American Gas Association

Energy Analysis

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# A COMPARISON OF ENERGY USE, OPERATING COSTS, AND CARBON DIOXIDE EMISSIONS OF HOME APPLIANCES 2016 UPDATE

## Introduction

Natural gas, electricity, oil, and propane compete in the residential sector in a variety of applications – primarily space heating and water heating. Natural gas, electricity, and propane also compete in cooking and clothes drying applications. Choosing which energy to use has significant implications in terms of efficiency, economics, and the environment. While the ultimate energy choice is made by consumers and builders, this choice is also influenced by government policies.

It is important that government policies and regulations that influence energy matters be based on accurate measurements of energy efficiency and environmental impacts. Most government policies and regulations that influence energy matters are "site-based" - that is, they only consider the impacts at the site where the energy is ultimately consumed. Site-based regulations, such as appliance efficiency standards and measurement, can lead to higher energy resource consumption as well as higher levels of pollution.

A full-fuel-cycle analysis is more comprehensive. This method examines all impacts associated with energy use, including those from the extraction/production, conversion/generation, transmission, distribution, and ultimate energy consumption. Site energy analysis only takes into consideration the ultimate consumption stage. Significant energy is consumed, with resulting polluting emissions, during all stages of energy use.

This view is supported by the National Academies' report to the Department of Energy (DOE), "Review of Site (Point-of-Use) and Full-Fuel-Cycle Measurement Approaches to DOE/EERE Building Appliance Energy Efficiency Standards."[1] The report found that DOE should consider changing its measurement of appliance energy efficiency to one based on the full-fuel-cycle. This more accurate measurement would provide consumers with more complete information on energy use and environmental impacts.

[1] National Academies, http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12670

The purpose of this analysis is to compare the relative impacts associated with residential appliances powered by natural gas, electricity, oil, and propane. Consideration is given not only to impacts at the point of ultimate energy consumption -- i.e., the home -- but also to those impacts associated with the production, conversion, transmission, and distribution of energy to the household. For example, energy is used and lost in the generation of electricity and in the processing required for crude oil and natural gas.

**Summary of Results**

The use of natural gas rather than electricity, oil, or propane in residential applications, when evaluated on a full-fuel-cycle basis, results in significant reductions in energy consumption, consumer energy bills, and air pollutant emissions.

<u>Natural Gas Use Results in Less Total Energy Consumption</u>

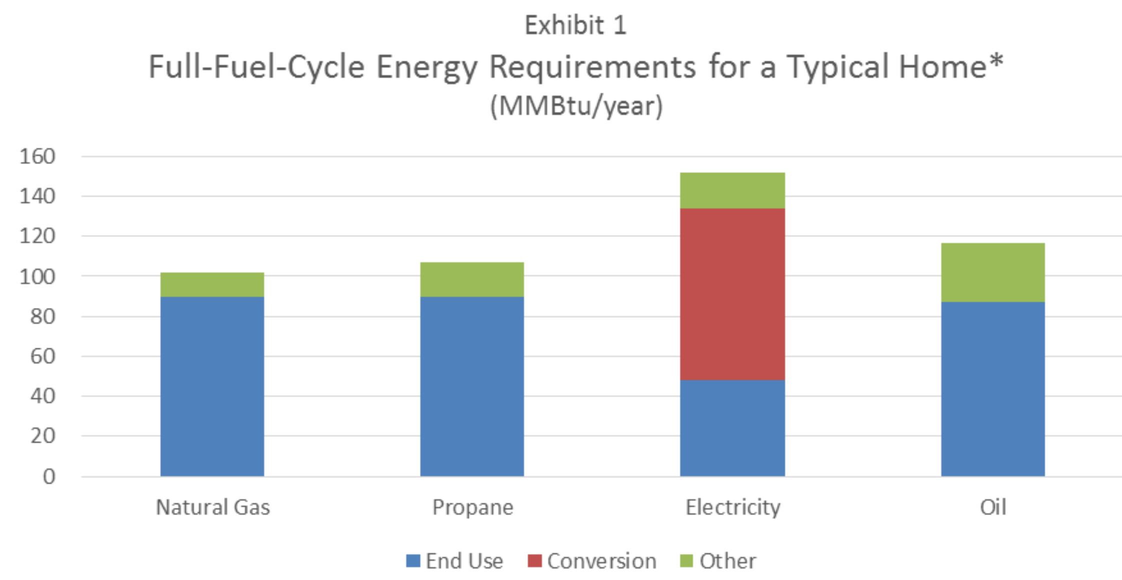
- Although electric appliances (e.g., space heaters, water heaters, stoves and clothes dryers) may consume less site energy than their natural gas counterparts, this disadvantage is more than offset by the greater energy efficiency of the overall natural gas production/delivery system.

    - In a typical residential application, a natural gas home requires about one-quarter less total energy on a full-fuel-cycle basis than is required for a comparable all-electric home (see Exhibit I) for those appliances.

    - This energy efficiency advantage of natural gas-based homes stems from the fact that less than ten percent of the natural gas energy produced is used or lost from the point of production to the residence. In contrast, almost 70 percent of the energy produced to satisfy the electricity needs of consumers is used or lost in the process of energy production, conversion, transmission, and distribution.

- A typical natural gas furnace consumes about the same site energy as a comparable oil furnace. A gas water heater uses slightly less site energy than an oil water heater. Also, since oil is not typically used in cooking and clothes drying, it was assumed that electric appliances would be used for those applications in the oil house. These factors, when combined with a slightly higher efficiency for the overall gas production/delivery system relative to oil, result in gas appliances requiring 9 percent less total energy than the oil house.

- While natural gas and propane have the same site-based appliance efficiencies, natural gas is more efficient in the overall production/delivery system. This better full-fuel-cycle efficiency results in the natural gas home requiring three percent less total energy than the propane house.




Note: "Other" includes impacts from distribution, transportation, processing, and extraction.
* Energy use for space heating, water heating, cooking, and clothes drying appliances.

Using Natural Gas Can Save Homeowners 43 to 49 Percent on Their Energy Bills

- The higher efficiency and lower price of natural gas relative to other energy forms result in annual utility energy bills for the gas home that are roughly 49 percent lower than the comparable all-electric home energy bills, about 46 percent lower than the oil home, and 43 percent lower than the propane home.

  - According to DOE,[2] the 2016 U. S. representative average unit cost for residential gas is $9.32 per million British thermal units (MMBtu) versus $36.93 per MMBtu for electricity, $14.28 per MMBtu for distillate oil, and $15.44 per MMBtu for propane.

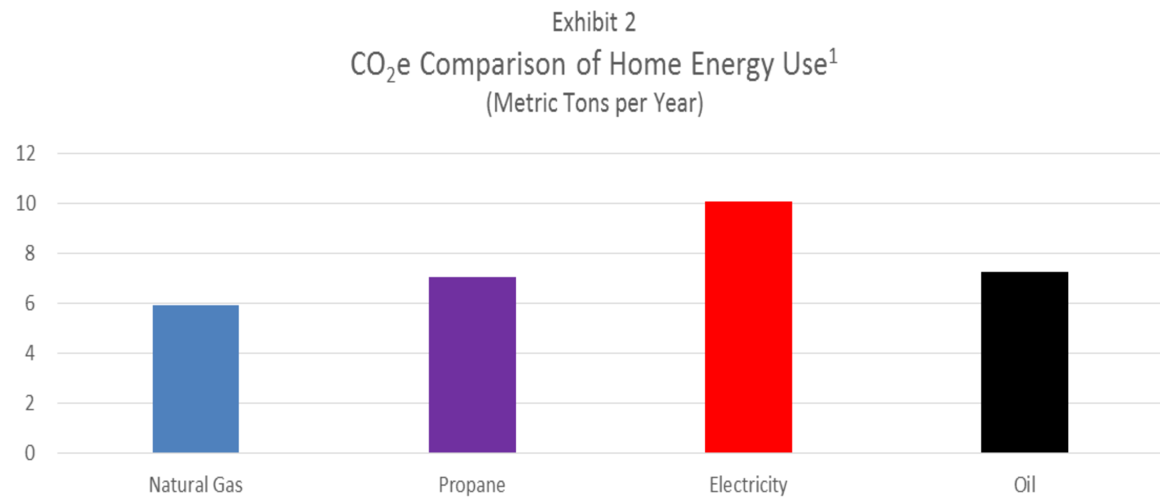
  - Based on these energy prices and the energy consumption levels modeled in this analysis, residential natural gas customers realize annual energy savings of approximately $743 relative to electricity customers, $803 relative to oil customers, and $635 relative to propane customers.

Natural Gas is the Cleaner Fossil Fuel

The inherent cleanliness of natural gas relative to other fossil fuels, in conjunction with its high efficiency, results in numerous environmental benefits relative to electric, oil, and propane systems. These include lower emission levels of the criteria pollutants regulated by the Clean Air Act. Natural gas combustion results in a fraction of the nitrogen oxides, sulfur dioxides, and particulate matter compared to oil, coal, and

[2] U.S. Energy Information Administration, Short-Term Energy Outlook (August 11, 2015), Annual Energy Outlook (April 14, 2015), and Monthly Energy Review (July 28, 2015)

propane combustion.[3] In addition, natural gas use is substantially cleaner than oil, coal, and propane in regards to carbon dioxide ($CO_2$), the principal greenhouse gas. For example, carbon dioxide equivalent ($CO_2e$) emissions are about 41 percent lower for the gas residence than those attributable to an all-electric home, about 18 percent lower than oil homes, and 16 percent lower than propane homes (see Exhibit 2).




[1] Emissions from space heating, water heating, cooking, and clothes drying
Note – includes impact on $CO_2$ equivalent from unburned methane

This analysis is based on new homes that meet the 2011 International Energy Conservation Code. Electricity is assumed to be generated by all the inputs consumed for generation in the United States, including renewable sources and nuclear energy. The appliances meet the minimum efficiency standards as set by the Department of Energy, where applicable, which represent the majority of appliances sold. An analysis based on the existing home stock would be even more favorable to natural gas, as older homes tend to require more energy due to their lower thermal integrity and less efficient equipment.

The analysis does not consider air conditioning, which is almost always provided by electricity, and the economic comparison focuses on energy costs and does not consider equipment and installation costs.

**Analysis of Full-Fuel-Cycle Impacts**

*Background*

Significant amounts of energy can be used or lost along the "energy trajectory," that is, in the extraction, processing, transportation, conversion, and distribution of

[3] Environmental Protection Agency, AP-42 Emission Factors, http://www.epa.gov/ttn/chief/ap42/ch01/index.html

energy. A more efficient energy trajectory translates into less overall energy production required. In addition, the efficiency of end-use equipment affects the total energy requirement. In order to obtain a comprehensive assessment of the total impact of end-use energy applications on energy resources, the full-fuel-cycle must be examined; that is, the efficiency of the energy trajectory in conjunction with that of the end-use device.

When compared with electricity, natural gas is delivered to consumers with much less energy wasted. The cumulative efficiency -- from the wellhead to the residential meter -- of the natural gas trajectory is approximately 92 percent. This means that for every 100 MMBtu of energy produced, 92 MMBtu of energy is delivered to the consumer. Based on the current mix of energy used for electricity generation, electricity delivers to the consumer only 32 MMBtu of the same 100 MMBtu of energy produced. For oil, each 100 MMBtu produced results in 84 MMBtu reaching the customer. For propane, each 100 MMBtu produced results in 87 MMBtu reaching the customer (see Table 1).

In terms of full-fuel-cycle -- the combined efficiency of the energy trajectory and the efficiency of the end-use equipment -- natural gas retains its superiority. For new residential applications, full-fuel-cycle efficiency will be 74 percent for the natural gas space heating option that meets the minimum efficiency rating of 0.80. For electric heat pumps, whose federal minimum standard for fuel utilization efficiency is about 200 percent, the full-fuel-cycle efficiency will be about 64 percent. Less efficient electric resistance heating has a full-fuel-cycle heating efficiency of only 32 percent. The full-fuel-cycle efficiency for an oil furnace averages about 67 percent, due to an energy trajectory efficiency of 84 percent. The propane furnace full-fuel-cycle efficiency measure is also 70 percent. Again, these efficiencies reflect the total of all losses from extraction, processing, transportation, conversion, distribution, and end use of the natural gas, electric, oil, and propane systems.

**TABLE 1**
**ENERGY TRAJECTORY EFFICIENCY OF ENERGY DELIVERED TO THE HOME[1]**

| | EXTRACTION | PROCESSING | TRANSPORTATION[2] | CONVERSION | DISTRIBUTION | CUMULATIVE EFFICIENCY |
|---|---|---|---|---|---|---|
| **Natural Gas** | 96.2% | 97.0% | 99.0% | -- | 99.0% | 91.5% |
| **Oil** | 94.9% | 89.1% | 99.7% | -- | 99.6% | 84.0% |
| **Propane** | 94.6% | 93.6% | 99.2% | -- | 99.2% | 87.1% |
| **Electricity**: | | | | | | |
| Coal-Based | 98.0% | 98.6% | 99.0% | 32.9% | 93.5% | 29.4% |
| Oil-Based | 96.3% | 89.1% | 98.8% | 32.0% | 93.5% | 26.7% |
| Natural Gas-Based | 96.2% | 97.0% | 99.3% | 43.2% | 93.5% | 37.4% |
| Nuclear-Based | 99.0% | 96.2% | 99.9% | 32.6% | 93.5% | 29.0% |
| Other[3]-Based | -- | -- | -- | 56.0% | 93.5% | 52.4% |
| **Electricity Weighted Average[4]** | 98.0% | 97.8% | 99.3% | 35.7% | 93.5% | 31.8% |

Source: *Source Energy and Emission Factors for Building Energy Consumption – 2013 Update*, Prepared by the Gas Technology Institute for the AGA – January 2014.

"--" indicates not applicable or no efficiency loss.
[1]Efficiency of energy delivered to the home refers to the energy used or lost, from the point of extraction to the residence, not including the end-use device.
[2]Transportation of natural gas from processing plant to local distribution system; transportation of fossil fuel to electricity generating plants.
[3]Includes renewable energy
[4]Current national weighted average mix of all power generation sources.

The superiority of natural gas, in terms of energy trajectory efficiency, more than offsets the often higher end-use efficiency of electric equipment. The point of greatest inefficiency along the electricity trajectory is generation, where roughly two-thirds of the input energy is lost as heat in the production of steam to turn large turbine/generators. Additionally, approximately six percent of the electricity generated does not reach the ultimate consumer due to transmission line losses.

*Methodology*

<u>Energy Efficiency Trajectories (Table 1)</u>

Data for full-fuel-cycle energy efficiency factors were taken from *Full-Fuel-Cycle Energy and Emission Factors for Building Energy Consumption – 2013 Update*, prepared by the Gas Technology Institute (GTI) for the American Gas Association. The conversion and cumulative efficiency factors for "Other" energy inputs for electricity generation was calculated based on the weighted average of the other factors as listed in the report.

Energy Use

The analysis examines the total energy requirements for space heating, water heating, cooking, and drying of one-story, single family detached residence (2,072 square feet of conditioned space) in an average climate in the United States (4,811 heating degree days). Only natural gas, electricity, oil, and propane appliances were examined. The home in the analysis was assumed to meet 2011 International Energy Conservation Code (IECC) standards with appliances that at least meet the minimum standards set by the Department of Energy.

In the natural gas and propane heated homes, the analysis assumed the furnace had an efficiency of 80 percent. The energy requirement for the system's fan was also included in the system's energy requirement calculation. The electric home used a heat pump with a heating seasonal performance factor (HSPF) of 7.7. For the oil home, a furnace with an efficiency of 80 percent was used. All units produced approximately 58 MMBtu per year of useable heat annually.

For heating water, the home was assumed to use a 50-gallon electric water heater with an efficiency/energy factor of 90 percent, a 32-gallon oil model with an efficiency of 51 percent, and a 40-gallon model with an efficiency of 59 percent in the natural gas and propane homes. All units meet the minimum efficiency set by DOE and can produce the number of gallons of hot water required by the home -- about 15 MMBtu of useful water heating output per year. Such sizing variations are common. Electric units must be sized somewhat larger in order to provide adequate quantities of hot water due to the units' lower recovery rates compared with natural gas units, and the oil units are relatively smaller due to their larger burner size. All water heaters have a first hour rating in excess of 60 gallons.

For cooking, the natural gas and propane units have an energy factor of 5.8 and the electric stove has an energy factor of 10.9, and all units produce 0.2 MMBtu of useful cooking energy. Clothes dryers have energy factors of 2.67 for natural gas and propane and 3.01 for electricity, and all units meet a drying energy output of 0.1 MMBtu per year. Since oil is not commonly used for cooking or clothes drying, it was assumed that electric appliances for these applications were used in the oil homes.

*Results*

On a full-fuel-cycle basis, natural gas use in primary residential appliance applications is far more efficient compared with electricity, oil, and propane. The full-fuel-cycle energy requirement for an average home using natural gas is 33 percent less than for a similar home using electricity, is 12 percent less than the similar oil home, and is five percent less than the similar propane home. End-use (site-based) energy requirements for this home would be 89.9 MMBtu per year of natural gas and propane, 48.3 MMBtu per year of electricity, and 87.0 MMBtu for oil. Total energy requirements (full-fuel-cycle), however, would be 102.0, 151.9, 116.6, and 107.2 MMBtu annually of natural gas, electricity, oil, and propane, respectively (see Table 2).

For many areas of the country, space heating represents the greatest portion of energy use in residences. The site energy required for heating the natural gas and propane homes of about 2,000 square feet is 59.6 MMBtu per year. A comparable home that has an electric heat pump requires 30.8 MMBtu of site energy annually for space heating while the oil home requires 58.9 MMBtu annually. The annual energy requirements for heating these homes, when measured on a full-fuel-cycle basis, would be 68.6 MMBtu for the natural gas furnace, 96.8 MMBtu for the electric heat pump, 74.9 MMBtu for the oil furnace, and 72.0 MMBtu for the propane furnace.

The annual site energy requirement for water heating would be 25.4 MMBtu for the natural gas and propane appliances, 16.6 MMBtu for the electric option, and 29.1 MMBtu for oil. When calculated on a full-fuel-cycle basis, the annual energy requirement would be 26.6 MMBtu for natural gas, 49.8 MMBtu for electricity, 28.6 MMBtu for oil, and 28.0 MMBtu for propane.

The energy requirements for residential cooking and clothes drying are typically lower than for those for space and water heating. On a site-basis, the combined energy consumption by both of these appliances would be 7.1 MMBtu for natural gas and propane compared to 5.1 MMBtu for electricity. On a full-fuel-cycle basis, the energy requirements would be 6.8 MMBtu for the natural gas appliances, 13.0 MMBtu for the electric appliances, and 7.2 MMBtu for the propane appliances (see Appendix for additional data on appliances).

**TABLE 2**
**TYPICAL SITE-USE AND FULL-FUEL-CYCLE ENERGY REQUIREMENTS FOR A NEW HOME**
**(MMBtu per year)**

| | NATURAL GAS | ELECTRICITY | OIL | PROPANE |
|---|---|---|---|---|
| Space Heating | 59.6 | 30.9 | 58.8 | 59.6 |
| Water Heating | 24.4 | 15.8 | 24.0 | 24.4 |
| Cooking | 3.3 | 1.8 | 1.8 | 3.1 |
| Clothes Drying | 3.0 | 7.3 | 7.3 | 3.1 |
| **Total Site Use** | **89.8** | **48.4** | **87.0** | **89.8** |
| Energy Losses [2] | 11.8 | 103.2 | 24.5 | 14.7 |
| ***FULL-FUEL-CYCLE USE*** [3] | **102.0** | **151.9** | **116.5** | **107.2** |

[1]It was assumed that electric appliances for these applications were used in the oil homes.
[2]Includes energy used or lost in extraction, processing, conversion, transportation, and distribution of energy.
[3] Sum of Site Use and Energy Losses

## Analysis of Consumer Cost

*Background*

Consumer energy costs are the product of the total end-use energy required and the price of energy. Full-fuel-cycle energy efficiencies affect consumer energy costs in that these costs reflect the total volume of fossil fuels required to ultimately satisfy consumer energy needs.

*Methodology*

The end-use (site) energy requirements calculated in the preceding section can be multiplied by national average prices for natural gas, electricity, oil, and propane to calculate the relative energy cost impacts on consumers. Each year the Department of Energy estimates representative average unit costs for energy (see Table 3). For 2016, DOE estimated that the price of electricity to the residential consumer in the U.S. would be 4.0 times higher than the price of natural gas. DOE estimated that the price for distillate oil would be 1.5 times that of natural gas. Finally, DOE estimated that propane would be 1.7 times that of the price of natural gas. Please note that energy prices, and resulting consumer costs, vary by region.

**TABLE 3**
**2016 REPRESENTATIVE AVERAGE UNIT COSTS FOR U.S. RESIDENTIAL ENERGY PRICES ($MMBtu)**

| NATURAL GAS | ELECTRICITY | DISTILLATE OIL | PROPANE |
|---|---|---|---|
| $9.32 | $36.93 | $15.44 | $14.28 |

*Source:* U.S. Energy Information Administration, Short-Term Energy Outlook (August 11, 2015), Annual Energy Outlook (April 14, 2015), and Monthly Energy Review (July 28, 2015)

*Results*

The total annual residential energy cost for the four appliances in a typical new natural gas home is $875 lower than the electric home, $784 lower than the oil home, and $677 lower than the propane home. For space heat alone, residential consumers of natural gas can save $445 a year relative to electricity consumers, $295 a year compared to oil customers, and $355 a year compared to propane customers.

For other baseload applications, energy cost savings can be realized for natural gas customers as well. Overall, typical new homes can save $429 per year in energy costs by using natural gas instead of electricity for water heating, cooking, and clothes drying. The natural gas house can save $490 per year in energy costs relative to the oil house for these applications. The natural gas costs for operating these baseload appliances would be $322 lower than those of the propane home.

**TABLE 4**
**ESTIMATED ANNUAL RESIDENTIAL ENERGY BILLS FOR TYPICAL NEW HOMES**
**(2016$)**

| | NATURAL GAS | ELECTRICITY | OIL | PROPANE |
|---|---|---|---|---|
| Space Heating | $601 | $1,046 | $896 | $956 |
| Other[1] | $314 | $742 | $803 | 635 |
| ***TOTAL*** | $915 | $1,789 | $1,699 | $1,591 |

[1] Includes water heating, cooking, and clothes drying

## Analysis of Environmental Impacts

*Background*

The issue of energy use and its impact on the environment has become increasingly important. This is particularly true regarding the subject of global climate change, as nations struggle with mitigation/abatement of carbon dioxide emissions, the principle greenhouse gas. Consumption of natural gas emits the least amount of $CO_2$ compared with all other fossil fuels -- approximately 44 percent less than coal, 27 percent less than petroleum, and 16 percent less than propane for similar amounts of energy consumed.[4]

*Methodology*

This analysis examines the emissions of $CO_2$ resulting from the full-fuel-cycle energy consumption. In addition, the $CO_2$ equivalent ($CO_2e$) of unburned methane released into the atmosphere during this energy process was calculated. The emission factors used to calculate greenhouse gas impacts for both combustion (site) and pre combustion (source) came from the GTI report on source energy and emission factors.[5] These emission factors, presented in pounds per MMBtu consumed and/or per kWh generated, were applied to the energy consumed by the appliances.

Unburned methane is also a greenhouse gas, and is emitted during all the fossil fuel cycles. The GTI report also provided methane emission factors for both pre-combustion (source) and combustion (site). The factors are presented as pounds per MMBtu and per kWh. These factors are then applied to the appliance energy consumption numbers. In order to convert the methane output into carbon dioxide

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[4] Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov/oiaf/1605/coefficients.html

[5] *Source Energy and Emission Factors for Building Energy Consumption*, Prepared by Gas Technology Institute for the Codes & Standards Research Consortium, August 2013, http://www.aga.org/Source Factors

equivalents ($CO_2e$), the methane emissions were increased by a factor of 25 in order to account for methane's global warming factor.[6]

*Results*

On a full-fuel-cycle basis, natural gas use in residential applications generates significantly less $CO_2e$ than electricity, oil, and propane. The full-fuel-cycle $CO_2e$ emissions resulting from appliance use in a typical new home are presented in Table 5.

The total efficiency advantage of natural gas, coupled with the fact that natural gas combustion emits approximately 44 percent, 27 percent, and 16 percent of the $CO_2$ emissions of coal, oil, and propane per MMBtu consumed, respectively, results in significantly lower emissions for natural gas. For the natural gas appliances, annual overall $CO_2e$ emissions were 5.9 metric tons. In comparison, the all-electric option was 8.9 metric tons $CO_2e$ annually, the oil home produced 7.2 metric tons, and the propane home produced 7.0 metric tons.

**TABLE 5**

**FULL-FUEL-CYCLE CARBON DIOXIDE EQUIVALENT EMISSIONS FOR NEW HOMES[1]**
**(Metric Tons of $CO_2e$[2] per Average Household Energy Use)**

| | |
|---|---|
| Natural Gas | 6.0 |
| Electricity[3] | 10.1 |
| Oil | 7.3 |
| Propane | 7.1 |

[1] Space heating, water heating, cooking, and clothes drying only
[2] Includes impact of unburned methane
[3] Based on actual generating mix in 2014

## Conclusion

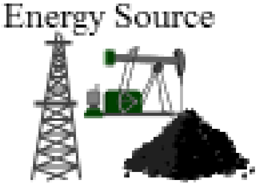
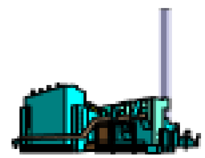
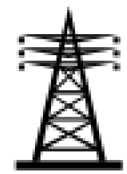
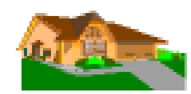
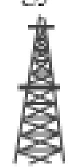
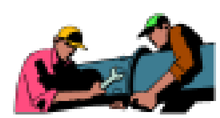
To analyze energy/environmental impacts on less than a full-fuel-cycle basis can mislead both policy makers and consumers. This more comprehensive method shows that natural gas use in the primary residential applications (space heating, water heating, cooking, and clothes drying) results in increased energy efficiency, substantial consumer energy cost savings, and reduced environmental impacts when compared with electricity, oil, and propane use. Direct use of natural gas in the residential sector offers an efficient, cost-competitive alternative to electricity, oil, and propane with fewer adverse impacts on the environment.

[6] Energy Information Administration, U.S. Department of Energy, http://www.eia.doe.gov/oiaf/1605/ggrpt/

Appendix

# Efficiency and Appliance Charts

# Three Times More Energy Reaches the Customer with Natural Gas

| | Extraction, Processing, & Transportation | Conversion[1] | Distribution | Delivered To Customer | |
|---|---|---|---|---|---|
| **Electricity** **32% Efficient** | 100 MMBtu Energy Source | 95 | 34 | 32 | |
| |  |  |  |  | **Total $CO_2$e** |
| $CO_2$ equivalent[2] emissions from typical household use[3] (metric tons) | 0.4 | 5.1 | 0.2 | 2.6 | **10.1** |
| **Natural Gas** **92% Efficient** | 100 MMBTU Energy Source | Not Applicable | 93 | 92 | |
| |  | |  |  | **Total $CO_2$e** |
| $CO_2$ equivalent[2] emissions from typical household use[3] (metric tons) | 0.4 | | 0.1 | 5.5 | **6.0** |

1 Includes all energy inputs, including renewable sources – based on actual fuel mix in 2015
2 Includes greenhouse gas impact from unburned methane
3 Energy consumed in space and water heating, clothes drying, and cooking.
NOTE: This full-fuel-cycle examines all impacts from the energy source through consumption

# Direct Use of Natural Gas Results in 34% Less $CO_2e$

Annual $CO_2$ equivalent* emissions from typical home heating, water heating, cooking, and clothes drying energy uses during the full-fuel-cycle

One Million Homes

## Natural Gas

**Total $CO_2e$**

**6.0 Million Metric Tons/Year**

## Electricity

**Total $CO_2e$**

**10.1 Million Metric Tons/Year**

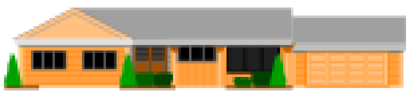
NOTES:

1. Fuels used in electricity generation based on 2015 actual generation mix of fossil fuels, nuclear, and renewable energy

* Includes greenhouse gas impact from unburned methane

# Full-Fuel-Cycle Impacts from Energy Consumption in a Typical Home

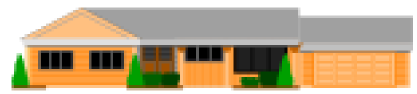
*Electric Home*



*10.0 metric tons $CO_2e$**

Full-Fuel-Cycle Energy Consumption: 151 MMBtu/yr
Site Energy Consumption: 48 MMBtu/yr
**Total Annual Energy Cost: $1,798**

*Natural Gas Home*



*6.0 metric tons $CO_2e$**

Full-Fuel-Cycle Energy Consumption: 102 MMBtu/yr
Site Energy Consumption: 90 MMBtu/yr
**Total Annual Energy Cost: $915**

•Based on a 2,000 square foot home in an average climate, using national average energy prices. Analysis includes the following only: space heating, water heating, cooking, and clothes drying. Home meets 2009 International Energy Conservation Code standards.

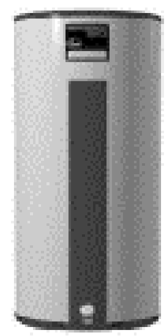
* Includes greenhouse gas impact from unburned methane

# Residential Energy Efficiency Ratings

## Water Heaters

***DOE site-specific energy ratings are misleading.***
*While DOE rates an electric appliance with a more efficient energy rating than a similar gas appliance, in reality that electric appliance consumes more source energy, pollutes more, and costs the consumer more to operate.*

***Environmental Impact: 1.3 million tons of $CO_2e$***
*A 10% market shift in shipments/sales would reduce $CO_2e$ emissions by 1.3 million metric tons per year.*

| | Electric Resistance | Natural Gas |
|---|---|---|
| |  |  |
| DOE NAECA Efficiency Rating [1]: | **.95 EF** | **.86 EF** |
| Full-Fuel-Cycle Energy Consumption (MMBtu/yr): | **49.8** | **26.6** |
| Energy Cost[2]/yr: | **$589** | **$244** |
| $CO_2e$* Emissions (metric tons/unit/yr): | **2.9** | **1.5** |
| Average Installed Cost[4] | **$662** | **$967** |

[1]Energy factors (EF) based on a 40-50 gallon storage water heaters of equivalent first hour rating
[2]Energy Cost is based on 2016 DOE representative average unit costs for energy where electric rate is 12.60 cents/KWh; gas rate is $9.323/MMBtu
4 New installations, from: Preliminary *Technical Support Document: Energy Efficiency Program for Consumer Products*, January 5, 2009
EF=Energy Factor

* Includes greenhouse gas impact from unburned methane

# Residential Energy Efficiency Ratings
## Space Heating

***DOE site-specific energy ratings are misleading.*** *While DOE rates an electric appliance with a more efficient energy rating than a similar gas appliance, in reality that electric appliance consumes more source energy, pollutes more, and costs the consumer more to operate.*

| | Electric Heat Pump | Electric Resistance Furnace | Natural Gas Furnace |
|---|---|---|---|
| |  |  |  |
| DOE NAECA Efficiency Rating: | **7.7 HSPF** | **99 AFUE** | **80 AFUE** |
| Full-Fuel-Cycle Energy Consumption (MMBtu/yr): | **96.8** | **154.8** | **68.3** |
| Energy Cost[1]/year | **$1,046** | **$1,818** | **$601** |
| $CO_2e$* Emissions (metric tons/unit/yr): | **6.4** | **10.3** | **4.01** |

[1]Energy Cost is based on 2016 DOE representative average unit costs for energy where electric rate is 12.60 cents/kWh; gas rate is $9.323/MMBtu
HSPF=Heating Seasonal Performance Factor, AFUE=Annual Fuel Utilization Efficiency

* Includes greenhouse gas impact from unburned methane

# Comparison of Residential Space Heating Appliances

| | Electric Heat Pump | | Electric Resistance Furnace | Natural Gas Furnace | |
|---|---|---|---|---|---|
| DOE/NAECA Efficiency | 7.7 HSPF | 9.0 HSPF | 99 AFUE | 80 AFUE | 94 AFUE |
| Full-Fuel-Cycle Energy Use per Year* | 97 MMBtu | 89 MMBtu | 155 MMBtu | 69 MMBtu | 52 MMBtu |
| $CO_2e$** Emissions/Yr* | 6.4 Metric Tons | 5.9 Metric Tons | 10.3 Metric Tons | 4.0 Metric Tons | 2.6 Metric Tons |
| Equipment Cost*** | $2,720 | $3,975 | $2,800 | $2,855 | $3,895 |

• Excludes A/C operations
** Includes greenhouse gas impact from unburned methane
*** Package price includes cost for air conditioning equipment

# Residential Energy Efficiency Ratings

## Clothes Drying

***DOE site-specific energy ratings are misleading.***
*While DOE rates an electric appliance with a more efficient energy rating than a similar gas appliance, in reality that electric appliance consumes more source energy, pollutes more, and costs the consumer more to operate.*

***Environmental impact: 240,000 tons of $CO_2e$***
*A 10% market shift on shipments/sales would reduce $CO_2e$ emissions by 240,000 tons per year.*

Electric

Natural Gas

| | Electric | Natural Gas |
|---|---|---|
| DOE NAECA Efficiency Rating: | **3.01 EF** | **2.67 EF** |
| Full-Fuel-Cycle Energy Consumption (MMBtu/yr): | **7.3** | **3.0** |
| Energy Cost[1]/yr: | **$86** | **$27** |
| $CO_2e$* Emissions (metric tons/unit/yr): | **0.5** | **0.16** |

[1]Energy Cost is based on 2016 DOE representative average unit costs for energy where electric rate is 12.60 cents/kWh; gas rate is $9.325/MMBtu
EF = Energy Factor

* Includes greenhouse gas impact from unburned methane

# Residential Energy Efficiency Ratings

## Cooking Equipment

***DOE site-specific energy ratings are misleading.***
*While DOE rates an electric appliance with a more efficient energy rating than a similar gas appliance, in reality that electric appliance consumes more source energy, pollutes more, and costs the consumer more to operate.*

***Environmental Impact: 131,000 tons of $CO_2e$***
*A 10% market shift on shipments/sales would reduce $CO_2e$ emissions by 131,000 tons per year.*

| | Electric | Natural Gas |
|---|---|---|
| Energy Factor | **10.9 EF** | **5.8 EF** |
| Full-Fuel-Cycle Energy Consumption (MMBtu/yr): | **5.7** | **3.9** |
| Energy Cost[1]/yr: | **$66** | **$43** |
| $CO_2e$* Emissions (metric tons/unit/yr): | **0.4** | **0.2** |

[1]Energy Cost is based on 2016 DOE representative average unit costs for energy where electric rate is 12.60 cents/kWh; gas rate is $9.323/MMBtu

* Includes greenhouse gas impact from unburned methane