SECTION 9 – ENERGY CONSERVATION: IMPROVING EFFICIENCY, REDUCING DEMAND

This section provides information for government agencies and institutions, public and private organizations, businesses, and residents about energy conservation programs, infrastructure -- such as educational resources, policies and regulations, and incentives to encourage energy conservation.

Energy Conservation

Energy conservation refers to efforts made to reduce energy consumption. It can be achieved through increased efficient use of energy, in conjunction with decreased consumption of depletable energy sources. The results of energy conservation can include increased financial capital, national and personal security, environmental quality, human comfort and health benefits, reduced energy costs, and maximized profits. Energy conservation is broader than energy efficiency. It includes active efforts to reduce energy consumption through behavior change, technological developments, and policies that encourage such efforts.

Other examples of the Commonwealth's focus on energy conservation and efficiency include the State energy policy framework established by the General Assembly in Chapter 1 of Title 67 of the *Code of Virginia* which directed the Department of Mines, Minerals and Energy to draft the Virginia Energy Plan (VEP). The *Code* sets several energy policy objectives, including one that provides that Virginia should "use resources efficiently and facilitate energy conservation."[1]

Energy conservation refers to efforts made to reduce energy consumption.

Energy Efficiency

Energy efficiency to a Virginia consumer could include taking steps to reduce consumption of energy, which will save both energy and money. But it can be more complicated. The U.S. Department of Energy's (DOE) Energy Information Administration (EIA) defines energy efficiency as "a ratio of services provided to energy input (e.g., lumens to watts in the case of light bulbs). Services provided can include buildings-sector end uses such as lighting, refrigeration, and heating; industrial processes; or vehicle transportation. Unlike conservation, which involves some reduction of service, energy efficiency provides energy reductions without sacrifice of service."[2] "Efficiency" is defined by The Merriam-Webster Thesaurus as "the capacity to produce desired results with a minimum expenditure of energy, time, or resources."[3] Energy efficiency tips and ideas can be found on the DMME website, including the *Virginia Energy Savers Handbook, A Guide to Saving Energy, Money and the Environment*[4], and the U.S. Department of Energy's *Energy Savers Tips on Savings Money and Energy at Home* [5].

[1] VEP, Section 1, General Energy information, page 1-2, http://www.dmme.virginia.gov/DE/VEP_TitlePage.html
[2] EIA, www.eia.gov/tools/glossary/index.cfm?id=E
[3] The Merriam-Webster Thesaurus, New York, 1978 edition, page 186
[4] http://www.dmme.virginia.gov
[5] http://www.energysavers.gov/pdfs/energy_savers.pdf

Market Trends

According to the U.S. Energy Information Administration in its Annual Energy Outlook 2011[6], growth in energy use is linked to population growth through increases in housing, commercial floor space, transportation, and goods and services. The following energy efficiency market trends have been identified to occur between 2014 and 2040:

- Annual electricity demand for the average household declines by 4 percent, from 12.1 megawatt hours (MHz) in 2012 to 11.6 MWH in 2014. In 2012, the largest uses of electricity at the household level are space cooling, small devices and other minor electric uses, and lighting. In 2040, electricity consumed for lighting per household is 65 percent lower, and electricity use for minor electric end uses and for space cooling rises by 33 percent and 17 percent, respectively. Regulations implementing lighting efficiency standards established by the Energy Independence and Security Act of 2007 (EISA2007) are a major factor in the replacement of incandescent bulbs with more efficient compact fluorescent lighting (CFL) and light-emitting diode (LED) lamps.

- The second-largest increase in total primary energy use, 3.3 quadrillion Btus from 2012 to 2040, is in the commercial sector. Even as standards for building shells and energy efficiency are tightened and commercial energy intensity (energy use per square foot) decreases by 0.4 percent/year from 2012 through 2040, energy use grows by 0.6 percent/year as annual growth in commercial floor space averages 1.0 percent.

Barriers to Achieving Conservation and Efficiency

Electric efficiency actions can be used to reduce future growth in electrical demand. Substantial cost-effective investments in energy efficiency remain unmade as there are factors that undercut market forces. These include:

- Principal-agent barriers – the party responsible for the building improvements may not pay electric bills for rented space

- Information barriers – consumers don't have sufficient information they can trust in order to act

- Transaction cost barriers – consumers cannot budget or borrow the upfront investment needed for energy efficiency projects

- Externality cost barriers – benefits of energy efficiency, such as lower utility costs from reduced peak demand, accrue to people other than those making the investments

- Traditional systems of utility regulation in which utilities use revenues from electricity and gas sales to recover the costs of production and administration. They earn a rate of return for investments in their rate base, typically through capital investments like power

[6] http://www.eia.gov/forecasts/aeo/topic_efficiency.cfm

plants and transmission lines. This creates two major disincentives for utilities to promote energy efficiency:

  - Utilities are not compensated for the direct cost of implementing efficiency programs
  - Efficiency reduces revenues and profits through decreased energy consumption

State government has taken a number of actions to overcome these market barriers, including:

- Adoption by the Virginia General Assembly of voluntary goals to reduce electric use by 2022, through conservation and efficiency, by an amount equal to 10 percent of 2006 use
- Creation of ***Virginia Energy Sense***, an informational source where consumers can learn how to save energy and lower their energy bills
- An Energy Star appliance sales tax holiday over the Columbus Day weekend in October
- An income tax exemption for sales tax paid on certain energy efficiency improvements
- $600 million in energy efficiency improvements made to State government facilities
- Authorization for local governments to provide property tax and other incentives for Energy Star buildings (at least 20 percent more efficient than minimum building code requirements); buildings with green roofs and solar energy systems
- Property Assessed Clean Energy (PACE) or support for Home Performance with Energy Star programs.
- The passing of S. 1416, in 2007 which allows utilities to recover the projected and actual costs of designing, implementing, and operating efficiency programs, subject to SCC approval. However, to garner approval, the SCC must determine that "the program is in the public interest"
- The decoupling of sales volume and revenue for natural gas utilities

Virginia consumers also benefit from federal incentives and programs that encourage efficiency, such as:

- Competitive State Energy Program awards made to Virginia's energy office that help create and support residential, commercial, and energy performance contracting programs
- Federal energy efficiency income tax credits [7]
- Strengthened minimum equipment efficiency requirements

[7] http://www.virginiaenergysource.org

- Expansion of the Energy Star program

Virginia's Regional Energy Alliance Network (REAs)

There are now three REAs operating programs in 4 areas of Virginia. These REAs are non-profit Virginia corporations that were established in the last 3 years to undertake residential and commercial energy efficiency retrofits in their self-designated service areas. Each REA has a Board of Directors that oversees the operation of the non-profit organization. Each REA has its own operating budget which combines DOE grants, local government funds, utility contracts and program participation fees, and private sources. The overriding economic development goal of this project is to develop, train, and sustain numerous partners in the new and emerging energy efficiency retrofit and renewable energy market. This project is a comprehensive undertaking that combines workforce training and development, building auditor and contractor training, and quality assurance and training of realtors and appraisers in incorporating the value of energy efficiency retrofit work when pricing a structure. The REAs act as catalysts for market transformation and through leveraging the power of market forces. They seek to underwrite program costs via fees for services tied to their mission.

Virginia Energy Efficiency Council (VAEEC)

DMME supports the efforts by the Virginia REAs and other energy efficiency stakeholders in the development of the Virginia Energy Efficiency Council a statewide association whose goals are to assess and support programs, innovation, best practices, and policies that grow Virginia's energy efficiency industry also provides a forum for stakeholder interaction. The VAEEC received a foundation grant to create the first Virginia Energy Efficiency Industry Census in 2013, and is part of a multistate consortium working under a DOE grant to complete a census update in 2014.

Accelerating the Commercial Building Retrofit Market

DMME was grant funded by the DOE to undertake a project with the goal of accelerating the commercial building retrofit market. Through the development and deployment of initiatives/deliverables in each of three areas of policy, best practices/protocols and pilot program implementation, DMME proposed to significantly increase the infrastructure and uptake of commercial building retrofits in Virginia and Maryland. This project proposed to increase the depth and breadth of ongoing commercial retrofits by incrementally facilitating improvements to both contractor capacity and customer demand. DMME also proposed to accelerate the policy and programmatic changes necessary to build and sustain a robust market-based industry for this sector five years from now.

This effort simultaneously confronted the major barriers to a successful private sector commercial building retrofit market: split incentives, lack of knowledge, shortage of capital, perception of poor value added, absence of documented successes, and economies of scale among them.

Energy Efficiency in Manufacturing

The Genedge Alliance of Martinsville (formerly the A. L. Philpot Manufacturing Extension Partnership), participates as the Commonwealth's representative in the federal Manufacturing Extension Partnership (MEP) Program. Supported by the National Institute of Standards and Technology, the MEP works with small and mid-sized U.S. manufacturers to help them create and retain jobs, increase profits, and save time and money.

The Genedge Alliance provides a variety of services, from innovation strategies to process improvements to green manufacturing to training. It works with partners on programs that put manufacturers in position to develop new customers, expand into new markets, and create new products. Training and education are offered in the areas of Lean Six Sigma, Lean Enterprise, Innovation & Business Growth, Quality Management Systems, Lean Supply Chain, and engineering and technical services. Visit the Genedge Alliance's website at: http://www.vpmep.org/index.php.

State Corporation Commission (SCC) 10% Savings on Electricity

Based on its goals of effecting a 10 percent reduction in electricity use by 2022, based on 2006 usage, the 2008 Virginia General Assembly directed the State Corporation Commission (SCC) to develop an energy consumer education program to encourage electric energy efficiency and conservation in Virginia households, businesses, and institutions. In 2009, the SCC developed and implemented as integrated statewide consumer education and outreach program called ***Virginia Energy Sense*** with the goal to transform the public's existing general awareness of energy efficiency and conservation into consumer action.

Virginia Energy Sense has engaged a broad spectrum of Virginians through a website (www.virginiaenergysense.com), social media outlets, statewide grassroots outreach, partnerships with non-profit and community-based organizations, television and radio public service announcements, media relations, and targeted advertising. Major resources include a free online home energy assessment tool to help consumers better understand their energy consumption and to identify opportunities to save energy and control utility costs. A "do-it-yourself" guide lists easy and inexpensive projects that can improve the comfort of a home and reduce energy use. The program provides links to local and regional energy efficiency programs dedicated to helping Virginians reduce their energy.

At the end of 2014, the ***Virginia Energy Sense*** program will have been in place for five years. The SCC determined that the program should be continued, maintaining the current scope and approach, for an additional three and one half years. The SCC will continue to monitor the program's objectives and make adjustments to the program that will assist Virginians in achieving the energy goals of the Virginia Energy Plan.

The campaign aims to establish ***Virginia Energy Sense*** as a widely used, credible source of information about energy efficiency and conservation, putting consumers in control to make decisions that are right for them. For more information on ***Virginia Energy Sense***, visit the website at: www.virginiaenergysense.com.

Utility Programs and Incentives

Demand-side management promotes initiatives and programs to shift the timing of electricity use from peak to nonpeak demand periods. Electric utility customers are encouraged to reduce their electricity usage during peak hours to manage load congestion over the course of the day.

Several utilities that provide energy services in Virginia currently offer, or plan to offer, their customers programs and incentives to encourage energy efficiency through such efforts as residential energy load control, on-line usage audits, installation of high efficiency technologies such as lighting and HVAC systems, and home retrofits for lower income residential customers. These programs are approved by the State Corporation Commission and change over time. Links to utilities providing electric, natural gas, and water service to Virginia are provided below:

Dominion Virginia Power
www.dom.com

Appalachian Power Company (APCO)
www.appalachianpower.com

Tennessee Valley Authority (TVA)
http://www.tva.com/power/index.htm, http://www.energyright.com/

Old Dominion Power (ODP)
http://lge-ku.com/ku/about_odp.asp

Electric Cooperatives
http://www.odec.com

Municipal Power Producers - Municipal Electric Power Association of Virginia (MEPAV)
http://www.vml.org

James City Service Authority
http://www.jccegov.com

Virginia Natural Gas
http://www.virginianaturalgas.com

Columbia Gas of Virginia
http://www.columbiagasva.com

Washington Gas
http://www.washgas.com

Municipal Gas Utilities
http://www.charlottesville.org/index.aspx

Utilities often partner with dedicated efficiency firms to achieve these goals. An example of one such firm is O-power, a behavioral energy efficiency firm. Behavioral energy efficiency firms operate by using statistical software to analyze client energy consumption patterns and then inform energy users of their use patterns and best methods of energy reduction. Incorporating behavioral science techniques helps these firms achieve better results. By allowing energy consumers to see how their energy consumption compares with that of other similar consumers in their region, consumers are further incentivized to compete in reducing their consumption, especially during peak times.

By partnering with firms like O-power, utilities are able to help their customers meet their energy needs at much lower cost than that derived from the generation of additional energy. To put this in perspective, an O-power like program costs utilities an average of $0.025 per kilowatt hour saved while generating new, low-emission electricity costs approximately $0.05 to $0.15 per kilowatt-hour produced. Under proper regulatory conditions, these cost savings can increase value for both consumers and utility shareholders when compared against new generation.

Federal Incentives

Federal Tax Credits for Consumer Energy Efficiency

Homeowners can claim a federal tax credit of 30 percent of the cost with no upper limit for the installation of geothermal heat pumps, small wind turbines, and solar energy systems, through December 31, 2016. Existing and new construction homes qualify. Principal residences and second homes qualify; but rentals do not qualify for the tax credit. Another tax credit is available for residential fuel cell and microturbine systems of 30 percent of the cost, up to $500 per 0.5 kW of power capacity, through December 31, 2016. Existing and new construction homes qualify, but it must be the homeowner's principal residence. Rentals and second homes do not qualify for the fuel cells tax credit. Go to www.energystar.gov for further details about federal energy efficiency tax credits.

Commercial Buildings Tax Deduction

The federal Energy Policy Act of 2005 established a tax deduction for energy efficient commercial buildings applicable to qualifying systems and buildings placed in service from January 1, 2006, through December 31, 2007. This deduction was subsequently extended through 2008, and then again through 2013 by Section 303 of the federal Energy Improvement and Extension Act of 2008 (H.R. 1424, Division B), enacted in October 2008.

A tax deduction of $1.80 per square foot is available to owners of new or existing buildings who install (1) interior lighting; (2) building envelope; or (3) heating, cooling, ventilation, or hot water systems that reduce the building's total energy and power cost by 50 percent or more in comparison to a building meeting minimum requirements set by ASHRAE Standard 90.1-2001. Energy savings must be calculated using qualified computer software approved by the Internal Revenue Service (IRS).

Deductions of $0.60 per square foot are available to owners of buildings in which individual lighting, building envelope, or heating and cooling systems meet target levels that would reasonably contribute to an overall building savings of 50 percent if additional systems were installed.

The deductions are available primarily to building owners, although tenants may be eligible if they make construction expenditures. In the case of energy efficient systems installed on or in government property, tax deductions will be awarded to the person primarily responsible for the system's design. Deductions are taken in the year when construction is completed.

Additional information is available from the *Commercial Building Tax Deduction Coalition* at www.efficientbuildings.org/.

FHA Energy Efficient Mortgages

The Federal Housing Administration (FHA) allows lenders to add up to 100 percent of energy efficiency improvements to an existing mortgage loan with certain restrictions. FHA mortgage limits vary by county, state, and the number of units in a dwelling. These mortgages were previously limited to $8,000. In June 2009, U.S. Department of Housing and Urban Development (HUD) announced the removal of the dollar cap. The maximum amount of the portion of an energy efficient mortgage allowed for energy improvements is now the lesser of 5 percent of:

- The value of the property
- 115 percent of the median area price of a single-family dwelling
- 150 percent of the Freddie Mac conforming loan limit

U.S. Department of Veterans Affairs (VA) Energy Efficient Mortgages (EEMs)

The VA insures EEMs to be used in conjunction with VA loans either for the purchase of existing homes or for refinancing loans secured by the dwelling. Homebuyers may borrow up to $3,000 if only documentation of improvement costs or contractor bids is submitted, or up to $6,000 if the projected energy savings are greater than the increase in mortgage payments. Loans may exceed this amount at the discretion of the VA. Applicants may not include the cost of their own labor in the total amount. No additional home appraisal is needed, but applicants must submit Home Energy Rating (HER) contractor bids and certain other documentation. The VA insures 50 percent of the loan if taken by itself, but it may insure less if the total value of the mortgage exceeds a certain amount.

This mortgage is available to qualified military personnel, reservists and veterans. (See http://www.benefits.va.gov/benefits/ for more details). Applicants should secure a certificate of eligibility from their local lending office and submit it to a VA-approved private lender. If the loan is approved, the VA guarantees the loan when it is closed.

State Incentives

Energy Star Sales Tax Holiday

Virginia holds an annual Energy Star Sales Tax Holiday over the Columbus Day weekend in October that exempts both State and local sales taxes on Energy Star qualified products purchased by homeowners, for certain appliances and items that cost $2,500 or less and are for non-commercial and personal use. Qualifying products include compact fluorescent bulbs (CFLs), ceiling fans, dehumidifiers, programmable thermostats, WaterSense labeled toilets, urinals, showerheads, and high efficiency bathroom sink faucets. Eligible appliances include clothes washers, dishwashers, refrigerators, and room air conditioners. In 2012, the Virginia General Assembly extended the sales tax holiday law through July 1, 2017. For more information about Energy Star and EPA's WaterSense programs, go to www.energystar.gov and www.epa.gov/watersense. Details about the State sales tax holiday guidelines are available through the Virginia Department of Taxation at: http://www.tax.virginia.gov/site.cfm?alias=EnergyStarQualifiedProductsHoliday.

Revolving Loan Funds

Through the American Recovery and Reinvestment Act (ARRA) stimulus law passed in 2009, DMME funded a number of financial incentive programs throughout the State to provide

Revolving Loan Funds (RLFs) as well as Loan Loss Reserve Funds (LLRFs) to assist homeowners with undertaking energy efficiency retrofit projects on their homes.

The RLFs funds were established by local governments and other governmental entities with ARRA Grant Funds to provide homeowners with loans to undertake energy efficiency improvements to their homes. These local government projects provided home energy audits to assist homeowners in deciding which retrofit projects to undertake on their homes.

The RLFs were established with financial institutions in the Richmond, Roanoke/ Blacksburg and Arlington County areas of the State. Homeowners can apply for market rate loans at these financial institutions to undertake comprehensive energy retrofit projects on their homes that will reduce energy consumption by 20 percent with the LLRF providing loan loss coverage in case a homeowner defaults on their loan.

In the Charlottesville and surrounding area, local housing foundations identified homeowners that were in need of a new heat pump for their homes. Once again, an ARRA-funded RLF was established to fund the new heat pumps. Funds from the loan repayments will be made available as loans to other homeowners in the future to replace their heat pumps.

In the Bristol area, the Bristol Virginia Utilities Authority (BVUA) operates a RLF that provides loan assistance for home retrofit projects. Their loan program works with BVUA customers who are having difficulty paying their utility bills and where energy efficiency improvements could help to lessen their energy usage.

There are several State incentives for alternative fuel use. They are described in the Section 11 of the 2014 Virginia Energy Plan on Alternative Fuels and Advanced Technology Vehicles and available on the website of the Alternative Fuels Data Center at www.afdc.energy.gov/afdc/laws/.

Virginia's Residential Sector

SECTOR DEFINITION AND BACKGROUND INFORMATION

The residential sector can be loosely defined as the sector of the economy that consists of private households and living quarters.[8] For energy planning, the U.S. Department of Energy defines the residential sector as single- and multi-family housing units and mobile homes. Typical energy consumption in the residential sector is driven largely by heating and cooling needs with the remainder of consumption coming from lighting, electronics, and household appliances.[9]

In 2011, 26.5 percent of total energy consumption in Virginia was attributed to the residential sector.[10] This is approximately 5 percent greater than the 21.05 percent of total energy consumption attributed to the residential sector at the national level in the same year. "Virginia homes are typically newer and larger than homes in other parts of the country."[11] Virginia's demographic characteristics are summarized in the table below.

[8] EIA, *Definitions, Sources and Explanatory Notes,* 2014
[9] EIA, *Household Energy Use in Virginia*, 2009
[10] EIA, *Virginia State Profile and Energy Estimates,* 2014
[11] EIA, *Residential Energy Consumption Survey (RECS),* 2014

Table 9-1: Residential Population and Housing Characteristics, 2010

	Virginia	US
Population 2013	8,260,405	316,128,839
Housing Units 2012	3,398,286	132,452,405
Households, 2008-2012	3,006,219	115,226,802
Persons per Household, 2008-2012	2.59	2.61
Homeownership Rate, 2008-2012	67.8%	65.5%
Housing Units in Multi-Unit Structures 2008-2012	67.8%	65.5%

Source: 2010 Census Data[12] [13] [14]

METRICS OF CURRENT CONSUMPTION

Energy Use

Virginia residential customers consumed 632 trillion BTUs of energy in 2011 or 3 percent of US total residential consumption, on which they spent $6761 million 2.7 percent of US residential sector expenditures.[15] "Virginia households consume an average of 86 million BTUs per year, about 4 percent less than the U.S. average."[16]

A breakdown of the sources utilized to provide this energy is shown below in Table 9-2. The Table outlines direct energy sources and does not include indirect sources such as the coal used to provide retail electricity to residential customers.

Table 9-2: 2011 Residential Sector Energy Consumption by Fuel Type (Trillion BTUs)

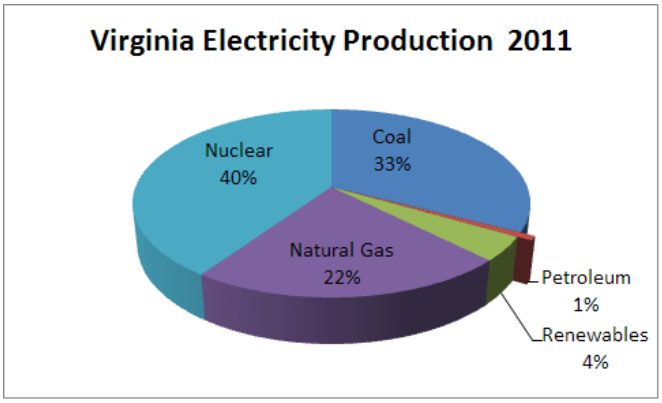
Coal	Natural Gas	Fuel Oil	Kerosene	Propane	Wood
0.0	81.4	16.4	0.9	13.0	14.4
Geothermal	**Solar**	**Retail Electricity Sales**	**Net Energy**	**System Energy Losses**	**Total**
0.8	1.3	156.2	284.3	347.8	632.0

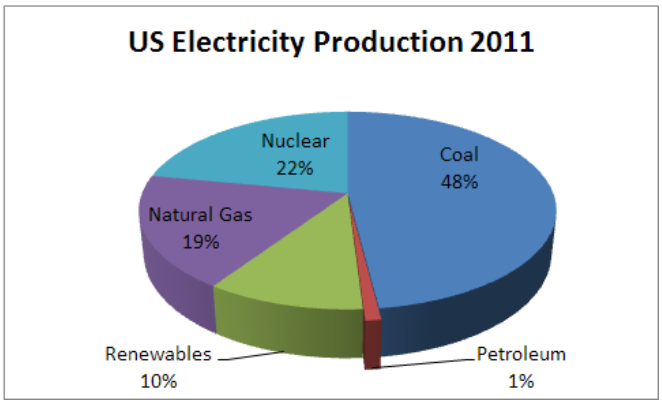
Source: EIA Table C5.[17]

[12] US Department of Commerce: *Virginia: 2010 Summary Population and Housing Characteristics*, 2010
[13] US Department of Commerce: *Virginia: 2010 Summary Population and Housing Unit Counts*, 2010
[14] US Census Bureau: *State and County QuickFacts Virginia,* 2014
[15] EIA, *Virginia State Profiles and Energy Estimates: Virginia Profile Data-Prices,* 2014
[16] EIA, *Household Energy Use in Virginia*, 2009
[17] EIA, *Table C5. Residential Sector Energy Consumption Estimates,* 2011

To get a more detailed picture of energy use in the residential sector we must look at Virginia's overall electricity mix. Figures 9-1 and 9-2 illustrate that when these are accounted for, the residential sector consumes more coal, natural gas, and nuclear power than the table above illustrates.

Figures 9-1 and 9-2: Fuel Sources for Electric Power Generation in Virginia and the US in 2011 (% Total of BTUs)





Source: EIA Table C5[18]

Virginians use electricity to heat their homes at a rate greater than the national average, as shown below.

Table 9-3: Virginia Fuel Use For Home Heating, 2012

Fuel Type	Virginia	US Average
Natural Gas	34.1%	49.4%
Fuel Oil	7.0%	6.5%
Electricity	50.9%	35.5%
Propane	4.5%	5.0%
Other/None	3.4%	3.6%

Source: EIA Virginia Profile Analysis[19]

In Virginia, one in three residential units uses natural gas for home heating. This accounts for approximately one-fourth of all natural gas delivered to end users in the State.[20]

Energy Costs and Prices

Current energy prices for residential consumers can be found in the table below.

[18] Ibid.
[19] EIA: *Virginia State Profiles and Energy Estimates: Virginia Profile Data-Prices.* 2014
[20] EIA: *Virginia State Profiles and Energy Estimates: Profile Analysis.* 2014

Table 9-4: Residential Energy Prices, 2014

	Electricity (¢/kWh)	Natural Gas ($/thousand sf)
Virginia Average	10.60	12.60
National Average	13.13	12.96

Source: Virginia Profile Data-Prices [21]

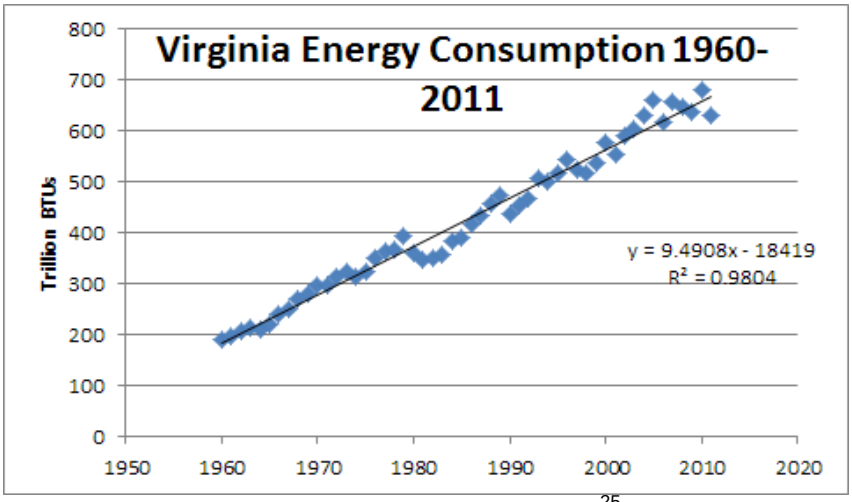
"Average electricity consumption and costs are higher for Virginia households than the national average, but similar to those in neighboring states where electricity is the most common heating fuel."[22]

PROJECTIONS

1. **Key drivers of ongoing changes in consumption** - There are 2 main drivers changing energy consumption trends in Virginia that push consumption in opposite directions. Increasing energy efficiency, especially in newer homes tends to reduce the amount of energy needed per household unit. These newer homes, however, are also significantly larger than older homes have typically been. This has the effect of increasing energy use per housing unit.[23]

2. **Historical consumption patterns** - Figure 9-4 below shows that total residential energy consumption in Virginia has increased from 192 trillion BTUs in 1960 to over 632 Trillion in 2011. This represents an average increase of 9.49 trillion BTUs per year. [24]

Figure 9-4: Historical Data on Residential Energy Consumption in Virginia



Source: EIA Table CT4 Virginia[25]

[21] EIA, *Rankings: Average Retail Price of Electricity,* 2014
[22] EIA, *Household Energy Use in Virginia*, 2009
[23] Ibid.
[24] EIA, *Table CT4. Residential Sector Energy Consumption1960-2011, Virginia*, 2014
[25] Ibid.

3. **Projections for 5, 10, and 20 years** Based on the historical trend, should energy consumption continue to grow at its historical rate, the following rough estimates of future energy use can be derived.

- Consumption in 2019: 742.92 trillion BTUs
- Consumption in 2024: 790.37 trillion BTUs
- Consumption in 2034: 885.29 trillion BTUs

Virginia's Commercial Sector

SECTOR DEFINITION AND BACKGROUND INFORMATION

EIA defines the commercial sector as all energy consuming, non-transportation activities other than whose principal activities are neither residential nor industrial. Thus the commercial sector is incredibly varied and diverse, including all private sector operations outside housing, manufacturing, and resource extraction.[26] It is important to note that under this definition much of the energy consumption in the MUSH sector (municipalities, universities, schools, and hospitals) is likely to be included in EIA commercial sector data. According to EIA, "the vast majority of energy use in this sector occurs in buildings, to maintain the building environment, and to provide building based services."[27]

In 2012, the Virginia commercial sector consumed 25.1 percent of all the energy consumed in the Commonwealth. This amounted to 590.8 trillion BTUs of energy that year and made the commercial sector the second largest consumer of energy in the State behind the transportation sector.[28] Over time, this sector has become increasingly energy efficient, as measured by the gross product produced in this sector, per kWh of electricity input adjusted for inflation. Despite these increases in efficiency in Virginia's commercial sector, growth has outpaced efficiency gains leading to a net increase in sector energy consumption over the last several decades.[29]

CURRENT CONSUMPTION AND EXPENDITURE

In 2011, Virginia's commercial sector consumed 607.7 trillion BTUs of energy, 16.9 trillion more BTUs of energy than in 2012. The sources of this energy are shown in Table 9-5 below.

Table 9-5: Commercial Sector Energy Consumption by Source- Virginia, 2011 (Trillion BTUs)

	Coal	Natural Gas	Petroleum Products	Wood and Waste	Geothermal	Retail Electricity Sales	Net Energy	Electrical System Energy Losses	Total
Virginia	2.4	66	13.7	6.6	1	160.5	250.2	357.5	607.7
United States	61.7	3,224.70	666.1	111.7	19.7	4,531.30	8,604.30	9,347.60	17,951.90

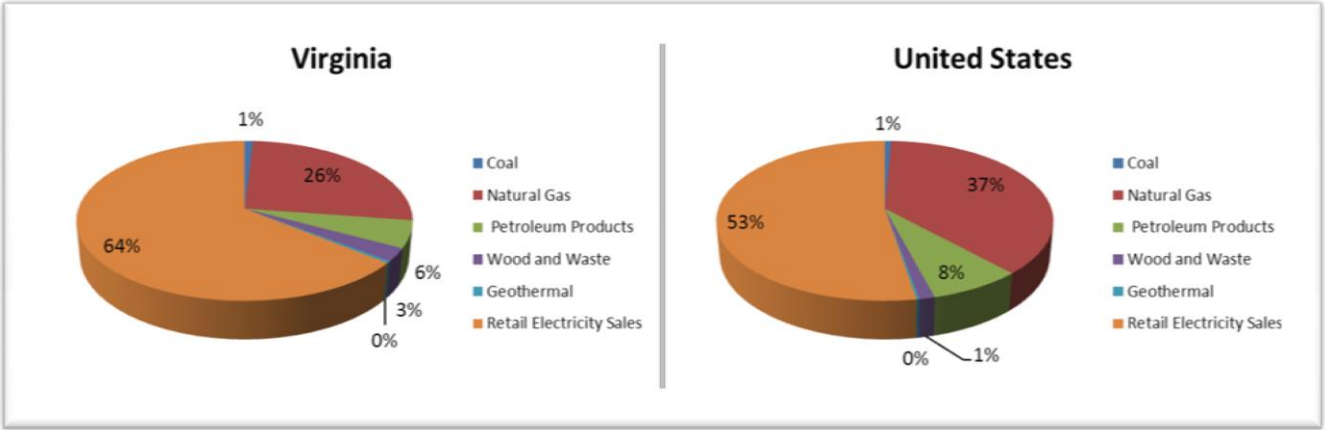
Source: EIA Table C6, Commercial Sector Energy Consumption Estimates, 2011[30]

The majority of the total energy used by the sector was through electricity consumption. On average for every BTU of retail electricity consumed by this sector, 2.23 BTUs of energy were

[26] EIA, *Commercial Building Sector,* 1999
[27] Ibid.
[28] EIA, *Virginia State Profile and Energy Estimates: Profile Overview*, 2012
[29] DOE, *Clean Energy in My Stat,* 2014
[30] EIA, *Table C6. Commercial Sector Energy Consumption Estimates, 2011.* 2014

lost through electrical system energy losses. As a result of this, electrical system energy losses accounted for over 58.8 percent of all energy consumption in the commercial sector. By comparison, at the national level, the commercial sector consumes less electricity as a proportion of its overall energy consumption as shown in Figures 9-4 and 9-5 and more natural gas.

Figures 9-4 and 9-5: Commercial Sector Energy Consumption by Source, 2011



Source: EIA Table C6, Commercial Sector Energy Consumption Estimates, 2011[31]

As a result of these patterns of consumption, the US on aggregate loses only 52 percent commercial sector energy through electrical system losses, 8 percent less than Virginia.

In order to pay for this energy, Virginia's commercial sector spent $4.73 billion dollars in 2011 alone. Table 9-6 shows that most of this expenditure came from the purchase of retail electricity.[32]

Table 9-6: Commercial Sector Energy Expenditures, Virginia, 2011 (Millions of Dollars)

	Total Primary Energy	Retail Electricity Sales	Total Energy
Virginia	984.9	3,742.90	4,727.80
% of Total	20.8%	79.2%	100.0%
United States	45,044.50	135,926.50	180,970.90
% of Total	24.9%	75.1%	100.0%

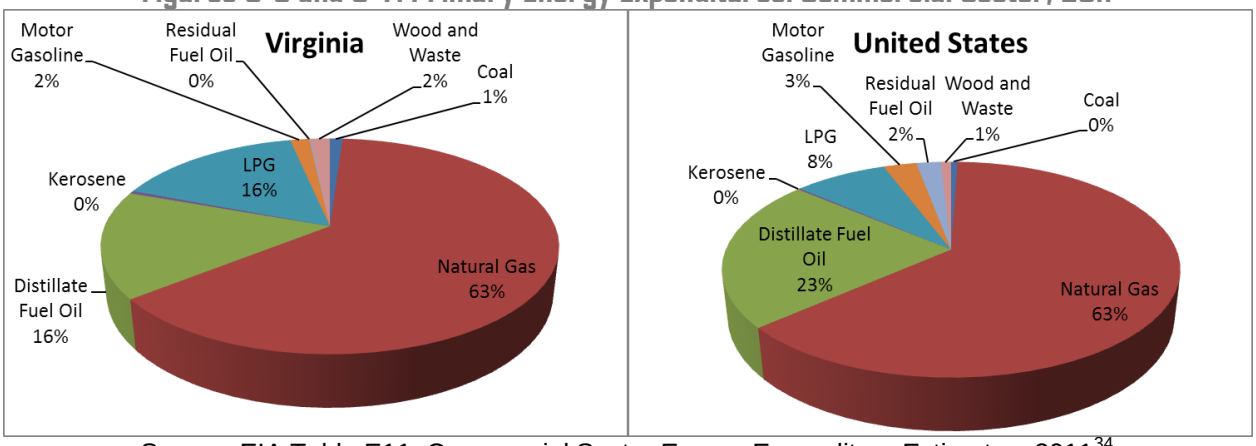
Source: EIA Table E11.[33]

This table illustrates two main points: first, Virginia's commercial sector pays more as a percentage of its energy expenditures for retail electricity than the US commercial sector does; Second, because retail electricity expenditures are, on a percentage basis, higher than electricity consumption, electricity is a relatively expensive form of energy use in this sector

[31] Ibid.
[32] EIA, *Table E11. Commercial Sector Energy Expenditure Estimates,* 2011
[33] Ibid.

compared to current alternatives. These alternatives which constitute 36 percent of Virginia commercial sector energy consumption and only 21 percent of total expenditures as shown in Figure 9-6. Figure 9-7 shows a comparison of these against primary energy use in the U.S. commercial sector.

Figures 9-6 and 9-7: Primary Energy Expenditures: Commercial Sector, 2011



Source: EIA Table E11, Commercial Sector Energy Expenditure Estimates, 2011[34]

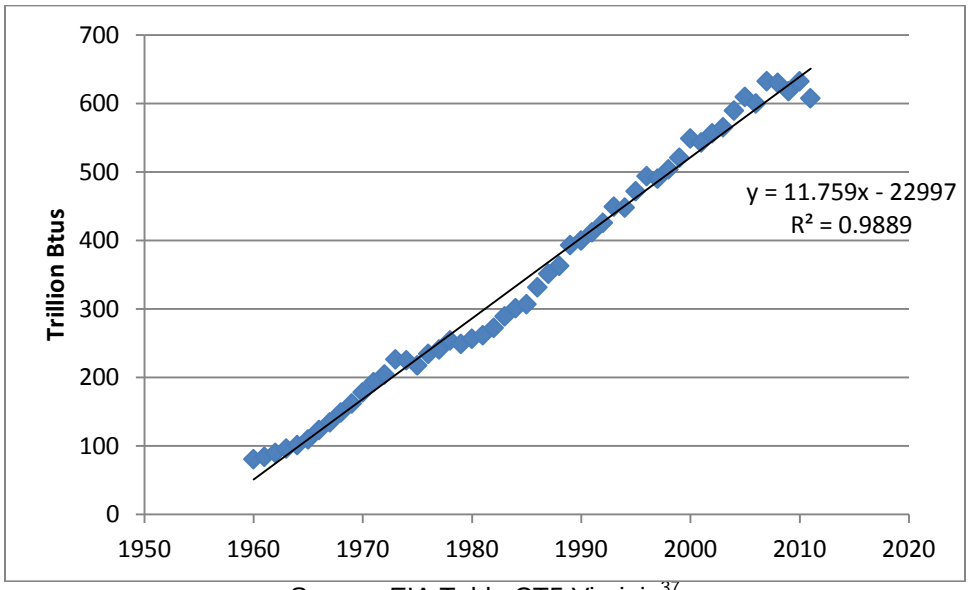
This table shows that while Virginia uses, as a percentage, less primary energy in its commercial sector than the US, the energy mix of this primary energy is similar, with the exception that Virginia uses less distillate fuel oil and more liquefied petroleum gas.

HISTORICAL CONSUMPTION AND PROJECTIONS

Energy consumption in Virginia's commercial sector has steadily risen over the past 50 years, at approximately 11.759 trillion BTUs a year.[35] This growth has occurred despite increases in energy efficiency measured in gross output per BTU, as mentioned in the introduction of this section. This trend of growing commercial sector energy consumption matches that of the U.S. overall.[36] In the U.S., the main drivers of this growth have been increases in the absolute number of commercial buildings and an even greater increase in the total amount of commercial floor space which has outpaced efficiency gains. Despite this, both Virginia and the U.S. have seen some leveling off of energy consumption in this sector in recent years. Figure 9-8 shows the historical trend of energy consumption in Virginia's commercial sector from 1960 to 2011.

[34] EIA, *Table E11, Commercial Sector Energy Expenditure Estimates,* 2011
[35] EIA, *Table CT5, Commercial Sector Energy Consumption Estimates, Selected Years, 1960-2011, Virginia*
[36] EIA, *Table CT5, Commercial Sector Energy Consumption Estimates, Selected Years, 1960-2011, United States*

Figure 9- 8: Historical Commercial Energy Consumption in Virginia (Trillion BTUs)



Source: EIA Table CT5 Virginia[37]

Based on this historical data, and assuming that historical trends continue into the near future, Virginia's commercial sector can be expected to roughly consume the following amounts of energy in the following years.

- 2019: 744.421 trillion BTUs
- 2024: 803.216 trillion BTUs
- 2034: 920.806 trillion BTUs

Virginia's Industrial Sector

SECTOR DEFINITION AND BACKGROUND INFORMATION

EIA defines the industrial sector as an energy-consuming sector that consists of all facilities and equipment used for producing, processing, or assembling goods. The industrial sector encompasses the following types of activity: manufacturing (NAICS codes 31-33); agriculture, forestry, fishing and hunting (NAICS code 11); mining, including oil and gas extraction (NAICS code 21); natural gas distribution (NAICS code 2212); and construction (NAICS code 23)."[38] Unlike the commercial and residential sectors, the main driver of energy consumption in the industrial sector is process heat and cooling and powering machinery. To a lesser extent, facility heating, air conditioning, and appliances also drive energy consumption. Fossil fuel inputs for manufactured products, such as those needed in plastics or pesticide manufacture are also counted in industrial sector energy consumption.[39]

[37] EIA, *Table CT5. Commercial Sector Energy Consumption Estimates, Selected Years, 1960-2011, Virginia*
[38] EIA, *Petroleum and Other Liquids: Definitions Sources and Explanatory Notes,* 2014
[39] Ibid.

Virginia's industrial sector is incredibly diverse with multiple different industries contributing to its vibrancy. Sectors of Virginia's economy that contributed $5 Billion dollars or more to the annual payroll in the State are listed in Table 9-7.

Table 9-7: Major Sectors of Virginia's Economy by Labor Force: 2012

Selected 2012 Labor Statistics		
Sector	**Paid Employees**	**Annual Payroll ($1000)**
Construction	168,289	8,128,619
Manufacturing	232,037	12,003,730
Wholesale Trade	103,377	6,085,181
Retail Trade	415,037	10,235,129
Information	95,292	7,869,285
Finance and Insurance	158,126	11,935,932
Professional, Scientific, and Technical Services	421,502	36,700,334
Management of Companies and Enterprises	63,693	6,458,223
Management and Remediation Services	245,675	9,847,709
Health Care and Social Assistance	407,055	18,338,902
Accommodation and Food Services	318,037	5,122,916

Source: *2012 County Business Patterns*[40]

There is a fine line between what in this table constitutes the commercial and what constitutes the industrial sector. Of the sectors shown here, manufacturing and construction are squarely part of the industrial sector while other sectors such as the professional, scientific, and technical services sector are a mix of both commercial and industrial sectors.

CURRENT CONSUMPTION AND EXPENDITURES

In 2011, Virginia's industrial sector consumed an estimated 436.5 trillion BTUs of energy according to the United States Energy Information Administration.[41] Table 9-8 shows this energy consumption by source.

Table 9-8: Virginia Industrial Sector Energy Consumption by Source, 2011

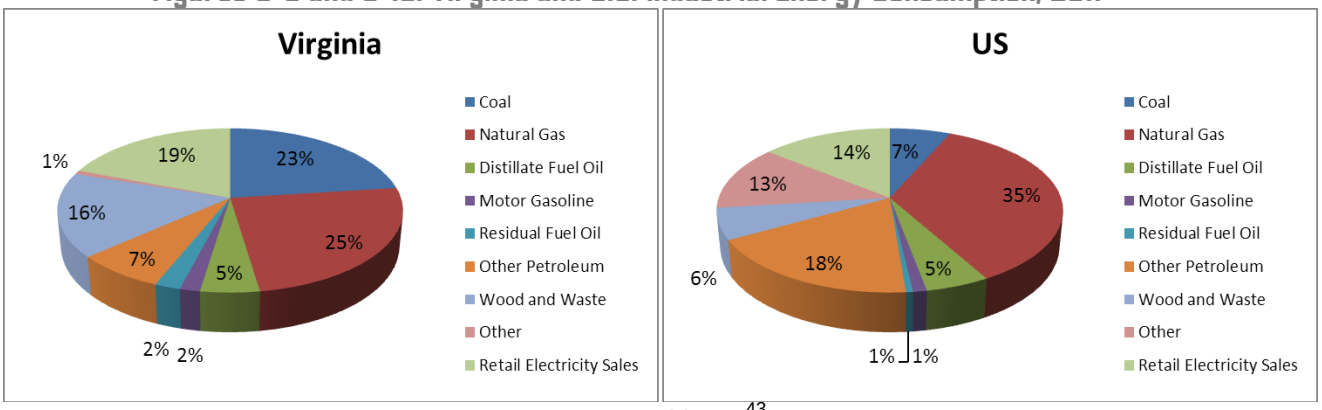
Trillion Btus	Coal	Natural Gas	Distillate Fuel Oil	Motor Gasoline	Residual Fuel Oil	Other Petroleum	Wood and Waste	Other	Retail Electricity Sales	Net Energy	Electrical System Energy Losses	Total
Virginia	70.3	75.3	14.6	5	6.4	22.4	50.7	2.3	58.7	305.6	130.8	436.5
US	1,566.70	8,410.80	1,242.50	261.7	134.9	4,329.30	1,473.60	3040.3	3,382.40	23,825.30	7,098.50	30,923.80

Source: EIA Table C7.[42]

[40] United States Census Bureau. *2012 County Business Patterns,* 2012
[41] EIA *Table C7, Industrial Sector Energy Consumption Estimate,* 2011
[42] Ibid.

Figures 9-9 and 9-10 show how this consumption compared against consumption trends in the U.S. industrial sector in the same year.

Figures 9-9 and 9-10: Virginia and U.S. Industrial Energy Consumption, 2011



Source: EIA Table C7[43]

As can be seen here, in percentage terms, Virginia's industrial sector consumes more coal, wood and waste, and retail electricity and less natural gas and petroleum products than the Nation overall. Of additional note, Virginia consumes vastly less liquefied petroleum gas than the U.S. on a percentage basis, which makes up the vast majority of the "other" category for both Virginia and the U.S. in Figures 9-9 and 9-10.

Virginia's industrial sector spent an estimated $3.08 billion dollars for this energy in 2011.[44] Table 9-9 shows these expenditures by source both for Virginia and for the US and their percentage of overall energy expenditure.

Table 9- 9: Industrial Sector Energy Expenditures by Source, 2011

Millions of Dollars	Coking Coal	Steam Coal	Natural Gas	Distillate Fuel Oil	LPG	Motor Gasoline	Residual Fuel Oil	Other Petroleum	Wood and Waste	Retail Electricity	Total Energy
Virginia	207.7	144.1	426	349.8	57.5	142	107.1	411.2	120.3	1,118.00	3,083.60
% of Total	6.74%	4.67%	13.82%	11.34%	1.86%	4.61%	3.47%	13.34%	3.90%	36.26%	100.00%
United States	3,885.40	3,452.60	37,511.40	30,483.90	48,840.20	7,337.10	2,086.10	47,436.20	3,272.80	64,566.10	249,213.60
% of Total	1.56%	1.39%	15.05%	12.23%	19.60%	2.94%	0.84%	19.03%	1.31%	25.91%	100.00%

Source: EIA. Table E12[45]

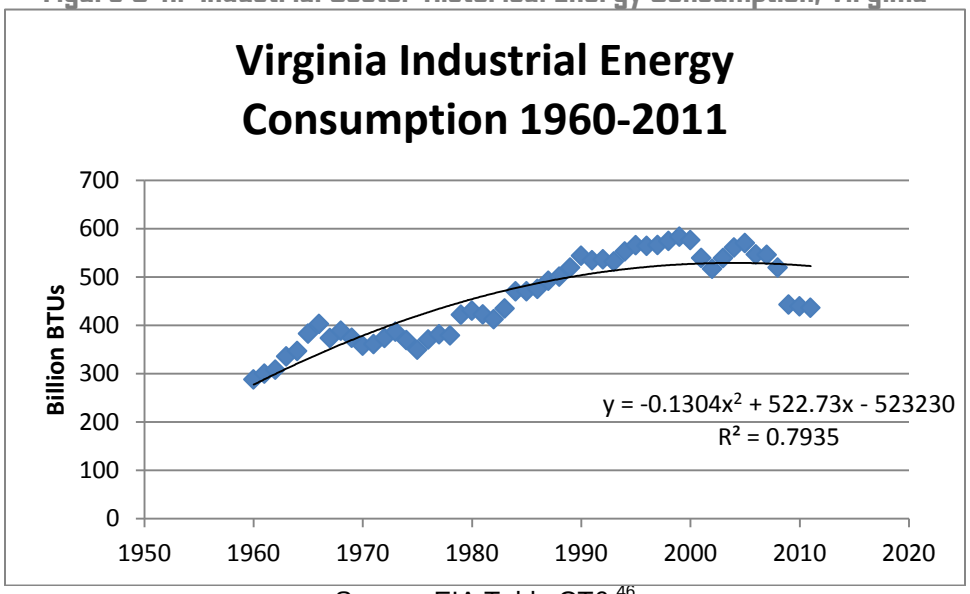
As the table demonstrates, Virginia's industrial sector spends a great deal more on coal and retail electricity, in percentage terms, than the nation does as a whole. It can also be seen, when comparing Tables 9-2 and 9-3 that the use of electricity in this sector is relatively expensive as retail electricity costs are disproportionately greater than electricity consumption when both are expressed as percentages of total cost and consumption, respectively. However, this may be an oversimplification since other fuel inputs are often used in industry to generate electricity on-site. When the additional costs of turning other energy inputs into electricity on-site are factored into non-retail electricity costs, retail electricity expenditures may appear more competitive than they seem at first glance.

[43] Ibid.
[44] EIA, *Table E12. Industrial Sector Energy Expenditure Estimates*. 2011
[45] Ibid.

HISTORICAL CONSUMPTION AND PROJECTIONS

Figure 9-11 shows the total amount of energy consumed by the industrial sector from 1960-2011.

Figure 9-11: Industrial Sector Historical Energy Consumption, Virginia



Source: EIA Table CT6.[46]

This sector is incredibly sensitive to economic booms and recessions and thus historical energy consumption in this sector can fluctuate substantially from year to year. This as well as a general trend in Organization for Economic Cooperation and Development (OECD) countries towards a leveling off of energy consumption in this sector makes forecasting consumption in this sector incredibly difficult. As can be seen above, a simple linear trend does not do a good job of capturing the historical trend of energy consumption in this sector. A polynomial trend while achieving a higher coefficient of determination also is of limited use. While there is a recent trend in the last two decades of industrial sector energy consumption leveling off in Virginia, the drastic reduction in energy use observed from 2009 to 2011 are likely largely driven by the 2007 recession and subsequent slow economic recovery.

Assuming historical trends continue, it is likely that energy consumption in this sector is will continue leveling off or even decline in the near to medium future. Extrapolating on the current trend line we would expect to see the following levels of energy consumption by Virginia's industrial sector in the following years.

2019: 604.4 trillion BTUs
2024: 582.0 trillion BTUs
2034: 517.7 trillion BTUs

[46] EIA, *Table CT6. Industrial Sector Energy Consumption Estimates, Selected Years, 1960-2011,* 2014

Municipal, University, State and Hospital (MUSH) Energy Use in Virginia

SECTOR DEFINITION AND BACKGROUND INFORMATION

The MUSH market in Virginia covers a wide range of building types and owners. There are government-owned and privately owned buildings that range in operation from typical office space to biosafety laboratories and acute care hospitals.

The Municipal sector is made up of 95 counties, 38 towns and 39 cities.[47] Each municipality provides services to citizens and maintains a building stock.

The University sector is made up of over 80 universities and colleges.[48] Almost half of the facilities are state owned institutions. The state universities, colleges, and community colleges serve over 70 percent of the student population.[49]

The State sector is comprised of over 50 state agencies[50] and departments with over 100,000 employees[51] that serve the citizens of the Commonwealth.

The Hospital sector has over 100 hospitals[52] with over 19,000 patient beds.[53] These hospitals include multi-site healthcare systems, independent community hospitals, state-owned hospitals, and behavioral health facilities.

CURRENT CONSUMPTION AND EXPENDITURE

The MUSH sector consumes approximately 43.43 trillion BTUs per year at an annual cost of $758 million.[54] This includes electricity, natural gas, petroleum products, coal, wood, and other fuels.

Fuel Type	BTUs (Trillion)	% of Total Consumption	Annual Cost (Million)
Electricity	21.46	49.4%	$540.4
Natural Gas	15.42	35.5%	$162.0
Petroleum Products	1.48	3.4%	$36.0
Coal	4.99	11.5%	$18.4
Wood and Other Fuels	0.09	0.2%	$1.2
Total	43.43	100%	$758

EIA data on energy pricing[55] was used to determine energy consumption, based on cost data collected from Commonwealth Data Point.[56]

HISTORICAL CONSUMPTION AND PROJECTIONS

Over the last few years, electricity and natural gas consumption has been increasing in this sector. Coal consumption has been declining and petroleum products have been stable. The

[47] Commonwealth of Virginia: Commonwealth Data Point; Transparency at Work in Virginia, 2014
[48] State Council of Higher Education for Virginia: Virginia Colleges and Universities, 2014
[49] IES, IPEDS Data Center, 2014
[50] Commonwealth of Virginia: Agency Website Directory. 2014
[51] USCB, Government Employment and Payroll, 2014
[52] VHHA, Map of VHHA Hospital and Health System Members, 2014
[53] AHD, Individual Hospital Statistics for Virginia, 2014
[54] Commonwealth of Virginia: Commonwealth Data Point: Transparency at Work in Virginia, 2014
[55] EIA, Virginia State Profile and Energy Estimates: Profile Data, 2014
[56] Commonwealth of Virginia, Commonwealth Data Point: Transparency at Work in Virginia, 2014

reduction in coal consumption and the increase in natural gas consumption are related; the environmental impacts of coal and the low price of natural gas are encouraging the market to convert to natural gas.

These trends are expected to continue. Electricity and natural gas consumption will increase slowly as the sector constructs new buildings and maintains the existing stock. Coal will continue to decrease as natural gas increasingly becomes the preferred fuel. Petroleum products should remain stable since the areas and equipment that rely on these fuels often have limited fuel choices.

Virginia's Transportation Sector

SECTOR DEFINITION AND BACKGROUND INFORMATION:

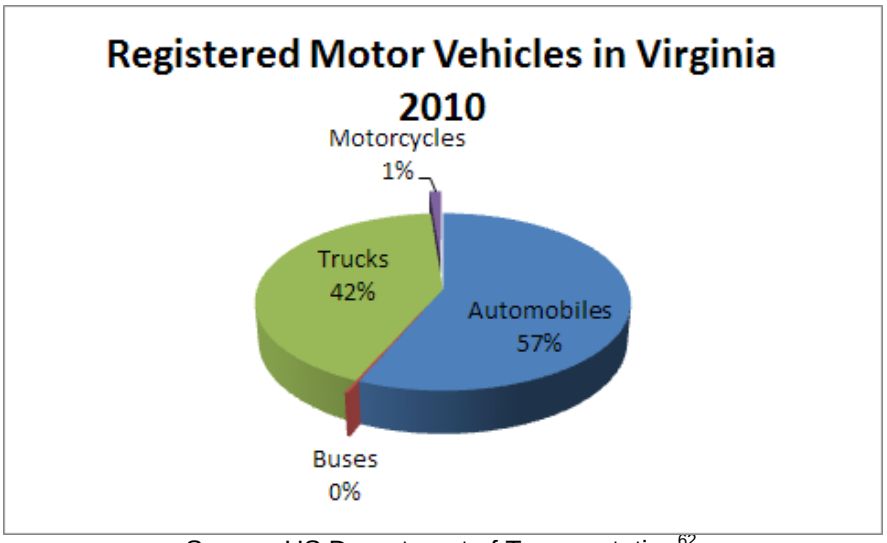
The Virginia transportation sector is defined as the sector of the economy devoted to the movement of people and goods within the State. Energy use in this sector includes all the energy used to transport these people and goods by road, rail, air, water, or pipeline. The main drivers of transportation energy demand are economic activity and trade with additional drivers such as urbanization, fuel market prices, land use patterns, and travel behavior contributing to demand to a lesser degree.[57]

The transportation sector uses more energy than any other sector of Virginia's economy, having accounted for approximately 747.3 trillion Btus, 31.7 percent of the State's total energy use, in 2012. By comparison, the commercial sector, the second most energy intensive sector after transportation, accounted for only 25.1 percent of the State's energy consumption in the same year.[58] For further comparison, the transportation sector accounted for 31.3 percent, 27.5 percent, and 24.7 percent of energy consumption in the neighboring states of Maryland, North Carolina, and West Virginia, respectively.[59,60,61]

The single largest in the Commonwealth driver of this energy consumption came from motor vehicles. The registered motor vehicle fleet consisted of 6,222,928 vehicles in 2010. Of these, 3,510,417 were automobiles, 15,823 were buses, 2,622,554 were trucks, and 74,134 were motorcycles.

[57] EIA, *International Energy Outlook,* 2013
[58] EIA, *Virginia State Profile and Energy Estimates:* 2014
[59] EIA, *Maryland State Profile and Energy Estimates:* 2014
[60] EIA, *North Carolina State Profile and Energy Estimates:* 2014
[61] EIA, *West Virginia State Profile and Energy Estimates,*2014

Figure 9-12: Virginia's Vehicle Fleet



Source: US Department of Transportation[62]

CURRENT CONSUMPTION AND EXPENDITURES

In 2011, the Virginia transportation sector consumed an estimated 712.3 Trillion BTUs of energy. Motor gasoline consumption was the main driver of energy use in this sector. The table below shows a breakdown of energy consumption in Virginia in 2011 by fuel type.

Table 9-9: Virginia Transportation Energy Consumption by Fuel Type 2011 (Trillion BTUs)

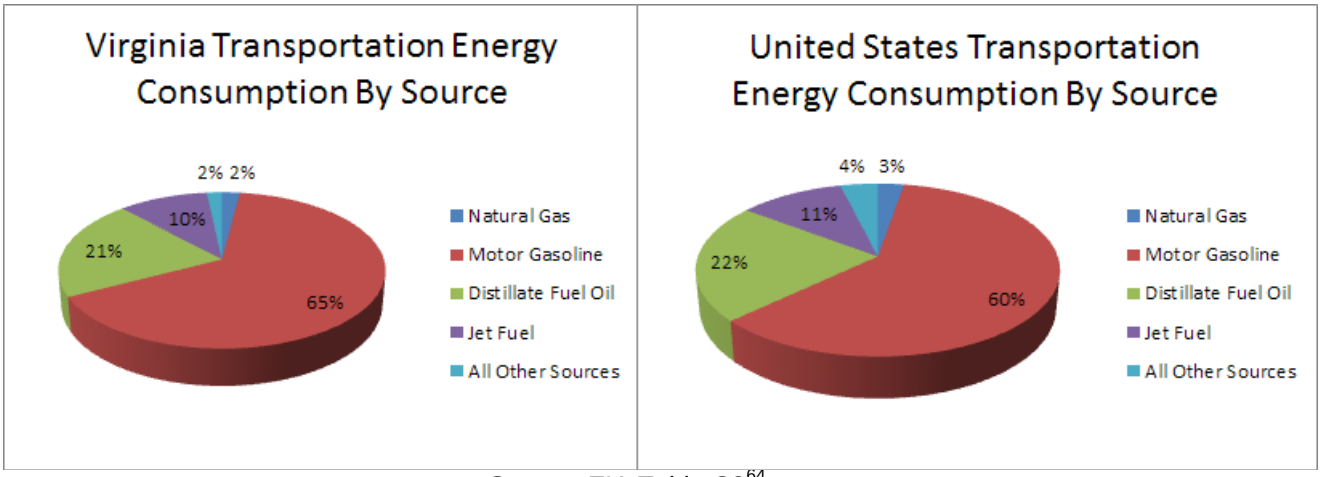
Natural Gas	14.4
Motor Gasoline	465.5
Distillate Fuel Oil	147.7
Jet Fuel	72.4
All Other Sources	12.2

Source: EIA Table C8[63]

Figures 9-13 and 9-14 demonstrate that Virginia used more motor gasoline and significantly less natural gas as a proportion of its transportation energy mix than the United States overall.

[62] U.S. DOT *State Motor-Vehicle Registrations*, 2010
[63] EIA, *Table C8. Transportation Sector Energy Consumption Estimates,* 2010

Figures 9-13 and 9-14: Virginia and U.S. Transportation Energy Consumption, 2011



Source: EIA Table C8[64]

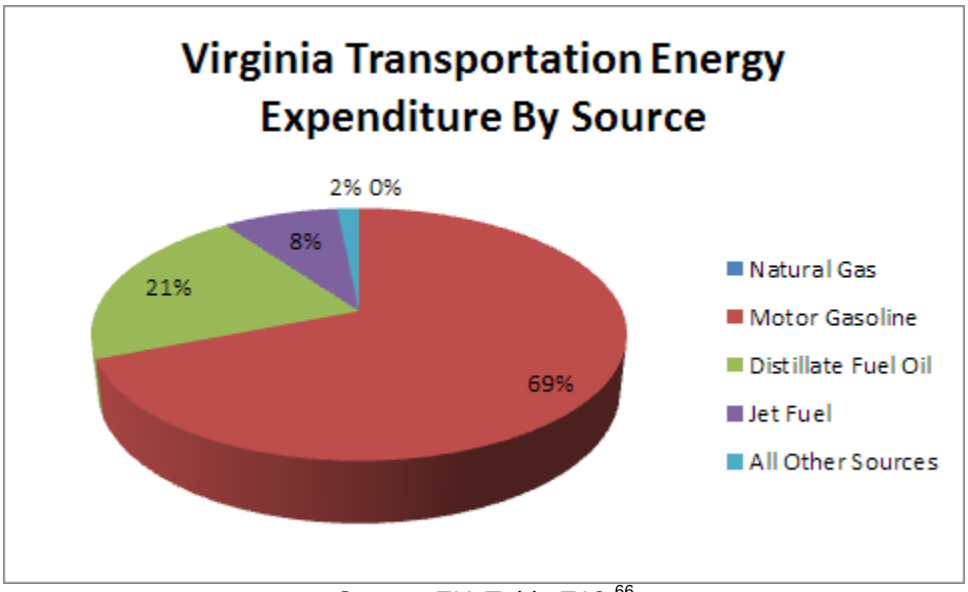
In 2011, the energy used to fuel Virginia's transportation sector cost the Commonwealth an estimated 19.342 billion dollars.[65] This expenditure largely reflected overall consumption but was also affected by market prices at the time. This is illustrated in Table 9-10 and Figure 9-15.

Table 9-10: Virginia Transportation Energy Expenditure by Source: Virginia 2011

Virginia Transportation Energy Expenditure By Source	Millions of Dollars
Natural Gas	0.7
Motor Gasoline	13342.9
Distillate Fuel Oil	4075.3
Jet Fuel	1617.2
All Other Sources	305.8

[64] Ibid.
[65] EIA, *Table E13. Transportation Sector Energy Expenditure Estimates, 2011*

Figure 9-15: Virginia Transportation Energy Expenditure by Source



Source: EIA Table E13.[66]

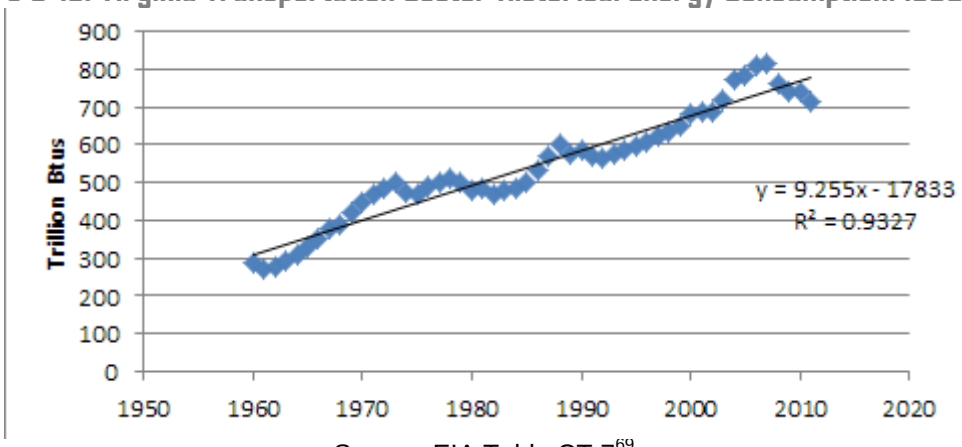
HISTORICAL CONSUMPTION AND PROJECTIONS

Virginia's energy consumption in the transportation sector has grown steadily over the past several decades, increasing at an average rate of 932.7[67] million BTUs per year since 1960. This growth has not been smooth, however, with high levels of growth during economic booms and stagnant or even negative growth during recessionary periods. Recent years have seen marked decreases in transportation energy use in Virginia. This is likely primarily driven by the great recession of 2007-08 and subsequent slow economic recovery. Other factors that may have affected some reduction in transportation energy use in Virginia include the federal cash for clunkers program, increasing federal vehicle efficiency standards, and several years of continuing high oil prices.[68]

Considering the various factors that affect energy consumption in the transportation sector, it is difficult to predict future consumption. Based on the historical trend however, and assuming business as usual continues for the next 10 years, we would expect Virginia to consume approximately 792.275 trillion BTUs of energy by 2019 and 838.4 trillion BTUs of energy by 2024. The current trend in transportation energy consumption can be found in Figure 9-16.

[66] Ibid.
[67] EIA, *Table CT7 1960-2011, Virginia* 2011
[68] EIA, *Virginia State Energy Profile,* 2011

Figure 9-16: Virginia Transportation Sector Historical Energy Consumption: 1960-2011



Source: EIA Table CT 7[69]

- Consumption in 2019: 792.275 trillion BTUs
- Consumption in 2024: 838.4 trillion BTUs
- Consumption in 2034: 930.65 trillion BTUs

Conclusion

Virginia's growing economy will need increasing amounts of energy over the next ten years as more computers, electric appliances, and equipment are placed in use. Virginia will need a broad mix of energy sources to accommodate this growth. At the same time, Virginia will also need to reduce the energy growth rate through conservation and efficiency measures.

Energy efficiency and conservation offer Virginians the most cost-effective and most readily deployable method to manage the Commonwealth's energy future. As Virginia's population, business community, and energy needs continue to grow, energy efficiency and conservation can defer the need for new energy supply facilities and the associated environmental burdens they place on land, water, and air resources. Energy efficiency is a true "pollution prevention" technique, because at its core is source reduction and improved production efficiency. Improvements to process efficiency result in the decreased use of materials, labor, and wastes. The efficient use of energy results in decreased use of resources, less air pollution, and therefore, more cost savings. [70]

[69] EIA, *Table CT7 1960-2011, Virginia,* 2011
[70] http://www.dmme.virginia.gov/DE/ConsumerInfo/consumerinfo.shtml