An Overview of Utilization Efficiency Codes and Standards in the United States and Their Potential Impact on the Growth of the Natural Gas Market

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Introduction: With the increased emphasize on global warming, climate change and reductions of greenhouse gas emissions comes more challenges for the natural gas industry to be receptive and responsible in order to maintain and increase the direct use of natural gas. As a fossil fuel, natural gas is often the subject of being attacked and having additional restrictions put on its end use both in home and building applications as well as in equipment and appliance efficiency standards. What will be provided in this paper is an overview of how end use building codes and appliance standards can stifle the growth of the natural gas market that can actually result in negative impacts on the environment and consumers. A primary reason for this belief is a very, basic misunderstanding of how all forms of energy are created, transmitted and distributed leading to policies that result in increasing emissions and total energy consumption vs. reductions that these policies are supposed to make happen.

The two areas that will be discussed in the paper are 1. Energy Efficiency Building Codes and 2. Minimum Efficiency Requirements for Appliances and Equipment. While both areas appear to be quite different, they have one thing in common…….how energy consumption is determined, recorded and reduced. Without the proper technical assessments, energy consumption and emissions may actually increase when the program and policy being implemented is suggesting a decrease. Additionally, consumers may be misinformed or even mislead by energy measurements that don't account for the entire full fuel cycle that takes place from production, transmission and end use.

Energy Efficiency Building Codes

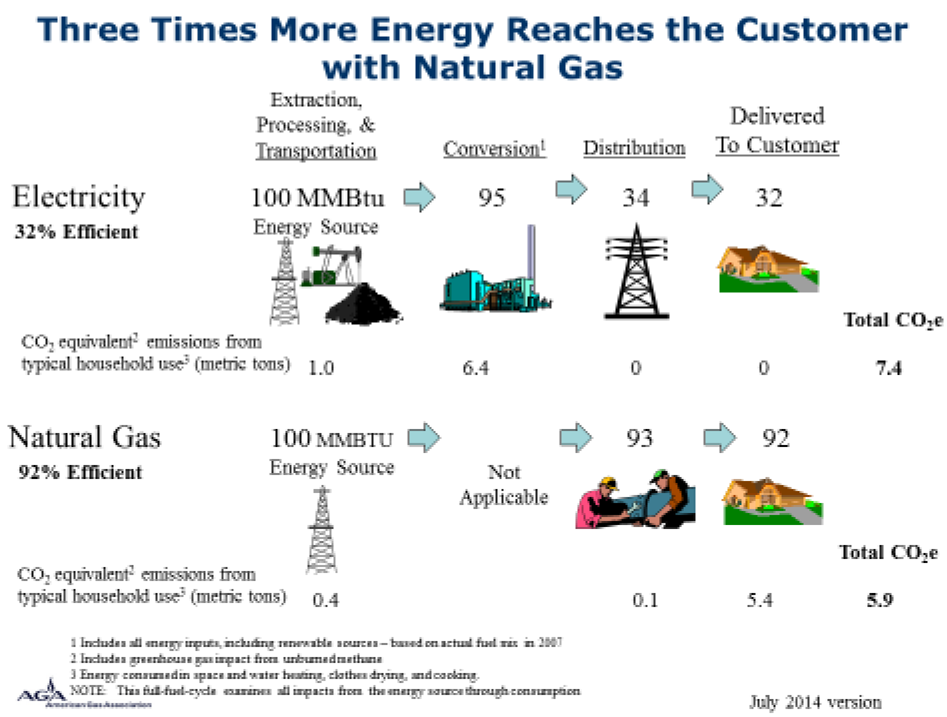
The U.S. does not have a national energy code or standard, so energy codes are adopted at the state and local levels of government. Voluntary Energy Codes are developed by two main trade associations in the United States. Generally, the American Society of Heating Refrigeration and Air Conditioning (ASHRAE) develops commercial building energy efficiency codes. The International Code Council (ICC) along with the National Association of Home Builders (NAHB) develop residential energy efficiency codes. There is some overlap between the commercial and residential development but for simplicity, the breakpoint is ASHRAE develops the commercial code and the ICC develops the residential efficiency code. These codes are typically updated every 3 years and states and jurisdictions are required to review new additions and addendum and adopt them (in whole or in part) if they improve building efficiency and are cost effective in their state. Both the commercial and residential building efficiency codes have 3 or more paths for compliance, prescriptive, performance or cost. The problem for the natural gas industry is that the codes, with the exception of the performance path in the ICC code, are all site based. What this can results in is requirements that place natural gas applications at a disadvantage because compliance with competing energy sources such as electricity appear and actually calculate out as being more "efficient", using less energy and producing less emissions because measurements are based on "site" and don't consider the losses from production, transmission and distribution.

What about United States federal policy regarding using source or site energy consumption metrics? In recent years, federal policy has been very consistent and supportive of using source energy in determining energy consumption and emissions. For example, for its Energy Star Commercial Building program, the US Environmental Protection Agency (EPA) http://www.energystar.gov/buildings has determined that "*source energy* is the most equitable unit of evaluation. EPA states, "Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses. By taking *all* energy use into account, a complete assessment of energy efficiency in a building is provides." S*ite energy*, is the amount of heat and electricity consumed by a building as reflected in the utility bill for the commercial building. Looking at site energy can help understand how the energy use for an individual building has changed over time. Site energy may be delivered to a building in one of two forms: primary or secondary energy. *Primary energy* is the raw fuel that is burned to create heat and electricity, such as natural gas or fuel oil used in onsite generation. *Secondary energy* is the energy product (heat or electricity) created from a raw fuel, such as electricity purchased from the grid or heat received from a district steam system. "A unit of primary and a unit of secondary energy consumed at the site are not directly comparable because one represents a raw fuel while the other represents a converted fuel."

To assess the relative efficiencies of buildings with varying proportions of primary and secondary energy consumption, EPA states that it is necessary to convert these two types of energy into equivalent units of raw fuel consumed to generate that one unit of energy consumed on-site. To achieve this equivalency, EPA uses source energy.

In summary, when primary energy is consumed on site, the conversion to source energy must account for losses that are incurred in the storage, transport, and delivery of fuel to the building. When secondary energy is consumed on site, the conversion must account for losses incurred in the production, transmission, and delivery to the site. The factors used to restate primary and secondary energy in terms of the total equivalent source energy units are called the *source-site* .

The technical arguments used by EPA for using “source” energy” are undeniable. But that has not carried over to the voluntary model energy efficiency building codes that are reluctant to embrace the concept for a number of reasons, some political and others, that suggest the complexity of utilizing source metrics make it less likely to be enforced by local jurisdictions who are required to do so. There continues to be momentum in the direction of source energy measuring metrics for commercial buildings, but the process is slow. Even the “stretch” energy efficiency building codes that are aimed at providing end users with opportunities and methods for building above the base energy codes, while containing more options to using “source” energy metrics, mainly embrace “site” based metrics. Once again, natural gas applications do not get credit for the full benefits it provides in lower emissions of greenhouse gases. Below is an illustration of the “source” vs. “site” issue and how it impacts the end user and the environment.



Appliance and Equipment Energy Efficiency Standards.

Unlike voluntary energy building codes, the United States Department of Energy is charged, by law with the development and enforcement of minimum efficiency standards for a whole host of residential and commercial appliances and equipment. The United States Congress has mandated through various statutes that the Department of Energy (DOE) is to implement energy conservation standards and test procedures for residential products and commercial and industrial equipment. DOE has published regulations in the Code of Federal Regulations for more than 50 categories of appliance and equipment types. These regulations apply to natural gas, electric and oil appliances and equipment.

The authority to develop, revise, and implement minimum energy conservation standards for appliances and equipment was established by Congress in Part B of Title III of the Energy Policy and Conservation Act (EPCA), Public Law 94-163, as amended by the:

- National Energy Conservation Policy Act, Public Law (P.L.) 95-619;
- National Appliance Energy Conservation Act, P.L. 100-12;
- National Appliance Energy Conservation Amendments of 1988, P.L. 100-357;
- **Energy Policy Act of 1992, P.L. 102-486**;
- **Energy Policy Act of 2005**, P.L. 109-58 (EPACT 2005); and the
- **Energy Independence and Security Act of 2007**, P.L. 110-140 (EISA 2007).

These laws are codified in the United States Code, Title 42, Chapter 77, Subchapter III, **Part A—Energy Conservation Program for Consumer Products Other Than Automobiles** and **Part A-1—Certain Industrial Equipment**. Regulations are issued by executive branch agencies to carry out federal laws and are available in the Code of Federal Regulations.

The legislation passed that gives the DOE authority and responsibility to develop and enforce minimum efficiency requirements for appliances and equipment is very important to understand because it goes right to the issue of site and source metrics. Specifically, the original legislation passed in 1978 requires that efficiency determinations must be made at the "point of use" that puts natural gas appliances and equipment at a disadvantage since it is required to be "site" based. This means that the ratings, minimum efficiency levels, and appliance labeling schemes do not provide recognition for the benefits of the "direct use" of natural gas and skew the efficiency ratings for other energy sources such as electricity. This occurs because the rating of those appliances and equipment are at a higher level then competing products such as central furnaces, water heaters, clothes dryers and cooking ranges. In short, electric appliances receive a higher efficiency ratings than comparable natural gas appliance despite emitting more greenhouse gas emissions and using more total energy. The following is an illustration of the distortion that "site" based efficiency metrics on comparing gas and electric furnaces, water heaters, clothes dryers and cooking ranges.

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):	**96.5**	**155.8**	**68.3**
Energy Cost[2]/year	**\$1,119**	**\$1,806**	**\$714**
CO_2e* Emissions (metric tons/unit/yr):	**5.47**	**8.83**	**3.97**

[2]Energy Cost is based on 2014 DOE representative average unit costs for energy where electric rate is 12.40 cents/kWh; gas rate is \$11.28/MMBtu
HSPF=Heating Seasonal Performance Factor, AFUE=Annual Fuel Utilization Efficiency

* Includes greenhouse gas impact from unburned methane

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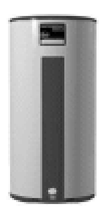
Residential Energy Efficiency Ratings
Water Heaters

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):	**49.7**	**26.5**
Energy Cost[2]/yr :	**\$576**	**\$275**
CO_2e* Emissions (metric tons/unit/yr):	**2.8**	**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 2014 DOE representative average unit costs for energy where electric rate is 12.40 cents/kWh; gas rate is \$11.28/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

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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*	96 MMBtu	89 MMBtu	156 MMBtu	68 MMBtu	52 MMBtu
CO_2e** Emissions/Yr*	5.5 Metric Tons	5.0 Metric Tons	8.8 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:	**$81**	**$29.5**
CO_2e* Emissions (metric tons/unit/yr):	**0.4**	**0.16**

[1]Energy Cost is based on 2014 DOE representative average unit costs for energy where electric rate is 12.40 cents/kWh; gas rate is $11.28/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**	**3.8**
Energy Cost[1]/yr:	**$63**	**$39**
CO_2e* Emissions (metric tons/unit/yr):	**0.3**	**0.2**

[1] Energy Cost is based on 2014 DOE representative average unit costs for energy where electric rate is 12.40 cents/kWh; gas rate is $11.28/MMBtu

* Includes greenhouse gas impact from unburned methane

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Summary

As the United States develops policy, legislation and regulations on federal buildings and homes, as well as appliances and equipment, it is crucial that the process include technical sound and correct energy consumption and emissions information. If not, natural gas applications will be disadvantages and not obtain the recognition they should be given as a clean burning, economic and abundant energy source. The United States federal government is making progress with recognizing "source" energy metrics but more need to be done to propel the increased use and benefits to consumers and the environment for the direct use of "natural gas".