# Total Energy and Emissions Perspective for Utility Energy Efficiency Initiatives

*Bob Stolarski, Director Customer Energy Management, Puget Sound Energy, Seattle, Wa.*
*Mary Smith, Senior Manager Energy Efficiency, Snohomish County Public Utility District, Everett, Wa.*
*Craig McDonald, Managing Director, Navigant Consulting, Philadelphia, Pa.*
*Jose Luis Contreras, Associate Director, Navigant Consulting, San Diego, Ca.*

## ABSTRACT

As utilities accelerate their energy efficiency programs as part of their integrated resource strategy and greenhouse gas reduction efforts, a combined total energy, environmental and economic perspective may be required. For a utility with aggressive goals for acquiring energy efficiency goals, do fuel conversions from electricity to gas provide net environmental, economic and energy benefits? This paper examines the thriple bottom line – energy, economic and environmental – case for fuel conversion programs as a part of an integrated, comprehensive energy efficiency effort.

Puget Sound Energy's (PSE') IRP, completed spring '07, determined that fuel conversion of end-use heating loads from electricity to natural gas, in those parts of its service area where PSE provides both gas and electricity, can contribute to meeting part of the utility's electric generation needs, in much the same way that energy efficiency programs do. An important consideration is the extent that burning natural gas 'on location' in a high-efficiency furnace (or boiler) is more efficient than using it to generate electricity and then delivering the electricity to the end-user for space heating. Thus, less CO2 emitted. But is this the case when heat pumps are used? Specifically, is it the case if the heat pump relies on electric resistance for back-up heating? What about 'hybrid' systems, which rely on natural gas for backup instead?

PSE, assisted by Navigant Consultant, developed a comprehensive energy, environmental, and economic scorecard approach to evaluate natural gas end-use energy efficiency strategy options. Noting the competing issues, the analysis approach was developed to look at impacts from multiple perspectives: total energy usage; economics including the end-use consumer (participating customer, gas ratepayers, and electric ratepayers), the utility (energy savings as a resource): and the environment (net CO2 impacts). To deal with the number of interrelated variables, certain assumptions are made. The result includes expanding gas efficiency programs and targeted conversions using a menu of options, based on the individual consumer's needs and wants in the future.

## Introduction & Background

PSE took a comprehensive view to gas energy efficiency strategy designed to maximize total energy, economic and environmental benefits to all of its stakeholders. PSE's gas energy efficiency strategy analysis was driven by the following considerations:

- PSE's IRP shows significant resource acquisition needs
- PSE's IRP indicates the vast majority of future incremental electricity generation will likely come from natural gas combined cycle plants
- The policy at PSE about conversions and direct use of gas is responsive only
- Acceleration of gas EE programs is desirable and difficult
- Efficiency is typically lowest cost, most environmentally friendly resource

- Customers are seeking advice regarding greenhouse gas footprint
- PSE thinks that's there may be net energy and environmental benefits of encouraging direct use of gas
- Some operations processes and policies may be impeding customers selecting the most resource efficient energy source

From a comprehensive analysis of the energy, economic, and environmental impacts, PSE identified a gas-energy efficiency initiative that included gas conversions, as well as accelerated gas energy efficiency programs. The key elements of this initiative included the following:

- The initiative objective is to optimize customers' end-use energy consumption while furthering corporate and customer, financial, environmental, and social responsibilities.
- The initiative provides both financially and environmentally responsible recommendations for development and/or refinement of:
    - Energy efficiency offerings
    - Fuel conversions
- Addresses issues relating to operational practices, customer and internal communications, and regulatory and public policies.

This paper focuses mostly upon the analysis of net benefits of gas conversions, because this is the unusual part of the initiative. But, the conversions are only one element of a comprehensive strategy to promote gas efficiency. In fact, leadership in promoting gas energy efficiency is the essential foundation for any conversion effort.

Subsequent to the completion of this analysis, one of the authors went to work at Snohomish County Public District. This framework is now being used to assess the net benefits of using gas as an energy efficiency strategy for an all-electric utility where gas-fired generation is not the marginal resource.

## Gas Energy Efficiency Initiative

The gas energy efficiency initiative was developed based upon the following objective and ambition:

- Aggressively develop all cost-effective gas efficiency programs and direct use of gas opportunities to improve total resource efficiency[1] while minimizing customer energy related costs and environmental footprint

    - Expand gas EE programs
    - Build highly energy efficient new construction
    - Encourage efficient direct end-use of gas
    - Improve utilization of underutilized assets
    - Focus on total energy resource efficiency / fuel neutral

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[1] Total resource efficiency is defined as meeting customer energy needs with the optimal energy resource (electricity or gas) from a total energy perspective (BTUs).

As part of this initiative, five strategic options were developed, each with its own, complimentary ambitions, summarized in Table 1.

**Table 1.** Gas Energy Efficiency Strategic Options

| Strategic Options | Description | Ambition |
|---|---|---|
| Advanced EE | Aggressively advance end-use gas efficiency through marketing efforts, innovative efficiency programs, and emerging technologies | •Develop the achievable potential identified in the IRP: a total of 7.3 million Dth by 2027, for an annual average acquisition of approximately 365,000 Dth/year<br>•Achieve 40% penetration of premium efficiency in new construction (Energy Star ≥ level 4, Built Green ≥ gold) |
| Direct Use Conversions | Aggressively convert end-uses in in-fill and existing customers to high-efficiency direct use of gas for heating applications through marketing, direct support and collaboration with trade allies | Aggressively convert single family homes, multifamily buildings with wood-frame construction, and commercial facilities on gas mains; goal is to convert 10,000 units per year, for the next five years, with 90% use of high efficiency equipment. |
| Direct Use in New Construction | Aggressively promote advancement of gas direct-use for heating applications in new construction through incentives and collaboration with developers | Advance multifamily penetration rate to a level similar to single family (90% where gas is available). Achieve a similar penetration rate for gas range and dryer (if available) as for space and water heating |
| Main Extension | Aggressively extend gas main infrastructure for customers on or close to main. In addition, identify opportunities to expand service into new areas. | Capture 5% of single family existing customers that require short main extension and 1% of single family existing customers that require long main extension, each year for 10 years |
| Combined Heat and Power | Promote combined heat and power to capture overall efficiency gains where attractive, perhaps with new business model | Support CHP where it is economic. Pilot CHP and continue to refine market focus. Monitor economics for possible expansion. |

## Analytics

A comprehensive framework and approach was required to determine the net benefits of specific gas efficiency and conversions strategies to address the key questions, including:

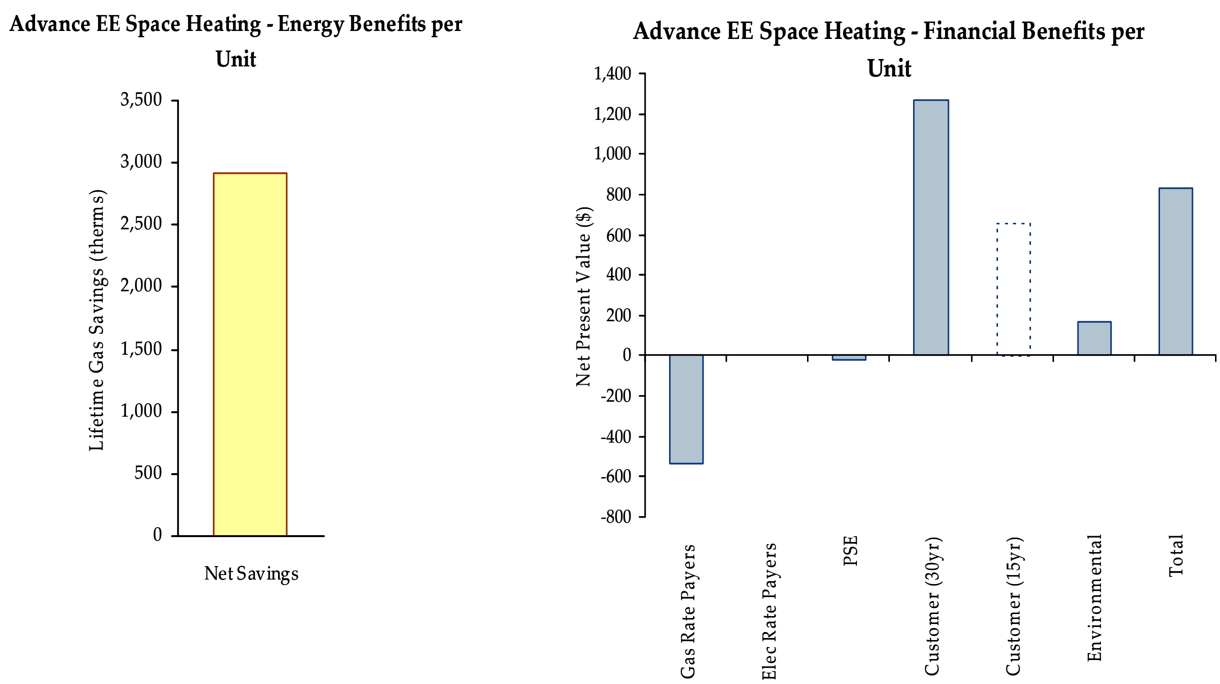
- What are the net energy savings (total BTUs) of efficient direct use of gas compared to efficient use of electricity for space and water heating?
- What are the net financial benefits of gas energy efficiency and conversion programs to the:
  - Participating customer
  - Other gas customers
  - PSE electric customers
  - PSE owners
  - Other stakeholders (as applicable, e.g. builders)?
- What are the net impacts upon greenhouse gas (GHG) emissions?

A model was developed that analyzed the financial, BTu, and GHG impacts of gas efficiency and conversion options. The model included annual cash flows from the perspective of each class of customer (participating, other gas, and electric) as well as for PSE owners. The model derived cash flows, rate and bill impacts based upon PSE cost-recovery mechanisms and planned rate cases.

There were two essential elements in developing this analysis. The first was to ensure that the net cash flows to each stakeholder were captured. In that way, one can determine where current policies may result in sub-optimal programs. Second, people from all major departments, including gas operations, electric, energy efficiency, integrated resource planning, gas supply, rates, and finance were actively engaged in the development and implementation of the analytical framework, assumptions and data. This was necessary to ensure alignment and support of the analytical results.

## Results

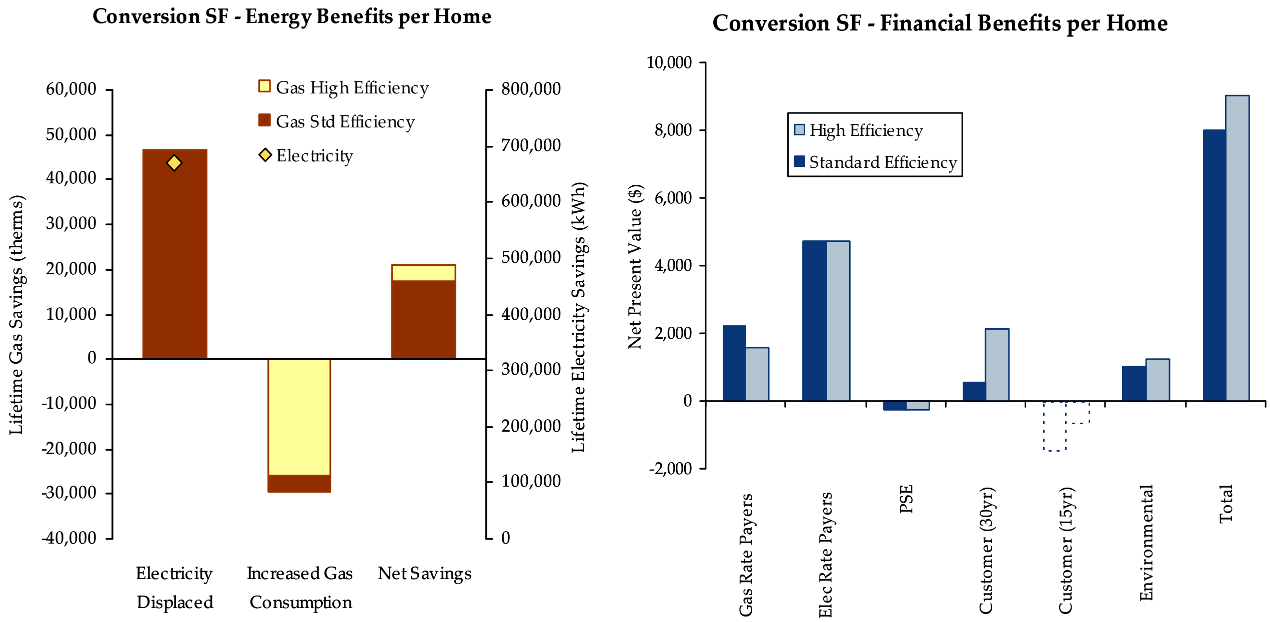
First, energy benefits, and financial impacts were calculated individually for various energy efficiency and conversions options and market segments. Figure 1 illustrates the calculations for replacing a standard efficiency gas furnace with high efficiency gas furnace. No surprises, the participating customer benefits, there are net economic benefits, and non-participating gas customers (gas ratepayers) incur some cost. This illustrates the analysis and perspectives that were evaluated.




Notes: Assumes 2,500 sqft single family existing home with gas service, with current space heating load of 722 therms/yr, in need to replace broken down std efficiency furnace (78%) with high efficiency furnace (90%). 30 year timeframe for all stakeholders. 15 year customer timeframe shown for comparison purposes but not included in total. $CO_2$ emissions valued at $10/ton.

**Figure 1**. Net Energy and Economic Impacts for High Efficiency Gas Furnace Upgrade

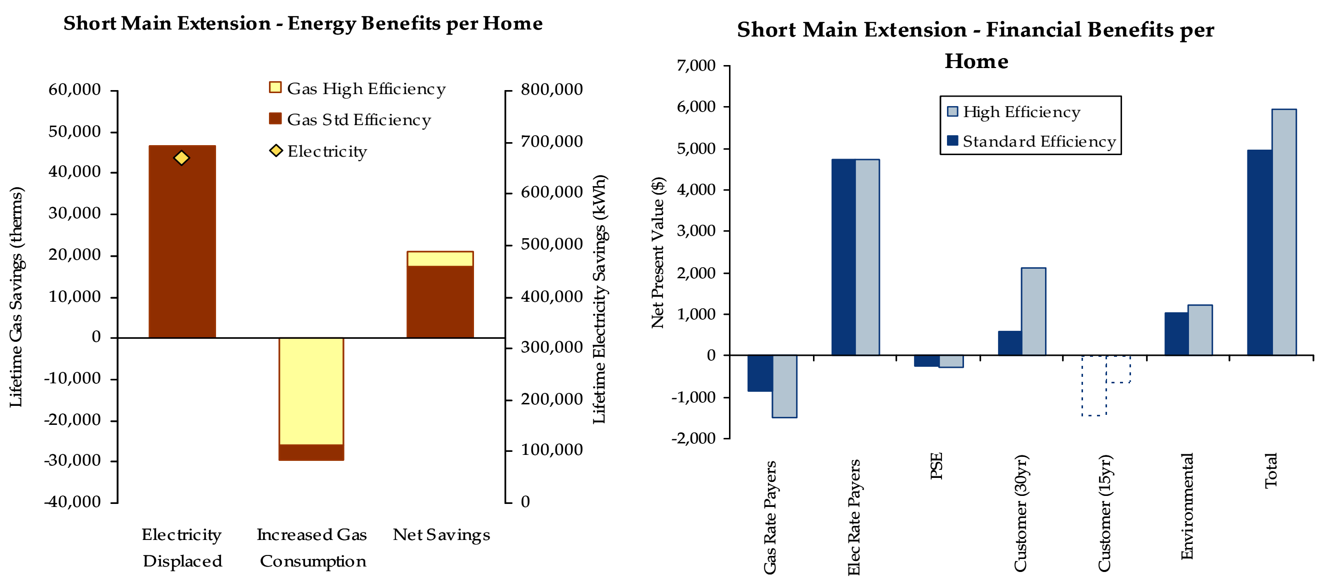
Conversion of electric to gas space produces substantial net energy and economic benefits, as shown in figure 2. PSE is the only stakeholder who loses when a conversion occurs. This is due to the two year lag between the time that PSE incurs the costs and when the costs are incorporated in the rates. This small loss could be reduced or eliminated by a prospective cost-recovery or performance incentive mechanism. The environmental benefit shown is based on valuing Co2 emission reductions at $10/ton.




Notes: Assumes 2,500 sqft single family existing home with current space heating central forced air electric load of 16,500 kWh and water heating load of 4,300 kWh. Assumes new gas service on main, replace functioning electric space and water heating with standard or highly efficient gas furnace (78% or 90%) and water heater (.59 or .64). All main service installation costs covered by gas ratepayers. 30 year timeframe for all stakeholders. 15 year customer timeframe shown for comparison purposes but not included in total. $CO_2$ emissions valued at $10/ton.

**Figure 2**. Energy and Financial Impacts for Conversion of Single Family Home to Gas

Even extending mains a short distance to support a conversion, produces net benefits, although under current cost-recovery and rate-making practices, the gas rate payers, as well as PSE, incur a loss, as shown in Figure 3, due to the cost of extending the main..




Notes: Assumes 2,500 sqft single family existing home with current space heating electric load of 16,500 kWh and water heating load of 4,300 kWh. Assumes new individual gas service 75 feet from main, replace functioning electric space and water heating with standard or highly efficient gas furnace (78% or 90%) and water heater (.59 or .64). All main extension and service installation costs covered by gas ratepayers. 30 year timeframe for all stakeholders. 15 year customer timeframe shown for comparison purposes but not included in total. $CO_2$ emissions valued at $10/ton.

**Figure 3**. Energy and Financial Impacts for Conversion with a Short Main Extension

A broad range of gas efficiency and conversion options and market segments were evaluated, similarly to the two previous examples. Both gas efficiency and conversion measures produced lifetime energy savings. Conversions produced significantly greater savings than simple upgrades of existing gas appliances, primarily due to the differences in efficiency of burning gas in an end-use appliance as opposed to using it to generate electricity[2]. Figure 4 summarizes the lifetime energy savings for different types of efficiency and conversion measures (per customer).

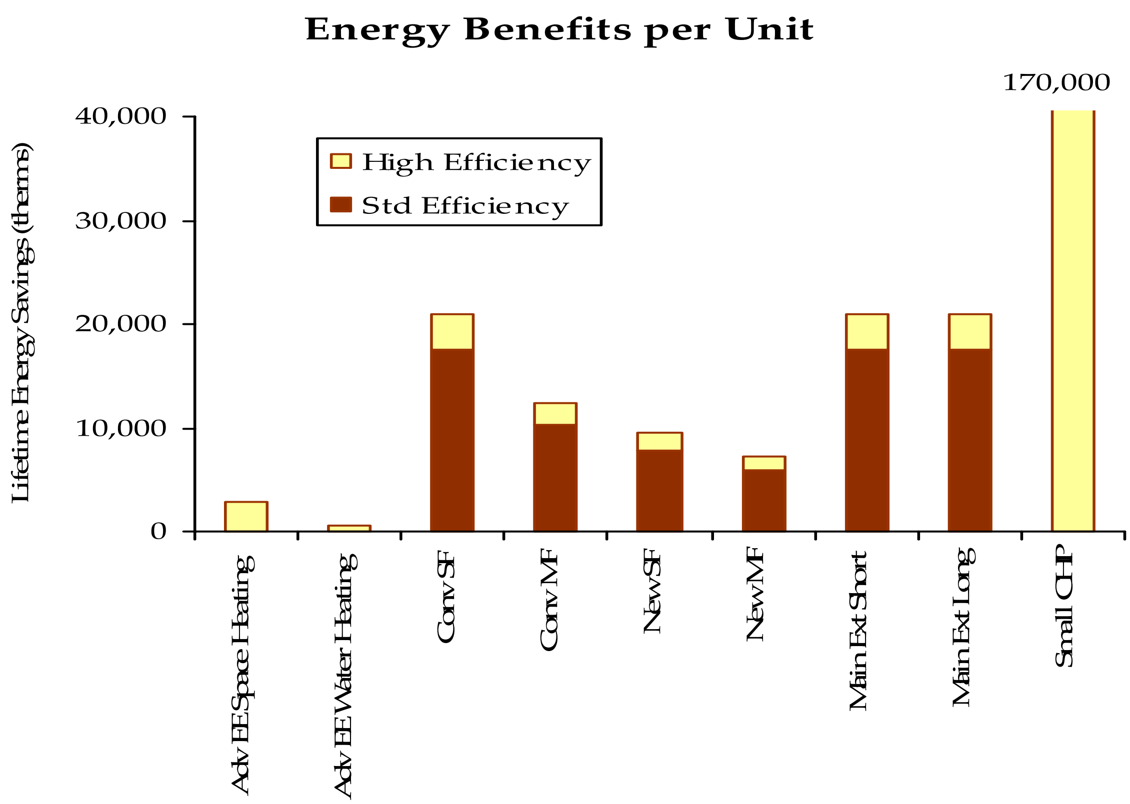



**Figure 4**. Energy Benefits for different Gas Efficiency and Conversion Options

The net environmental impacts, measured as reduction in GHG, closely parallel the net energy benefits since, for PSE, the marginal source of electricity in gas-fired generation, as shown in Figure 5.

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[2] The lifetime savings figures include generations, transmissions and distribution losses both within the electric and the gas systems.

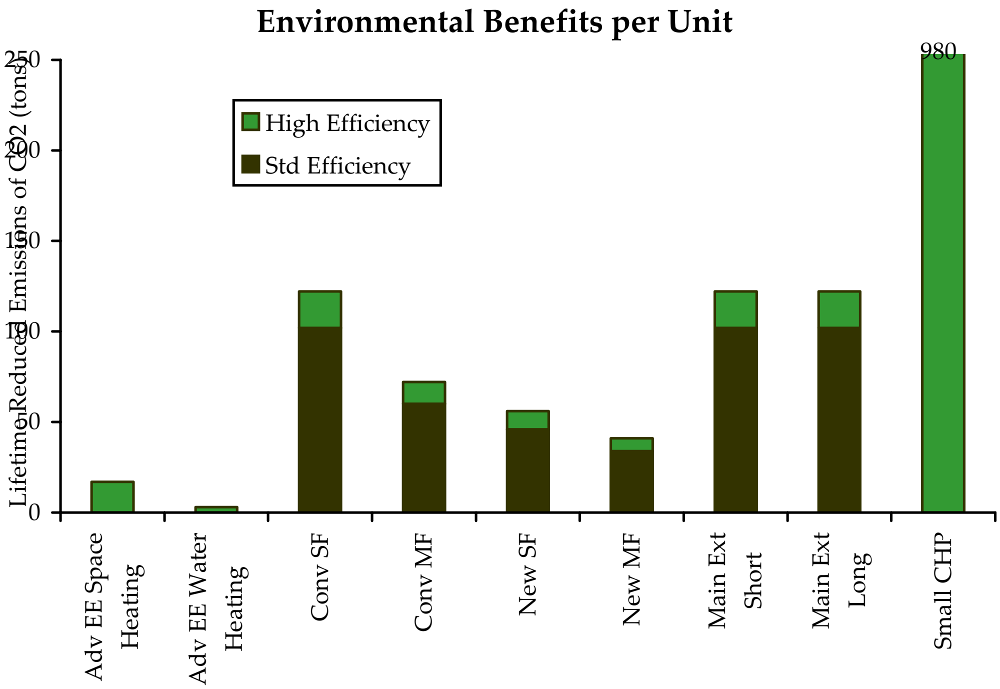
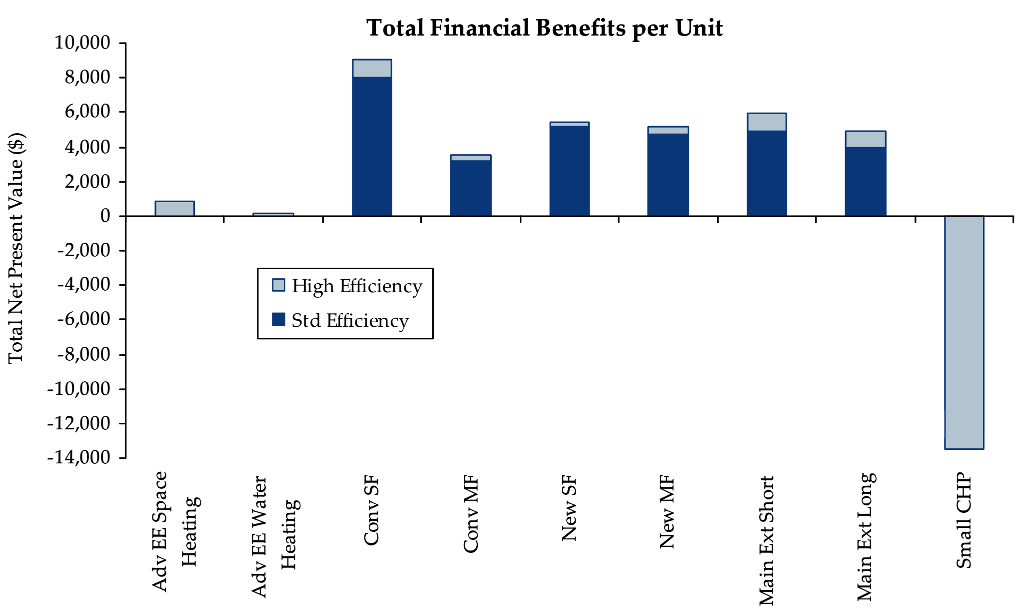



**Figure 5.** GHG Impacts for Different Gas Efficiency and Conversion Options

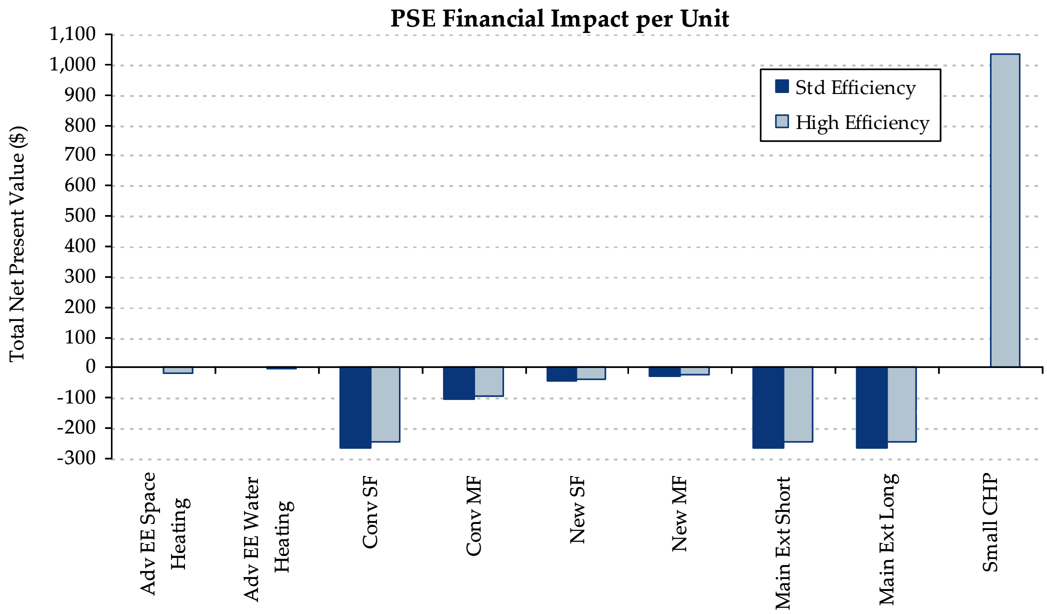
All measures, except small combined heat and power (CHP), provided net financial benefits (Figure 6). In the case of small CHP, the high capital costs of the machines, as well as the linkage between avoided costs for marginal electricity (gas, combined cycle) and the costs of gas results in net losses. If CO2 reductions were valued at more than $50/ton, then the small CHP would start producing net benefits. Larger CHP plants, which have scale economies and, often high efficiencies were not evaluated as part of this effort.




Note: Total Net Present Value considers the cash flows to all key stakeholders: PSE shareholders, gas ratepayers, electric ratepayers, customers and developers.

**Figure 6.** Total Financial Benefit for Gas Efficiency and Conversion Options

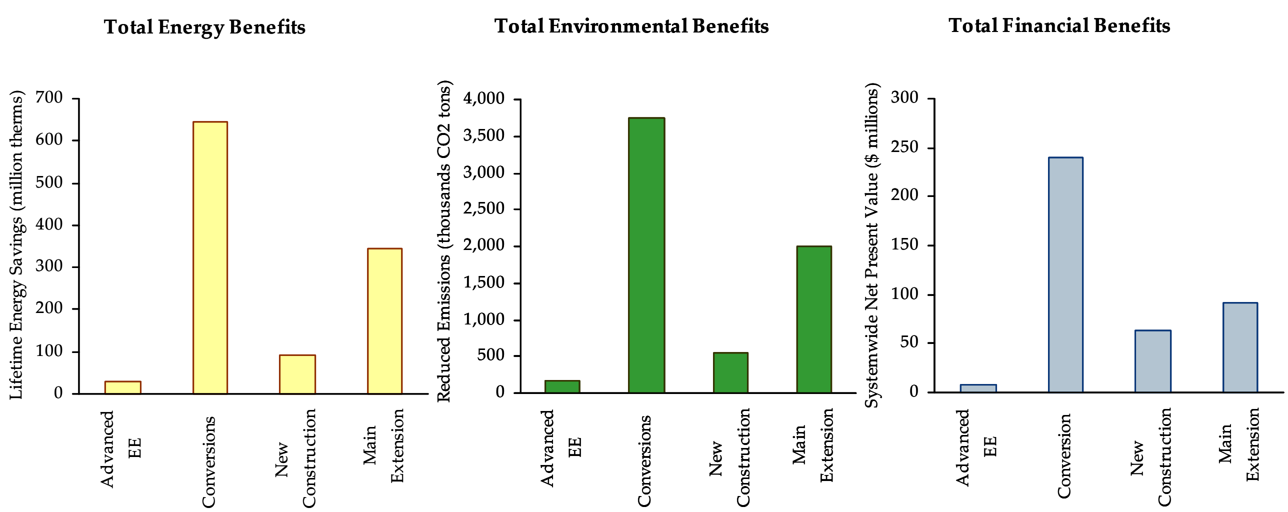
Interestingly, while the strategies provide significant, long-term, overall economic benefits, in most cases, PSE suffers a net negative financial loss (Figure 7). These could be addressed through different rate-treatment or financial incentives (e.g. based upon savings produced).




Note: PSE Total Net Present Value considers operating cash flows to PSE during the first year of implementation. Infrastructure investments and operating cash flows after the first year are passed to ratepayers, assuming a rate case on average every 2 years.

**Figure 7.** Financial Impact to PSE for Gas Efficiency and Conversion Options

In summary, the efficiency and conversion options provide substantial energy, environmental, and economic benefits, as shown in Figure 8.




Notes: PSE combined service territory. Excludes CHP strategic option as it has negative financial value. Includes benefits over the 30 yr lifetime of each measure with high efficiency gas equipment. Financial benefits do not include program management costs (e.g., staff, marketing, market intelligence). Advanced EE includes cumulative savings after 10 yrs as calculated in the 2007 IRP. Conversions assume capture of 80% of existing single family, multifamily and commercial customers on main willing during a 4 yr period. New construction assumes increasing gas service penetration for new multifamily and commercial customers on main to same level as single family (70%) for a period of 10 yrs. Main extension assumes capturing 5% of single family existing customers that require short main extension and 1% of single family existing customers that require long main extension, each year for 10 years

**Figure 8.** Summary of Energy, Environmental and Financial Benefits of the Option

## Outcomes

Based on these analyses, PSE is developed the following action items that it is now in the process of implementing:

- Expand gas efficiency and direct use programs
  - Aggressively expand current gas EE programs
  - Implement a program to encourage conversions to direct gas use for customers located on existing lines
  - Develop an effort to extend gas mains
- Enhance PSE's energy efficiency organization
  - Expand marketing capabilities and resources
  - Dedicate staff to focus on the new construction
  - Integrate gas and electric efficiency programs
- Improve processes for new connections and conversions
  - Improve communication and collaboration between efficiency and operations groups
  - Fastrack gas service installations for customers with broken electric space heating equipment
  - Reduce overall gas service installation time
- Develop and pursue a new regulatory strategy:
  - Recognize that direct use of gas provides electric avoided cost savings and environmental benefits, and allow (i) electric energy efficiency funds to be used for efficient gas substitution; (ii) count savings from community code upgrades and similar actions to count towards EE goals; and (iii) move to total energy and environmental savings goals (e.g., BTUs savings, CO2 emissions reductions)
  - Assess efficiency connection fees/discounts to promote efficiency
  - Decide the combination of decoupling/incentives/recovery mechanisms that best aligns PSE' shareholders and customer interests
- Investigate in more detail the net energy impacts of hybrid heat pumps

PSE and Snohomish County Public Utility District are currently jointly using this framework for evaluating the case for gas as an electric efficiency option when the gas and electric utilities have different owners and the marginal electric source is renewables mixed with regional wholesale market purchases.

## Conclusions

- As utilities and governmental entities strive to achieve more aggressive energy efficiency goals, it will be necessary to take a broader look at energy efficiency and embrace a total Btu perspective.
- Expanded gas energy efficiency programs and fuel conversion programs may provide substantial net benefits, especially when the marginal electricity supply is gas-fired generation.
- A comprehensive framework is required to evaluate the net economic and environmental impacts of fuel conversions.
- Changes in cost-recovery and rate-making may be necessary so that the net benefits are equitably shared.