Chapter 8: Direct Use of Natural Gas

THE POLICY QUESTION

The appropriate role for the Council in promoting the direct use of natural gas for space and water heating has long been an issue in the region. The Council has analyzed the technical and the policy issues in a number of studies dating back to its very first power plan. While the specific issues have changed somewhat over time, three central questions remain:

1. Is the conversion from electricity to natural gas for residential space and water heating a lower-cost and lower-risk alternative for meeting the region's load growth when compared to other options?

2. If so, how much cost-effective "fuel-switching" potential is there in the region?

3. Are fuel-choice markets working adequately?

During development of the sixth plan, a fourth question arose: How does the conversion from electricity to natural gas for space and water heating impact the region's carbon emissions?

Current Council Policy on the Direct Use of Gas

The Council's current policy on the direct use of natural gas is stated in the text box below. This policy was adopted with the Council's Fourth Power Plan following a detailed analysis of fuel-conversion potential and cost in 1994.[1] The policy was reaffirmed in the Council's Fifth Power Plan.[2]

[1] Northwest Power Planning Council. Fourth Northwest Conservation and Electric Power Plan. March 1996 (96-5). Pages 4-10,11.
[2] Pacific Northwest Power and Conservation Council. Fifth Northwest Electric Power and Conservation Plan. May 2005 (2005-7). Pages 3-45.

Council Policy Statement

The Council recognizes that there are applications in which it is more energy efficient to use natural gas directly than to generate electricity from natural gas and then use the electricity in the end-use application. The Council also recognizes that in many cases the direct use of natural gas can be more economically efficient. These potentially cost-effective reductions in electricity use, while not defined as conservation in the sense the Council uses the term, are nevertheless alternatives to be considered in planning for future electricity requirements.

The changing nature of energy markets, the substantial benefits that can accrue from healthy competition among natural gas, electricity, and other fuels, and the desire to preserve individual energy source choices all support the Council taking a market-oriented approach to encouraging efficient fuel decisions in the region.

The Council has not included programs in its power plans to encourage the direct use of natural gas, or to promote conversion of electric space and water heat to natural gas. This policy is consistent with the Council's view of its legal mandate. In addition, the Council's analysis has indicated that fuel-choice markets are working well. Since the large electricity price increases around 1980, the electric space-heating share has stopped growing in the region while the natural gas space-heating share in existing homes increased from 26 percent to 37 percent. A survey of new residential buildings conducted in 2004 for the Northwest Energy Efficiency Alliance found that nearly all new single-family homes constructed where natural gas was available had gas-fired, forced-air heating systems.[3] The survey also found an increased penetration of natural gas heating in the traditionally electric-heat-dominated multi-family market, especially in larger units and in Washington.[4] Fuel conversion of existing houses to natural gas has been an active market as well, often promoted by dual-fuel utilities.

The Council policy on fuel choice has consistently been that fuel conversions, while they do reduce electricity use, are not conservation under the Northwest Power Act because they do not constitute a more efficient use of electricity. However, the Council's analysis also has recognized that in some cases it is more economically efficient, and beneficial to the region and individual customers, to use natural gas directly for space and water heating than to use electricity generated by a gas-fired generator. However, this is very case-specific and depends on a number of factors including the proximity of natural gas distribution lines, the size and structure of the house, the climate and heating requirements in the area, and the desire for air conditioning and suitability for heat pump applications. In general, although direct use of natural gas is more thermodynamically efficient (except for the case of heat pumps), it is more costly to purchase and install. Therefore, its economic advantage depends on the ability to save enough in energy costs to pay for the higher initial cost.

[3] Northwest Energy Efficiency Alliance. "Single-Family Residential New Construction Characteristics and Practices." Portland, OR, March 27, 2007. Prepared by RLW Analytics.

[4] Northwest Energy Efficiency Alliance. "Multi-Family Residential New Construction Characteristics and Practices." Portland, OR, June 14, 2007. Prepared by RLW Analytics.

Analysis of the Direct Use of Natural Gas for the Sixth Power Plan

In 1994, the Council analyzed the economic efficiency of converting existing residential electric space and water heating systems to gas systems.[5] The results of that study showed there were many cost-effective fuel-switching opportunities within the region, representing a potential savings of over 730 average megawatts. As stated above, the market, with its high rate of conversions from electric to gas systems, was performing many of the conversions on its own. Consequently, the Council has not included fuel switching or fuel-choice measures in its subsequent power plans.

With the financial support and cooperation of the Northwest Gas Association and Puget Sound Energy, the Council, working through its Regional Technical Forum, is conducting an updated economic analysis of fuel conversion for residential space and water heating equipment in existing homes and fuel choice for residential space and water heating equipment in new homes in the Pacific Northwest. While the study results were not available at the time the Council adopted the Sixth Power Plan, it is possible to forecast potential implications. Should the direct use of natural gas prove to be a lower-cost and lower-risk alternative for meeting the region's load growth, including potential cost and risk from carbon emissions, the Council will need to assess whether the fuel-choice markets are working adequately. If the markets appear to be working adequately -- i.e, consumers are selecting natural gas for space and water heating where it makes economic sense -- then the Council will retain its current policy, which leaves the choice of heating fuels to individual consumers. If however, the market is not working adequately, the Council may decide to make specific recommendations in the future including but not limited to providing information and promoting efficient pricing of electricity.

The Council's objective for this analysis is to recreate its 1994 study with up-to-date information. The scope of the analysis has been expanded to include new construction for single-family dwellings and both new construction and existing buildings for multi-family dwellings. The updated analysis is also testing the cost, risk, and carbon-emissions impact of converting from natural gas to electricity as well as conversions from electricity to natural gas. A major difference between the Council's 1994 study and the current analysis is that all direct use of natural gas alternatives will be modeled as "resources" directly in the Council's portfolio model. This will allow the Council to directly compare the cost and risk associated with meeting regional electricity loads with conservation and traditional generating resources (including those fired by natural gas) against meeting those same needs by using natural gas directly in the home.

Multiple space and water-heating technologies are being considered in the analysis. Individual residential customers have different combinations of these technologies. In addition, each customer has a number of technology options from which to choose when existing equipment fails and needs to be replaced. This analysis assumes that customers install new equipment only when existing equipment needs to be replaced because it has come to the end of its useful life. At that time, customers can install the same type of equipment they already have or install a different technology. In new construction, the customer has the choice of all technologies and energy sources, but once that choice is made, they must live with it for the life of the equipment.

[5] Northwest Power Planning Council. "Direct Use of Natural Gas: Analysis and Policy Options". Issue Paper 94-41. Portland, OR. August 11, 1994.

For example, in one identified market segment, the home has an electric forced-air furnace (FAF) for space heating and an electric-resistance water heater. This study assumes that when the electric FAF fails, it could be replaced with a gas FAF, a gas/heat pump hybrid, or a gas hydronic system. Likewise, when the electric-resistance water heater fails it could be replaced with the same type of water heater, a gas tank water heater, or an instantaneous gas water heater.

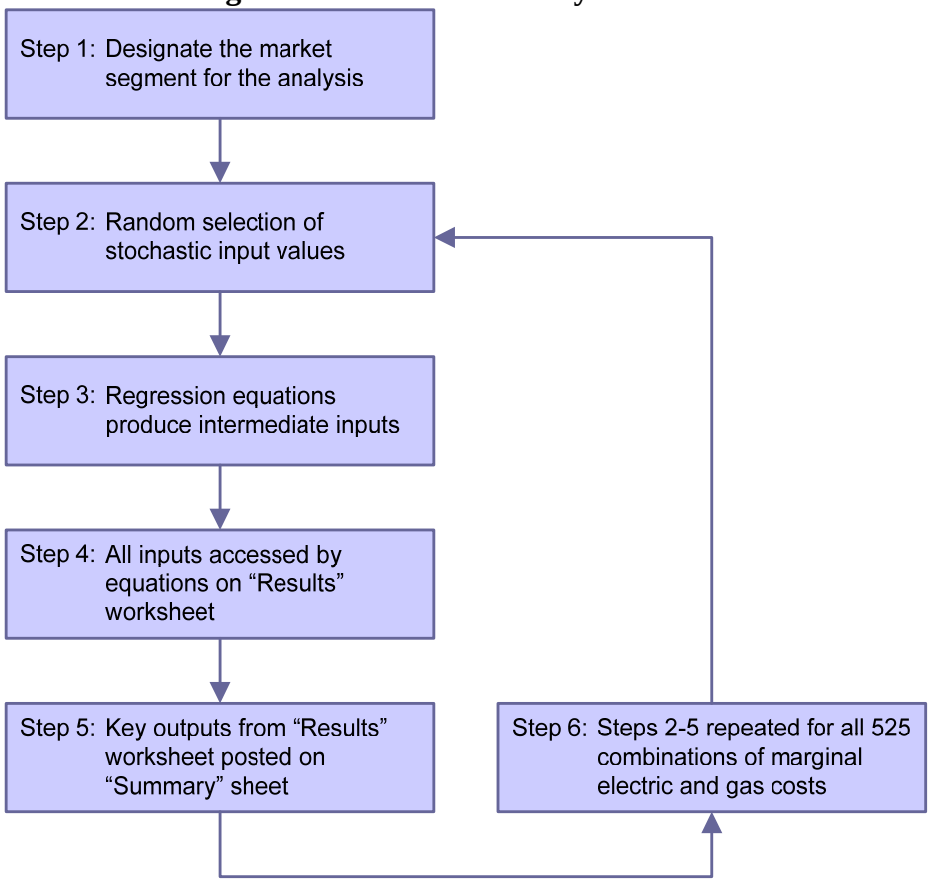
In this study each market segment consists of just one type of equipment for replacement of the failed existing equipment. Therefore, one market segment would include a gas FAF and a gas tank water heater as the retrofit equipment options for the electric FAF system and the electric resistance water heater, while another market segment would specify another combination of technologies.

Each of these technology choices comes at a cost to not only the individual customer, but more importantly, the entire region. Consistent with the Council's other analysis, this analysis accounts for both the money spent by customers to install a different type of new equipment and the resulting impact on natural gas or electricity consumption, changes in operations, and maintenance costs and changes in greenhouse-gas emissions.

The economics of these technology choices are highly dependent on the relative costs of natural gas and electricity and the capital cost of conversion. To address the wide range of conversion costs faced by consumers, a "Monte Carlo" model was developed similar to that used in the 1994 Council analysis. The flowchart in Figure 8-1 illustrates the six-step "Monte Carlo" process being used in this economic analysis. In Step One, the model designates one of the 91 market segments (inputs) for the analysis. Of the 91 inputs, 49 are stochastic, meaning they are randomly selected. In Step Two, the values for the 49 stochastic inputs are selected. In Step Three, values for four of the stochastic inputs are established by regression equations. In Step Four, the 49 stochastic inputs, the four regression inputs, 29 deterministic (fixed) inputs, and two decision inputs (marginal cost of electricity and marginal cost of gas) are accessed by the model's equations. After the completion of the calculations, the values for key outputs are displayed for summary viewing in Step Five. In Step Six, steps two through five are repeated as the model performs all the necessary calculations 1,000 times for each of the 91 market segments and for each of the 525 combinations of marginal electric and marginal gas costs.

A complete description of the direct use of natural gas economic model and the input assumptions used in the model are available on the Regional Technical Forum's website: http://www.nwcouncil.org/energy/rtf/studies/rfp/directuse/GEPReport.pdf.

Figure 8-1: Economic Analysis Process



Once the Monte Carlo model has identified the most economical market choices for fixed combinations of natural gas and electricity prices this information will be fed into the Regional Portfolio Model (RPM). The RPM will then be used to test the economics of each technology choice over the wide range of future natural gas and electricity price combinations. This analysis will seek to determine whether across the entire range of electric and gas cost combinations there are conversions to natural gas that are economically efficient and which result in lower risk to the region's power system.

The Council was unable to complete the RPM analysis of the economics and emissions impacts of the direct use of natural gas prior to the release of the Sixth Power Plan. Due to the significant regional interest in this analysis, the Council believes it should provide adequate opportunity for review and comment on the input assumptions and results of this work before considering changes to its current policy. Therefore, the Council included a specific task in the action plan (ANLYS-16) to complete this analysis during the first six months of 2010 and to consider any policy changes and action items related to the findings.