641. The use of such funds shall be reported each year until the funds are completely disbursed and all contractual obligations have expired or otherwise terminated.

Nebraska Energy Trends and Needs

The Nebraska Energy Office tracks trends in different energy sectors as part of its mission. These trends can forecast future energy use. In all cases, the most current energy data available from all sources has been used in the *Annual Report*. Energy statistical data required by statute to be maintained by the Energy Office can be found on

the agency's website at <http://www.neo.ne.gov/statshtml/index3c.html>. Much of the information included in this report is obtained from the U.S. Department of Energy's Energy Information Administration. Data referred to or included in the graphs reflect the most current data available at the time of publication.

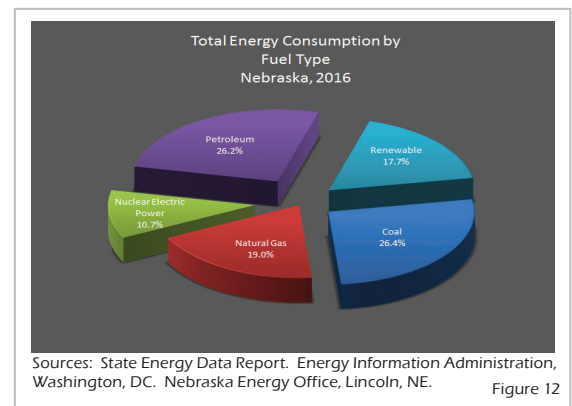
Statewide Energy

Need

Nebraska's total energy consumption in 2016 was 868 trillion British Thermal Units (Btu), an increase of 14.3 trillion Btu — or 1.7 percent, from 2015 to 2016. A Btu is a standard measure of heat energy. It takes one Btu to raise the temperature of one pound of water by one degree Fahrenheit at sea level. Five categories of sources comprised the energy that Nebraska consumed in 2016 — coal made up 26.4 percent, petroleum (and products) made up 26.2 percent, natural gas 19 percent, renewable energy 17.7 percent and nuclear electric power 10.7 percent (see figure 12).

In 2016, the use of natural gas, petroleum and renewable energy increased while the use of nuclear electric power and coal decreased.

Among all the states, Nebraska ranked 19th lowest in total energy consumption in the nation in 2016.

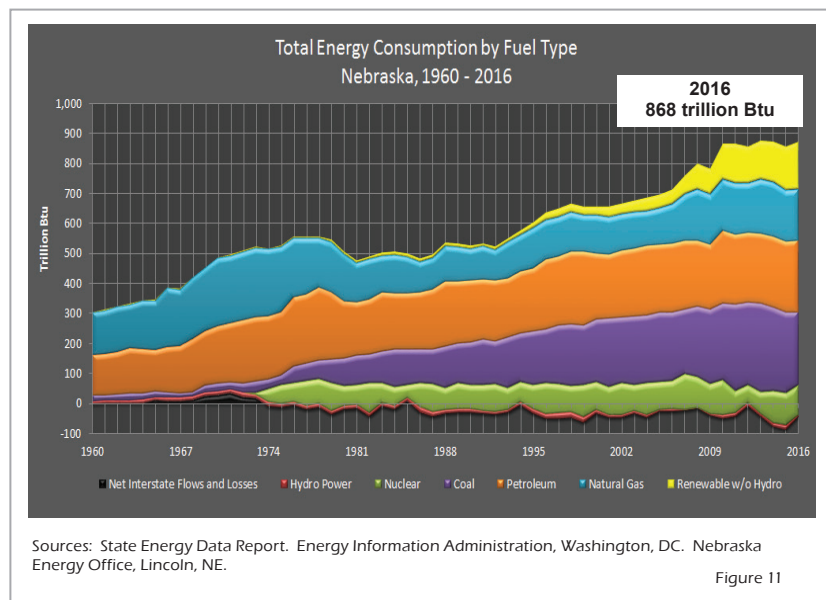


Resource Assessment

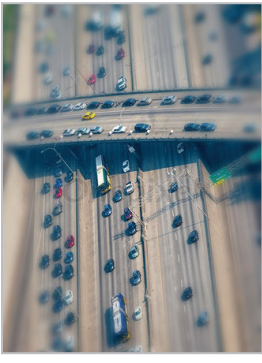
Current Energy Supplies. As shown in figure 11, energy use over the past 56 years has changed markedly. Overall, total energy consumption has

nearly tripled from 308 trillion Btu in 1960 to 868 trillion Btu in 2016.

- Coal use has increased elevenfold from 20 trillion Btu to 240.5 trillion Btu between 1960 and 2016. Peak use of coal was reached in 2013. Virtually all of this growth is attributable to coal used to generate electricity.



Statewide Energy



“Gasoline and distillate fuel oil — primarily diesel fuel — comprise the bulk of refined petroleum products consumed.”

- Natural gas consumption has increased and declined at different times during the 56 years from 140.4 trillion Btu in 1960 to 172.9 trillion Btu in 2016. Natural gas consumption peaked in 1973 at 230.8 trillion Btu. The rise, fall and recent rise in consumption of natural gas is a result of increased equipment efficiency, fewer homes using natural gas as a primary heating source, electric utilities using natural gas for peak power production and use by ethanol plants.
- Use of petroleum products nearly doubled over the past 56 years from 136.2 trillion Btu in 1960 to 238.8 trillion Btu in 2016. Gasoline and distillate fuel oil — primarily diesel fuel — comprise the bulk of refined petroleum products consumed. Both types of refined petroleum products increased between 1960 and 2016. Diesel fuel consumption more than quadrupled from 24.2 trillion Btu in 1960 to 111.4 trillion Btu in 2016. This increase is attributable to increased trucking and agricultural use. Gasoline consumption only increased by less than a quarter during the period from 78.8 trillion Btu in 1960 to 102.2 trillion Btu in 2016. Gasoline consumption peaked in 1978 at 116.0 trillion Btu, just before the second Oil Price Shock. Changes in gasoline consumption can be traced to increased fuel efficiency of vehicles, relative lack of population growth and incremental

changes in miles traveled annually. Motor vehicle miles traveled increased from 12.0 billion miles a year in 1978 to 21.01 billion miles a year in 2017, maintaining peak rises every year since 2012. Overall, petroleum consumption peaked in 1978 at 246.7 trillion Btu.

- Nuclear power was not generated commercially in the state until 1973-1974. Nuclear consumption has increased significantly over the period, rising from 6.5 (1973) and 44.6 (1974) trillion Btu to 97.8 trillion Btu in 2016. Nuclear consumption peaked in 2007 at 115.8 trillion Btu.
- **Feasible Alternative Sources.** Renewable energy consumption from 1960 to 2016, rose and fell over the decades from 13.4 trillion Btu in 1960 to 161.3 trillion Btu in 2016. Energy production from renewables peaked in 2016. Between 1960 and 1994, the primary renewable energy source was hydropower. Beginning in 1995, biofuels — ethanol — production began and continued to soar, initially equaling hydropower production. By 2000, biofuel production was double the amount of hydropower produced. By 2016, 69.97 percent of all renewable energy produced in that year came from biofuels, 4.9 percent from hydroelectric power, 21.7 percent from wind and 2.5 percent from wood and wood waste. Very minor amounts came from geothermal and solar.

Agricultural Sector

According to the U.S. Department of Agriculture National Agricultural Statistics Service, there were 47,400 farms and ranches on 45.2 million acres in Nebraska in 2017 encompassing 91 percent of the state's total land area. The average farm size contained 954 acres, up 20 acres from 2016.

Agricultural energy data is aggregated with other data in the industrial sector. As such, separate agricultural energy data is not always available on a consistent or annual basis.

Energy Supply

Energy supplies for the state's agricultural sector have been met. Over the years, any energy supply problems have been limited to infrequent shortfalls of petroleum products or fertilizer — reliant on energy inputs — usually during periods of peak demand or energy shortfalls because of worldwide demand.

Demand

As indicated earlier in this section, energy demand information for the agricultural sector is not available on a consistent or annual basis. One of the primary tracking tools, the Census of Agriculture, is only conducted every five years, so the 2012 census of Agriculture was released last year. However, yearly information provided by the USDA National Agricultural Statistics Service is more current. National energy databases commingle agricultural demand with data from the industrial sector.

Conservation

As with most consumer behavior, high fuel costs or limited availability of energy resources induces demand for efficiency practices in this sector. Historically, when natural gas prices have reached record highs, farmers alter practices such as when and how much anhydrous ammonia fertilizer — a natural gas product — is used. High diesel prices have motivated farmers to adopt conservation tillage practices, resulting in reduced cultivation on crop land, and to switch from using natural gas, diesel and propane to electricity to power irrigation systems.

As energy costs have increased, the state's agricultural producers — with assistance from the agricultural extension agents and research — have adopted a variety of practices that have reduced energy use: conservation tillage and irrigation efficiency improvements, scheduling and load management, and soil moisture measurement practices. For example, the Nebraska Energy Office provides low-cost financing for irrigation efficiency projects that demonstrate energy savings such as low-pressure pivots and replacement pumps and motors. Low-interest Dollar and Energy Saving Loans have also been used to finance grain dryers, no-till equipment, dairy vacuum pumps and related agricultural equipment. Over the past number of years, U.S. Department of Agriculture's Rural Energy for America Program grants have partially financed hundreds of irrigation efficiency improvements that

“Low-interest Dollar and Energy Saving Loans have also been used to finance grain dryers, no-till equipment, dairy vacuum pumps and related agricultural equipment.”



Agricultural Sector

“As ethanol production in the state has grown, so has the amount of corn needed as a feedstock.”



also included switching fuel sources from diesel, propane and natural gas to electricity. As long as federal funding remains available and fossil fuel prices remain high or fluctuate dramatically, this trend in irrigation is likely to continue.

In 2017, the U.S. Department of Agriculture estimated that nearly nine percent of the total cash production expenses were for energy, directly or indirectly.

Due to the adoption of energy conservation practices, since the 1970s farm energy consumption has fallen 26 percent as farm output has increased 63 percent.

Energy Need

Energy need in the ag sector can be influenced by the cost of inputs which are a significant factor in modern farming. Over the decades, farms have increased in size and energy has replaced labor, allowing fewer people to produce larger harvests of agricultural goods. Another long-term trend has been the increase in irrigation. In 1966, only

3.1 million acres were irrigated, but by 2017, 8.3 million acres were under irrigation. As ethanol production in the state has grown, so has the amount of corn needed as a feedstock. In 2018, an estimated 38.6 percent of the nation's corn crop was utilized in ethanol production. Corn requires ten inches of evapotranspiration to produce the first bushel — the highest of all the crops grown in the state. As a result, any rainfall shortage is made up from irrigation which requires an energy input. According to the latest farm and ranch irrigation survey, the fuel used to power irrigation pumps in 2013 was diverse (2008 figures in parentheses): electricity, 55 percent (52 percent); diesel, 26 percent (31 percent); natural gas, 10 percent (11 percent); propane, 7 percent (5 percent) and gasoline/ethanol, 0.2 percent (less than one percent). The fuel shifts over the past five years show the near ten percent increase in electricity came at the expense of natural gas, diesel and propane.

Commercial Sector

“For 56 years, natural gas and electricity have remained the top two fuel types used in the commercial sector.”

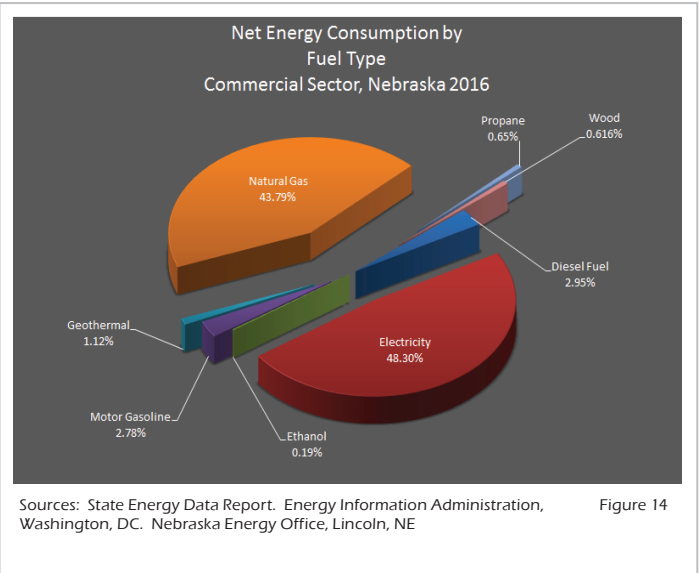


The commercial sector, which includes non-manufacturing business establishments, closely parallels consumer energy use and economic activity in the state. Energy use by local, state and federal governments is also included in this sector.

Energy Supply

The long-standing use of two fuel types — natural gas and electricity — in this sector continued in 2016. Shown in figure 14, more than 90 percent of all fuel used in the commercial sector was supplied by these two fuel types. Supplies of both types of fuel have been sufficient to meet this sector’s energy needs. The only disruptions have been due to weather-related electric transmission issues.

For 56 years, natural gas and electricity have remained the top two fuel types used in the commercial sector. Trends indicate that the long dominance of natural gas has ended and a period of near parity between the two fuel types is likely into the near future (see figure 13).



Demand

In 2016, 134.5 trillion Btu of energy were consumed in the sector, down 2.6 trillion Btu of energy, or 1.9 percent, from 2015.

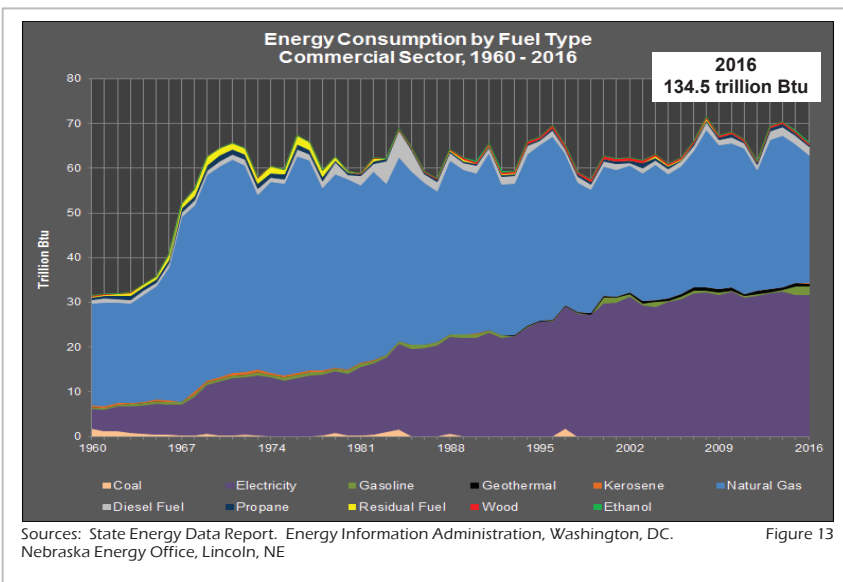
Figure 13 shows when data collection began in 1960, the commercial sector demand was 42.1 trillion Btu, one-third of the amount of energy used in this sector in 2016 (134.5 trillion Btu). The peak year of demand in this sector was 2008 when consumption reached 145.8 trillion Btu.

Conservation

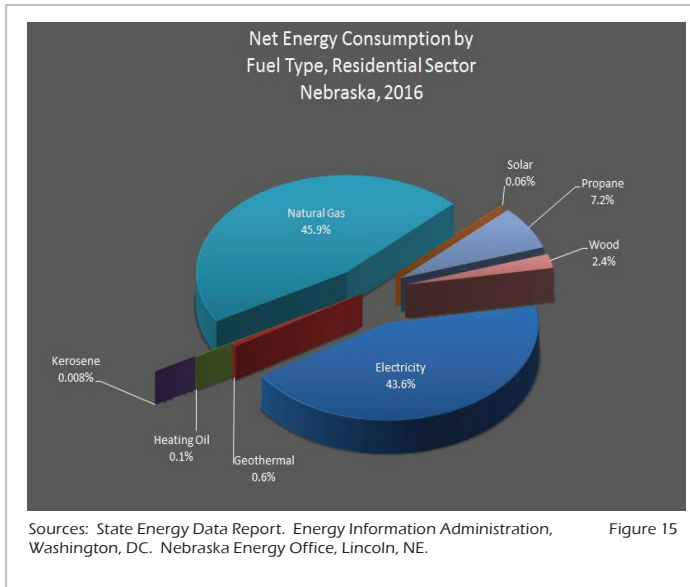
Efforts to conserve energy use tend to be economically driven, especially when fuel prices rise above historic levels. Reduced energy use often results from economic downturns in the larger economy. For example, energy use in this sector declined by almost 10 trillion Btu from 1991-1992, which paralleled a national recession. The economic decline that started in late 2008 and continued in 2009 shows a similar decline in energy use in this sector.

Energy Need

Since the primary needs of the commercial sector are confined to readily available supplies of natural gas and electricity, no issues relating to energy need are foreseen since supplies of both fuel types are ample.



Residential Sector



Residential use of energy is primarily for home heating, water heating, air conditioning, refrigeration, cooking, clothes drying, and lighting. Electricity service is available statewide, and natural gas service is available to a majority of the state's residents, but many small communities do not have natural gas service due to lack of infrastructure.

Energy Supply

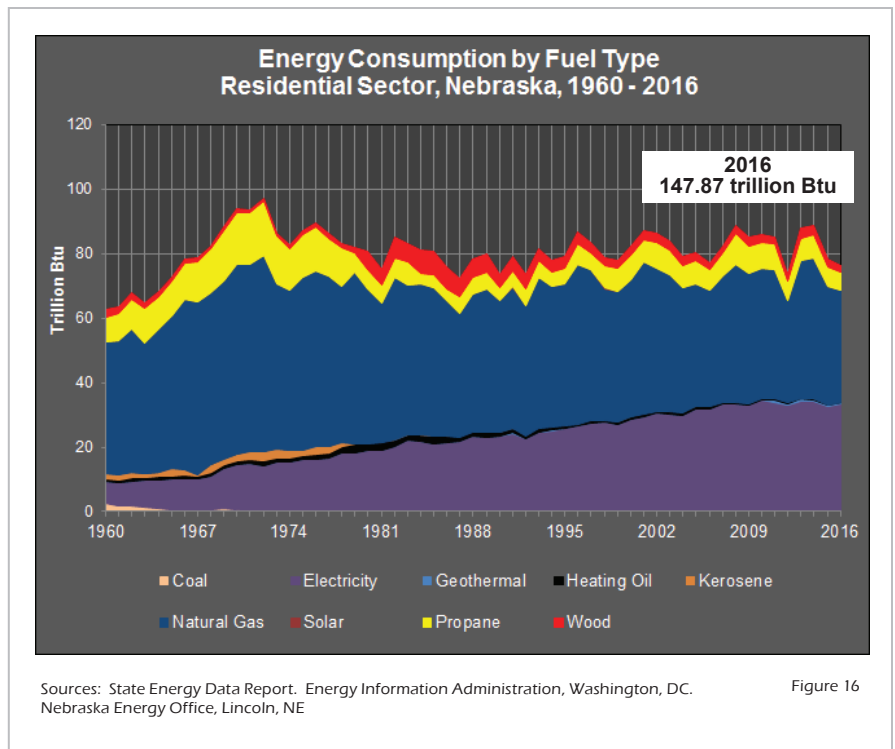
As shown in figure 15, in 2016, 46 percent of the residential sector's energy needs were met by natural gas. Forty-three and six-tenths percent (43.6%) of the energy consumed in the residential sector was electricity, 7.3 percent were petroleum products, and 3.1 percent was renewable energy.

Supply trends and fuel types used in the residential sector have not changed substantially over 56 years of data collection.

Demand

Seventeen percent or 147.9 trillion Btu of the state's total energy demand was consumed in the residential sector in 2016. During 2016, demand decreased 0.4 percent to 147.9 trillion Btu, from 148.4 trillion Btu in 2015. Natural gas use decreased 4.5 percent from 2015, petroleum use decreased 11.5 percent, electricity use decreased 2.2 percent, renewable energy use decreased 15.8 percent from 2015, and coal consumption remained at a level low enough to round to zero.

Total energy consumption in 1960 in the residential sector was 78.55 trillion Btu, of which slightly more than half — 40.88 trillion Btu came from natural gas. As seen in figure 16, by 2016, the total energy consumption in this sector was 147.87 trillion Btu, down 0.56 trillion Btu from 2015.



Residential Sector

Changes in how and how much this sector uses energy becomes clear over the 56-year span. In 1960, electricity use totaled only 6.51 trillion Btu, but by 2016 electricity demand totaled 33.23 trillion Btu. Natural gas demand was 40.88 trillion Btu in 1960, peaked at 60.86 trillion Btu in 1972 and generally declined by about a third until recently. Propane demand in 1960 was 7.50 trillion Btu, and was 5.52 trillion Btu in 2016. Electric system line losses accounted for a larger share of the energy used in this sector as electrical use increases. In 1960, electrical line losses accounted for 16.09 trillion Btu, but by 2016 amounted to 71.73 trillion Btu, 48.51 percent of all the energy used in this sector in 2016.

“Electricity service is available statewide, and natural gas service is available to a majority of the state’s residents...”



Conservation

Conservation in the residential sector is influenced by price, weather and efficiency actions. Like most sectors, residential users are extremely responsive to dramatic price rises. Increases in the price of natural gas, at various times over the decades, have resulted in reduced average annual consumption. Higher than normal heating bills have propelled homeowners to make energy saving improvements such as replacing aged furnaces with new efficient models or efficient electric heat pumps, adding insulation and replacing windows and doors with more energy efficient ones. One of the simplest reactions by people to higher energy bills is to adjust the thermostat which can also result in savings.

Industrial Sector

The industrial sector includes manufacturing, construction, mining, forestry and agricultural operations.

emergence of new industries such as ethanol plants can also alter fuel use patterns. For example, natural gas use in 1960 was 38.27 trillion Btu and soared in 1973 to 73.73 trillion Btu. Subsequent energy price spikes and other factors reduced natural gas consumption to 20.31 trillion Btu by 1986. Natural gas has fluctuated considerably since then. A new historical peak occurred in 2016 at 96.48 trillion Btu.

Consumption of diesel fuel doubled from 1960 to 2016, rising from 14.01 trillion Btu to 28.21 trillion Btu. Motor gasoline consumption dropped by nearly 73 percent between 1960 and 2016 from 11.27 trillion Btu in 1960 to 3.06 trillion Btu in 2016. The growing use of electricity in this sector is demonstrated by the nearly thirteenfold increase from 3.03 trillion Btu in 1960 to 38.06 in 2016.

Demand

Nearly half of the state's total energy consumption — 44 percent or 384.8 trillion Btu — was consumed by the industrial sector in 2016. As shown in figure 18, the increase in industrial sector energy consumption in 2016 from 2015 was 4.5 percent.

In 1960, the industrial sector was the second largest

This sector relies on more diverse fuel types than the other sectors of the economy. Natural gas, renewable energy, electricity, coal and a variety of petroleum products — gasoline, asphalt, road oil, propane and diesel — are the fuel types utilized in industrial sector operations.

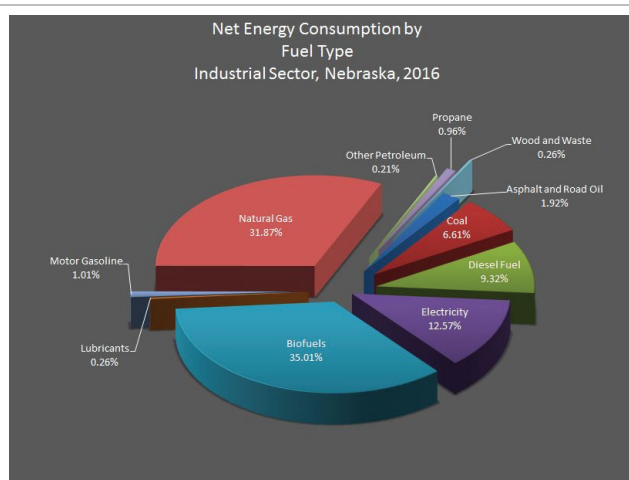
Energy Supply

As shown in figure 17, nearly all of the industrial sector's energy needs were met by biofuels,

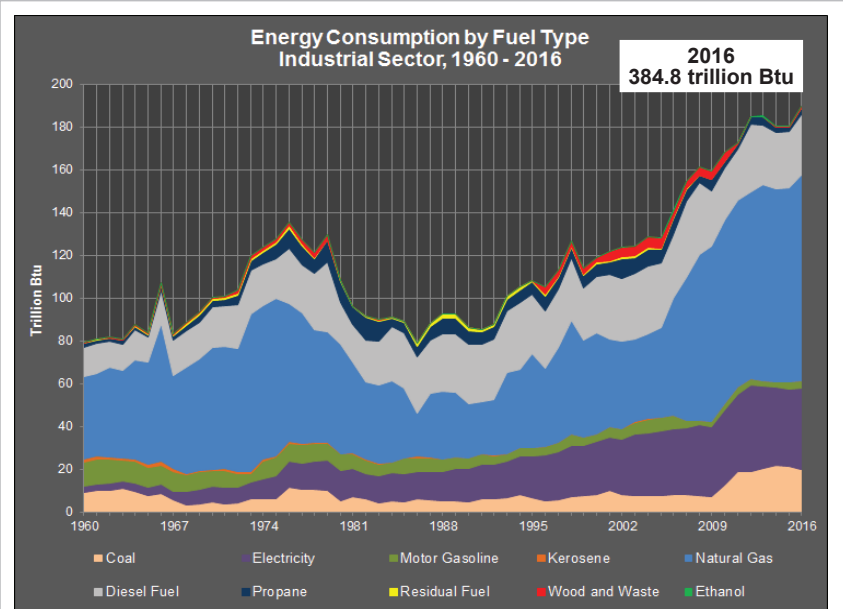
natural gas, petroleum products, electricity, and coal in 2016. Petroleum products include diesel fuel, asphalt and road oil, propane, lubricants, and motor gasoline.

Supplies of these fuel types have been readily available to industrial users.

Trends in fuel types used in the industrial sector illustrate the dynamic needs of this sector and how industries can switch fuel types over time. The



Sources: State Energy Data Report. Energy Information Administration, Washington, DC. Nebraska Energy Office, Lincoln, NE. Figure 17



Sources: State Energy Data Report. Energy Information Administration, Washington, DC. Nebraska Energy Office, Lincoln, NE.

Figure 18

Industrial Sector

“If energy costs are a significant factor — and rising — industrial sector users are likely to find ways to reduce the costs and impacts of energy on their operations.”



energy user after transportation, 93.1 trillion Btu to 94.2 trillion Btu, respectively. Industrial sector energy consumption surpassed the transportation sector in 1994. By 2016, the industrial sector was the largest energy-using sector at 384.8 trillion Btu, surpassing the transportation sector by 183.7 trillion Btu.

Conservation

The industrial sector is making energy efficient system, lighting and building improvements more of a priority than other sectors due to cost savings through economy of scale. If energy costs are a significant factor — and rising — industrial sector users are likely to find ways to reduce the costs and impacts of energy on their operations. The roller coaster consumption of

natural gas over the past 56 years is an indicator of the impact of conservation of use, fuel switching and the impact of new industries.

Energy Need

Energy need in the industrial sector is subject to the ebb and flow of the business cycle and national, regional and local economic trends which can cause a spike or reduction in energy need and demand. The surge in ethanol production in the state added to this sector's growing energy needs for electricity and natural gas. The phenomenal growth in the renewable energy category — which includes ethanol, ethanol coproducts, and wood and wood waste — is the story of the rise of ethanol production in Nebraska.

Transportation Sector

Traditional methods of transportation such as public and private vehicles, railroads, aircraft and boats are included in the transportation sector as well as energy used to transport oil and natural gas through pipelines.

Energy Supply

In 2016, 93 percent of energy used — 187.53 trillion Btu in the transportation sector — was in the form of petroleum products, especially diesel fuel and gasoline. The next two fuel types used of any consequence in 2016 were natural gas at 6.79 trillion Btu and biofuels at 6.77 trillion Btu.

Generally, supplies of these fuel types have been readily available to transportation users.

As shown in figure 19, trends in fuel types used in the transportation sector illustrate the static nature of this sector and how modes of transportation have changed little since record-keeping began in 1960. The transportation sector was nearly totally dependent upon petroleum-based fuels in 1960 and remained as dependent in 2016. The changes that occurred in

the 56-year period primarily related to increased fuel use. Renewable fuel use, specifically ethanol, began marginally in 1981 at 0.27 trillion Btu and hit a new historical peak of 6.77 trillion Btu in 2016. Ethanol use in 2016 increased by 1.6 percent or 0.11 trillion Btu over 2015. Diesel fuel use in 1960 was 8.17 trillion Btu, declined to 58.43 trillion Btu in 2008, and peaked at 91.416 trillion Btu in 2010. Diesel fuel use decreased in 2016 to 81.08 trillion Btu from 83.30 trillion Btu in 2015. Motor gasoline use in 1960 was 67.07 trillion Btu, peaked in 1978 at 106.78 trillion Btu, declined by 1985 to 83.59 trillion Btu, and started to rise again in 1995 to 94.49 trillion Btu.

Demand

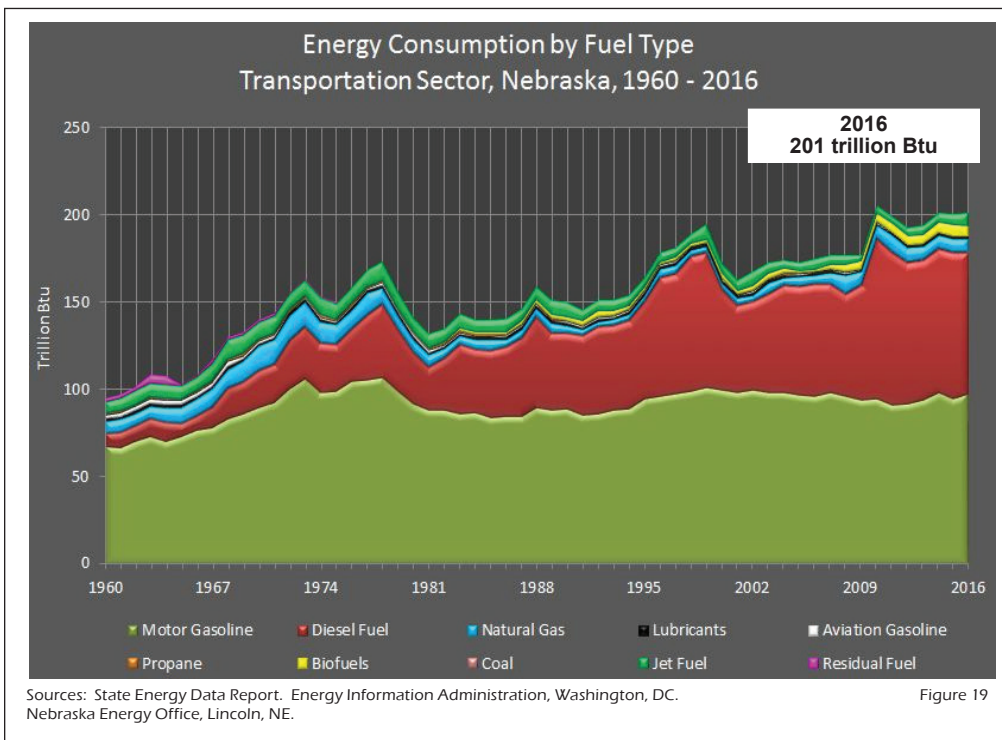
Nearly a fourth — specifically 23 percent of the state’s total energy consumption — 201.1 trillion Btu — was used in the transportation sector in 2016. The increase in demand from 2015 to 2016 totaled 0.8 trillion Btu, an increase of 0.4 percent.

In 1960, the transportation sector was the largest energy-using sector at 94.2 trillion Btu, 30.6 percent of consumption of all sectors. By 2016, the transportation sector had been eclipsed as the largest energy-using sector by the industrial sector.

The number of vehicles registered in the state has risen from 1.09 million in 1970 to 2.42 million in 2016, according to the Nebraska Department of Motor Vehicles.

In 2016, 2.04 billion gallons of ethanol was produced in Nebraska. On a yearly basis, about three percent of ethanol produced in Nebraska is consumed in the state as transportation fuel.

After mid-September, 2014, refiners began to supply 84-octane gas to eastern Nebraska terminals in lieu of the minimum 87-octane gas required by law. In the western quarter of the state,



Transportation Sector

“The impact of hybrid, compressed natural gas and electric vehicles is slowly increasing at this time...”



where 85-octane is the standard because of higher elevations, refiners supply 82-octane gasoline. Refiners continue to supply 91-octane premium gasoline to Nebraska terminals. This action was initiated by refiners in response to the Renewable Fuel Standard, a federal law requiring renewable fuels in the country's fuel mix. Nebraska and Iowa are among the last states to see this practice implemented. Local suppliers are using either ethanol or premium gasoline to increase the octane levels to state-required minimums.

Conservation

The transportation sector is particularly challenged in conservation efforts. Over the decades, a variety of approaches by the state and federal governments have been used to make this sector less dependent upon petroleum products: mandated Corporate Average Fuel Efficiency standards, introduction of efficiency technology in vehicles, lighter weight vehicles and Nebraska Clean-burning Motor Fuel rebates.

Trends in this sector — such as sport utility vehicles and large trucks used for personal transportation — have thwarted conservation efforts. However, fuel price rises can induce conservation behavior.

Rising pump prices for petroleum-based fuels since 1999 have had an impact on demand. Peak total energy consumption in this sector was reached in

2010 at 205.3 trillion Btu. The precipitous decline in transportation sector use from 1999 to 2000 — from 194.4 trillion Btu to 172.8 trillion Btu — continued into 2001 and was caused by dramatic price increases. Since 2001 when demand was 162.6 trillion Btu, demand marginally inched upwards nearly every year until 2011.

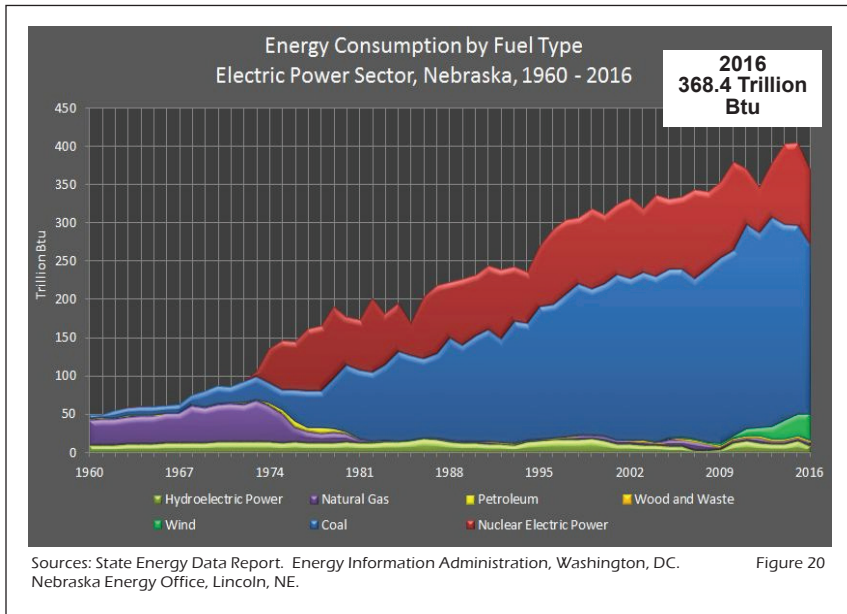
Energy Need

Trends in price and vehicle technology as well as federal government initiatives such as more efficient vehicles are expected to have an impact on energy use in this sector in the future, leading to declines in consumption. An offsetting trend has been the gradual increase in the number of motor vehicle miles traveled nearly every year since 1982, when the annual total was 11.44 billion miles. By 2016, that figure was 20.71 billion miles traveled.

In 2016, the average age of cars in the U.S. was 11.6 years; a historic high was set in 2016. Nebraska's average fleet age may even be higher since traditionally the state has been one of the top five states with older vehicles.

The impact of hybrid, compressed natural gas and electric vehicles is slowly increasing at this time, but could have a significant impact if consumer acceptance of the technologies is high and more infrastructure is developed.

Electric Power Sector



the industry has evolved over 56 years. In 1960, 63.9 percent of the electricity generated came from natural gas, with hydropower (20.6 percent) and coal (12.6 percent) supplying most of the balance. An experimental nuclear reactor was located at Hallam and operated between 1963-1964, but generated only marginal amounts of power before being deactivated. Coal used in this sector peaked in 2013 at 272.66 trillion Btu, natural gas used peaked in 1973 at 53.11 trillion Btu, nuclear power — which began in 1973 — peaked in 2007 at 115.82 trillion Btu, hydropower peaked in 1999 at 17.58 trillion Btu and wind use peaked in 2016 at 35.07 trillion Btu.

Demand

The demand in the state’s electric power sector in 2016 totaled 368.4 trillion Btu, a decrease of 17.5 percent, or 35.4 trillion Btu, from 2015 demand. Among the changes in fuel used to generate electricity in 2016 were increased use of wind and natural gas along with reductions in hydropower, nuclear and coal.

Electricity purchases generated by hydropower for use by Nebraska utilities from the Western Area Power

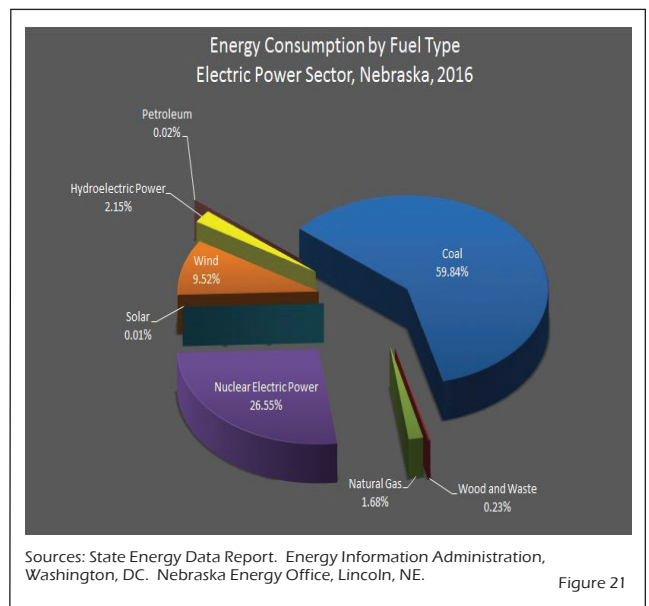
The electric power sector consists of facilities which generate electricity primarily for use by the public. Energy is used for the generation, distribution, and transmission of electric power.

Energy Supply

Looking at figure 21, in 2016, 60 percent of the electric power energy feedstocks came from coal, 220.45 trillion Btu out of a total of 368.39 trillion Btu. The second most used fuel in this sector, nuclear, supplied nearly 27 percent, 97.80 trillion Btu. Three lesser fuel sources supplied nearly all the remainder: hydropower, 2.15 percent, 7.91 trillion Btu; wind, 9.52 percent, 35.07 trillion Btu; and natural gas, 1.68 percent, 6.17 trillion Btu.

Generally, supplies of these fuel types have been readily available to consumers served by the state’s electric utilities.

As shown in figure 20, trends in fuel types used by the state’s electric utilities illustrate how



Electric Power Sector

Administration in 2016 totaled 1.973 billion kilowatt hours at an average price of four cents per kilowatt hour. The total cost of the power purchased in 2016 was \$81.60 million. In 2016, the amount of power provided from Western Area Power Administration met 6.7 percent of the electricity demand in the state.

In 1960, the state's electric power demand was 50.2 trillion Btu. By 2016, the demand in this sector had increased more than sevenfold from 1960 to 368.4 trillion Btu.

Over the 56-year period, only 16 years recorded declines in demand. A number of these declines were marginal; however, larger declines in demand paralleled economic cycles as well as favorable climate periods which affected irrigation and air conditioning use.

Conservation

Energy efficiency efforts in the electric power sector generally result from technological advances in the generation and transmission of power.

One on-going target of efficiency improvements is reducing electricity transmission line losses. While technological breakthroughs can lessen the problem, other improvements can be made. Local utilities estimate standard line loss at seven percent, but in some cases actual losses can be considerably higher — more than double the seven percent — if preventative maintenance is not performed on a regular basis on utility lines. An example of future technologies being developed: The copper wires used in typical transmission lines lose a percentage of the electricity passing through them because of resistance, which causes the wires to heat up. But “superconductive” materials have no resistance, and if they are used to transmit electricity in the future, very little of the electricity will be lost.

Smart grid technology has garnered a great deal of attention. Smart electrical grids and accompanying communications infrastructures enable end-use efficiency. Deployment of this technology in Nebraska is just getting underway.

Consumer behavior, also known as demand side management, can be a source of conservation from which the electric power sector will benefit since the cheapest kilowatt is the one that doesn't have to be produced. For example, Nebraska utilities have been very proactive in the past several years in encouraging Nebraskans to utilize new lighting technologies, especially compact fluorescents and light emitting diodes. Some electric utilities have provided discount coupons, free light bulbs or financial incentives for larger commercial, industrial or governmental operations.

In late 2011, the Nebraska Power Association, with the support of the Nebraska Energy Office and others, issued the *2010 Research & Conservation Report* which documented research, energy efficiency and sustainability efforts of the state's electric utilities and the Energy Office. The *Report* quantified approximately 24 megawatts and 80,000 megawatt hours that were reduced because of utility and agency activities and programs in 2010. A copy of the *Report* is at <http://www.neo.ne.gov/reports/2010-NPA-Report.pdf>.

Energy Need

Nebraska's electric utilities more than met their customers' needs, continuing to export electricity to customers outside the state. Between 1990 and 2016, electricity exports varied from a low of 9.4 percent of generation in 1994 to a high of 26.1 percent in 2015. In 2016, electricity exports were 17.3 percent of generation. This was a drop of 8.8 percent from 2015.

Status of Ongoing Studies

No ongoing studies were performed during the reporting period.

“Consumer behavior, also known as demand side management, can be a source of conservation from which the electric power sector will benefit since the cheapest kilowatt is the one that doesn't have to be produced.”

