"PUBLIC POLICY AND REAL ENERGY EFFICIENCY"

Executive Summary

Attention is often focused on U.S. energy consumption and its long-term impact on the economic and environmental health of the nation. Many policy initiatives have been directed toward conservation of energy in our homes, appliances, buildings, factories, and vehicles. However, most of these measures target reductions in energy demand at the point of use without specifically addressing overall efficiency or relative emissions that result from the processes required to provide energy to the customer.

Energy efficiency measures the amount of energy consumed in a process relative to the output derived from that process. Three methods of measuring energy efficiency are examined in this report:

- **Site Energy** examines only those impacts that occur at the site of the customer's energy use. For example, an electric water heater efficiency rating is approximately 93% on a site basis, indicating that almost all of the energy delivered to the appliance actually heats water and only about 7% of the energy is lost or wasted.

- **Real Energy** (also known as source, primary, and full fuel-cycle) examines all the impacts of consumer energy use, including those impacts from obtaining, processing, generating, and delivering energy. These processes result in additional energy use\loss and environmental impacts. For example, the electric water heater cited above may be 93% efficient at the site, but a more complete examination of the full fuel-cycle impacts reveals that its real energy efficiency is only 25%. This difference is due to the inclusion of energy lost or consumed in processes required to convert fossil fuel to electricity and to deliver that electricity to customers.

- **Energy Cost** focuses on the amount paid by the consumer for using energy. This approach is founded on the premise that higher consumer costs can be equated with lower efficiency and, conversely, lower consumer cost can be equated with higher efficiency.

PURPOSE OF THIS REPORT

In an effort to assess the effects of Federal energy efficiency statutes, programs, and policies on energy consumption and the environment, this report:

- Reviews the treatment of energy efficiency in current and proposed energy policies

- Analyzes the reasonableness of using **Energy Cost** as a surrogate for energy efficiency

- Estimates the potential benefits of using the **Real Energy** (site plus all upstream energy consumption) approach for selected energy policies

- Estimates market share distortions for end-use equipment from policies based on **Site Energy** efficiency and potential market shifts from utilizing the **Real Energy** approach for these policies

- Identifies barriers to implementation of the **Real Energy** efficiency approach

- Selects candidate programs that would benefit from the **Real Energy** approach

MAJOR FINDINGS

- **Real Energy** analysis is the best method for measuring energy efficiency and the impacts of energy consumption on the environment. While **Energy Cost** analysis at times can be an acceptable alternative, regional pricing variations and non-cost based utility pricing structures impair the accuracy of this approach.

- Most federal energy efficiency policies use **Site Energy** as their criteria. As a result, many federal energy efficiency policies actually encourage the use of less efficient applications. Not only does this result in higher total energy consumption, it increases total pollution. The activities associated with providing energy to the customer, particularly electricity generation and transportation, often emit substantial amounts of CO_2 and other gasses associated with global warming.

- Modifying a number of current and proposed efficiency policies that utilize **Site Energy** criteria to incorporate a **Real Energy** efficiency approach could cause market shifts away from less overall efficient technologies. This is particularly true if policies promoted more efficient electric and gas technologies compared to electric resistance applications. At a minimum, these energy policies could utilize a combination of the approaches, similar to the Federal Energy Management Program (FEMP) policy for analyzing government energy efficiency projects. FEMP requires government agencies to choose the lowest life cycle cost option while reducing **Site Energy** use per square foot, and any increases in site energy use can be offset by decreases in **Real Energy** use.

- Numerous barriers impede federal policy use of **Real Energy** efficiency standards. Political and legal barriers pose the greatest challenges to changing the policies. Market and technical barriers could be more easily overcome with sufficient education and resources.

COMPARISON OF ENERGY EFFICIENCY MEASUREMENT OPTIONS

While easy to use and understand, **Site Energy** analysis is often misleading as it ignores impacts that occur before energy is delivered to the customer. These upstream activities include a variety of processes. In order for a customer to use energy, fuels must be extracted, processed, transported to central sites, often converted to alternate forms of energy , and delivered to the customer. Energy is consumed\lost and environmental impacts are realized at each of these points.

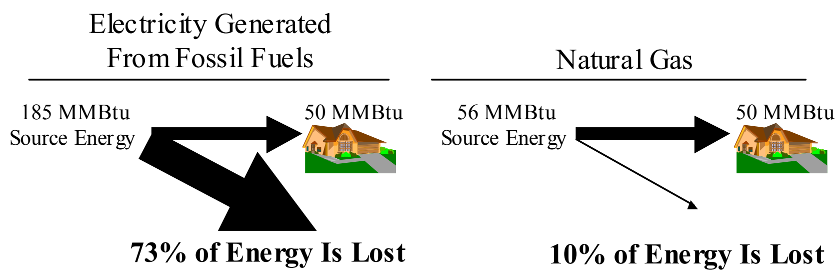
Using **Energy Cost** as an efficiency surrogate captures some of the impacts that are ignored in the site analysis. Each of the processes along the energy chain entails costs, which are included in the ultimate price to the consumer. While the **Energy Cost** approach is superior to simple **Site Energy** analysis, the **Energy Cost** method has deficiencies. First, cost may not account for all environmental impacts of energy use. Consumer costs reflect only the cost of pollution that is actually controlled, but not the societal costs of uncontrolled pollution. Second, most energy pricing structures do not reflect the true cost of providing energy to the consumer, particularly for seasonal and time of day fluctuations, thus sending imprecise signals to the customer.

The **Real Energy** approach, while less simple, provides the most accurate ranking of energy consumption impacts. The analyst must obtain data and perform calculations for determining the impacts from all the processes involved in providing energy to the customer. The results provide the most comprehensive analysis of energy resource use and impact on the environment of the three options.

The figure below illustrates the real energy efficiency difference between electricity and natural gas[1], from the point of production up to, but not including, the efficiency of the appliance.

Real Energy Efficiency

Total Energy Required to Deliver 50 MMBtu to a Customer



Energy losses occur through extraction, processing, generation, and delivery of energy in its final form.
Source: Based on data from *A Comparison of Carbon Dioxide Emissions Attributable to New Natural Gas and All-Electric Homes,* American Gas Association, October 31, 1990.

Further, the relative advantages of the **Site Energy**, **Real Energy**, and **Energy Cost** approaches are outlined as follows:

Advantages of Energy Efficiency Measurement Systems

Site Energy	Real Energy	Energy Cost
Historical precedence	More complete picture of energy resource use	Influences consumer actions
Easily understood	Accounts for regional fuel mix and price variations	Easily understood & measured for simple pricing structures
Easily measured	Best measurement of societal impacts (e.g., pollution)	May be a reasonable substitute for real energy analysis

[1] While this report may refer to natural gas in previous case studies and analyses, it should be noted that the use of propane in these examples should result in very similar conclusions regarding real energy efficiency and environmental impacts.

Examining three residential space-heating options – electric resistance furnace, electric heat pump, and a gas furnace – the table below further illustrates the differences in the approaches. Based on a **Site Energy** analysis, the electric options are 26% to 151% more efficient than the gas furnace. Using an **Energy Cos**t basis, the electric heat pump has a 2% advantage over the gas furnace and a 27% advantage over the resistance furnace. However, employing a **Real Energy** efficiency basis, the gas furnace uses 4% to 52% less overall energy than the electric options. Further, whereas the **Site Energy** analysis implies that the electric options are "cleaner" than the gas option, the **Real Energy** efficiency analysis shows that the gas option actually results in far fewer emissions.

A Comparison of Energy Efficiency Approaches for Residential Space Heating

Space Heating Technology	Energy Use (MMBtu/yr)		Total Emissions (lbs/yr)		Annual Energy Cost
	Site Energy	Real Energy	Site Energy	Real Energy	
Electric Resistance Furnace	50.5	139.1	0	20,345	$1,362
Electric Heat Pump	25.3	70.3	0	10,253	$989
Natural Gas Furnace	63.5	67.2	7,001	7,409	$1,013

Data Source: Savings and emissions analysis of the New Energy Efficient Home Credit. Electric technologies reflect impact of power plant energy consumption (coal, nuclear, hydro, natural gas, etc.) based on the fuel mix of the area analyzed. Refer to Section 3.2.1 for more details.

FEDERAL ENERGY EFFICIENCY POLICIES ANALYSIS

Federal energy efficiency policies primarily use **Site Energy** when determining efficiency. This is particularly true for those policies that have a significant impact on energy use (e.g., appliance standards). The **Energy Cost** approach is used to a lesser extent, mainly for tax credits and building envelope efficiency. Very few federal energy policies include **Real Energy** as a part of their evaluation process, such as building efficiency ratings and federal facility projects. In some instances, energy policies require that more than one method be used -- for example, the FEMP requirement on federal building efficiency uses **Energy Cost** and **Site Energ**y as the primary criteria, but **Real Energy** efficiency gains can be used to offset increases in **Site Energ**y use in the selection process. Even when analyses at least address the implications that arise from a **Real Energy** approach, the programs do not always prioritize or undertake activities to maximize **Real Energy** efficiency.

POTENTIAL BENEFITS FROM USING REAL ENERGY EFFICIENCY IN FEDERAL POLICIES

Based on analyses of selected policies, the **Real Energy** approach could promote more efficient technologies over less efficient options.. Most energy policies, such as proposed efficiency tax credits and the National Appliance Energy Conservation Act (NAECA), are intended to be "technology/fuel neutral" – that is, they do not seek to promote one fuel or technology system over another; however, because of the use of a misleading measurement using **Site Energy**, actually biases decisions in favor of inefficient fuel uses. **Real Energy** analysis shows that significant national efficiency and environmental benefits could be obtained from these programs by encouraging more overall efficient technologies.

The **Site Energ**y approach has caused market shifts away from more energy efficient technologies, thus increasing relative energy use, consumer costs, and emissions. Examples of such policies include:

- The Department of Energy increased the minimum efficiency of commercial gas water heaters in both 1994 and 2002, while relaxing the standards for electric resistance applications in 1999. These higher standards caused gas water heaters to increase in price, particularly in relation to electric resistance units. Since the late 1990's, electric resistance water heaters have gained market share at the expense of the more efficient (on a **Real Energ**y efficiency basis) gas units. Thus, these standards have contributed to increased energy consumption, higher consumer costs, and higher levels of pollution.

- The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) proposed a building energy envelope guideline in 1996 that differentiated between buildings using electric resistance technologies and other technologies. This dual envelope standard was then supplemented by a blended envelope standard that did not differentiate among technologies. A report by Optima Consulting Services (Optima 1997) concluded that the blended envelope approach increased overall **Real Energy** consumption by 5% and increased overall **Energy Costs** by 10% relative to the dual-envelope approach.

POTENTIAL BARRIERS TO IMPLEMENTATION OF REAL ENERGY EFFICIENCY STANDARDS

Political and legal barriers pose the greatest impediments to improving energy efficiency policies. Examples include:

- Current federal law (42 USC 6291(4)) defines energy use as, "…the quantity of energy directly consumed by a consumer product at point of use…" This statute would have to be amended in order for most government policies to utilize a **Real Energy** efficiency approach.

- The federal government has adopted a "fuel neutral" approach that discourages inter-fuel comparisons in many efficiency rulemakings. This approach can promote inefficient technologies that were originally supported by **Site Energy** analysis.

- Many stakeholders (utilities, environmental and efficiency proponents, appliance manufacturers, legislators and regulators, builders, and consumers) influence energy policy. The goals of these stakeholders often conflict, intentionally or unintentionally, with **Real Energy** efficiency.

- Stakeholders who assert that particular energy policies and regulations are discriminatory often resort to legal actions to halt or alter such policies. Even when the policies are upheld, those legal actions can significantly delay implementation.

Market and technical barriers also impede the promotion of energy efficiency. Examples include:

- Builders that make appliance decisions for new construction generally favor lower equipment costs options. These low first-cost options also tend to be less attractive from an energy efficiency perspective.
- Energy consumers and policy makers are generally poorly educated with respect to the options and impacts related to energy efficiency decisions.

PROGRAMS AND POLICIES THAT WOULD BENEFIT FROM A REAL ENERGY APPROACH

While recent energy efficiency tax incentives focus on improving efficiency within a particular heating and cooling system, incentives to switch from less efficient electric resistance technologies would offer greater potential benefits. Policies based on **Real Energy** efficiency would encourage homeowners to switch from electric resistance appliances to heat pumps or efficient fossil fuel technologies, thereby reducing overall energy consumption and pollution.

ASHRAE developed the Advanced Energy Design Guide, with the goal of reducing office building **Site Energy** consumption by 30%. However, the guide results in only a 25% reduction in overall energy use and a reduction of only 10% in overall pollution because the guide does not target energy savings from electric furnaces and boilers. The design guides miss a significant potential efficiency gain by not promoting more efficient fossil fuel and heat pump technologies.

The Department of Energy and the Federal Trade Commission regulate the new appliance labels that estimate an appliance's **Site Energy** use and **Energy Cost**. This EnergyGuide label also compares the product's **Site Energy** use to similar models. The EnergyGuide program examines each fuel type separately. Labels based on the **Real Energy** efficiency concept would allow consumers to better compare appliances using differing fuels and technologies in terms of overall energy consumption and environmental impact.

Weighting factors have been introduced in recent legislation for dual-fuel and alternative fuel vehicles to account for the societal benefits of reducing our dependence on foreign energy supplies. However, these weighting factors do not take full fuel-cycle issues fully into account. For example, there have been numerous studies that call into question the full fuel cycle efficiency of ethanol-derived fuels. In terms of energy output compared with energy input for ethanol production, a recent study (Pimentel 2005) found that ethanol requires anywhere from 29% to 57% more fossil energy than the fuel produced depending on the feedstock used.

FEDERAL POLICY RECOGNITION OF IMPORTANCE OF REAL ENERGY APPROACH

The Energy Policy Act of 2005 (EPACT 2005), which was passed by Congress in July 2005 and signed into law by President George W. Bush on August 8, 2005 includes a provision (Section 1802) that requires the Secretary of the Department of Energy to contract the National Academy of Sciences (NAS) to "examine whether the goals of energy efficiency standards are best served by measurement of energy consumed, and efficiency improvements, at the actual site of energy consumption, or through the full fuel cycle, beginning at the source of energy production." Since the objective of this American Gas Foundation (AGF) study closely coincides with the expressed objectives in EPACT2005, it is envisioned that this AGF study can serve as a strong "foundation" for NAS in the development of their study by providing an independent, comprehensive overview of the energy efficiency measurement and policy issues.