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EA 2004-04

September 21, 2004

FORECASTED PATTERNS IN RESIDENTIAL NATURAL GAS CONSUMPTION, 2001-2020

I. Executive Summary

This analysis estimates that the trend of declining use per residential natural gas customer will continue through 2020, although at a slower pace than experienced in the past two decades Natural gas use per residential customer is projected to drop by 10 percent from 2001 through 2020. The rate of this decline is almost half that experienced in the past two decades. On average, natural gas use per residential customer has been declining by about one percent per year since 1980, but the forecasted rate through 2020 is 0.5 percent annually. Nationally, natural gas use per residential customer was 106 thousand cubic feet (Mcf) per year in 1980 and 83 Mcf per year in 2001 (Chart 1)¹. This analysis estimates that use per residential customer will drop to 80 Mcf per year by 2010 and to 75 Mcf per year by 2020. It should be noted that all data have been adjusted to reflect normal weather.



¹ Patterns in Residential Natural Gas Consumption, 1980-2001, American Gas Association, May 28, 2004

Two factors will tend to moderate the rate of this decline in use per customer:

- **Relatively modest furnace efficiency gains --** While average furnace efficiency will continue to improve, the rate of improvement will slow down as most of the older, less efficient units have already been replaced.
- Larger homes -- The typical home is expected to have five percent more floor space than the existing housing stock in the coming decades, which will increase the heating load.

II. Introduction & Methodology

Two previous studies² analyzed the historic trends in normalized residential gas use per customer from 1980 through 2001. Overall, the use per customer dropped 21 percent during those 21 years, caused mainly by enhanced appliance efficiency, and, to a lesser extent, tighter, more energy efficient home construction. This analysis estimates the future trends through 2020 in residential natural gas use per customer.

The calculations are based on data from the most recent energy forecast³ by the U.S. Energy Information Administration (EIA). EIA forecasts the:

- Number of gas space heaters, water heaters, clothes dryers, and cooking appliances in use by year;
- Average annual consumption of each of those appliances other applications such as gas hearth products and lights are summed into an "other" category;
- Average annual ratings of home thermal efficiency, furnace efficiency, and water heater efficiency; and,
- Average square footage for homes per year, both new construction and total market.

This analysis is based on the above estimates and the resultant calculations of future use per customer. The following methodologies were employed:

- Estimated use per appliance EIA's total number of appliances divided by their total consumption for that application.
- Estimated number of gas customers EIA's incremental count of gas water heaters (the fastest growing end-use application) was added to the known 2001 customers base.
- Estimated gas appliance saturation EIA's projected number of appliances for each end use was divided by the estimated number of gas customers.
- Estimated use per customer Estimated gas appliance saturation times estimated use per appliance. The results for each appliance and EIA's estimate

² <u>Patterns in Residential Natural Gas Consumption Since 1980</u>, American Gas Association, February 2000, and <u>Patterns in Residential Natural Gas Consumption</u> 1997-2001, American Gas Association, June 2003

³ <u>Annual Energy Outlook 2004 with Projections to 2025</u>, Energy Information Administration, Department of Energy, January 2004 http://www.eia.doe.gov/oiaf/aeo/index.html

of consumption by other gas applications were summed to forecast total use per customer.

A variety of factors affect use per customer, such as appliance efficiency, appliance saturation, and housing size. The following methodologies were employed to calculate these impacts:

- Furnace efficiency These calculations incorporated EIA's forecasts for average annual efficiency and the gas load methodology set forth in the Gas Appliance Manufacturers Association's Directory⁴.
- House size The impact of increasing house sizes on heating load was estimated through a simulation program developed by Columbia Gas⁵.
- Water heater efficiency All changes in use per water heater as estimated by EIA were assumed to be due to efficiency changes.
- Appliance saturation This impact was calculated by dividing the appliance use per customer by the change in the average market share of that appliance for all gas customers.

III. Overview

This analysis estimates that the trend of declining use per residential natural gas customer will continue through 2020, but at a slower pace than experienced in the past two decades. The average annual decline from 1980 through 2001 was 1.1 percent, roughly twice the rate expected for the forecast period of 0.54 percent. Table 1 illustrates the decline rates by period.

Year	Normalized Use Per	Per Average Annual Decline		
1000				
1900	105.0	IN/A		
1990	95.8	0.97%		
2001	83.5	1.24%		
2010	80.1	0.46%		
2020	75.4	0.67%		

Table 1Use Per Customer and Decline Rates

Residential natural gas use can be segmented into space heating and baseload applications. On average, space-heating demand accounts for three-quarters of residential gas consumption. This demand is very weather sensitive, with use per customer higher in the colder climates than in the warmer regions.

Baseload gas use is typically not weather sensitive. On average, water heaters account for 86 percent of baseload use. The other two primary residential gas applications are cooking and clothes drying. Natural gas logs/fireplaces are increasing in market share, and can be used for heating or decorative purposes. Appliances that

⁴ <u>Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating</u> <u>Equipment</u>, Gas Appliance Manufacturers Association, Arlington, VA

⁵ Energy Help for the Home, Columbia Energy software

could also be considered baseload, but have a much lower market penetration, are gas lights, pool heaters, and outdoor grills.

IV. Examination of Contributing Factors

A number of factors contribute to declining use per customer. This analysis examines appliance efficiency, appliance penetration, thermal efficiency for home construction, and average home size. Table 2 presents the expected impacts of these factors.

Table 2Impact of Contributing Factors on Use per Customer, 2001-2020
(Mcf/yr)

Appliance Efficiency	-5.97
Appliance Penetration	-2.12
Thermal Efficiency	-2.28
Home Size	2.37
Total	-8.01

Appliance Efficiency

According to the EIA forecast, the average furnace efficiency for residences will improve from 79.2 percent AFUE in 2001 to 84.1 percent in 2020. This improvement is expected to result in a decrease of 2.5 Mcf/year in normalized use per customer. This is substantially less than the decrease of 10.4 Mcf/year experienced from 1980 through 2001. The historical decrease is much higher because the actual improvement in appliance efficiency was much greater (22 percent) than the anticipated improvement (6 percent). The future improvements in overall furnace efficiency are limited because:

- Most homes have furnaces that meet or exceed federal minimum efficiency standards, leaving little room for significant improvement
- Improvement in furnace efficiency is limited by current technology and economics traditional furnaces cannot exceed 82 percent AFUE, and condensing furnaces can achieve AFUEs in the low- to mid-ninety percent range
- Condensing furnaces are not economically feasible in many parts of the country – only cold weather areas create sufficient savings to pay back the additional cost of these more efficient furnaces

The EIA forecast calls for the in-place stock of water heaters to improve in efficiency from 0.55 energy factor (EF) in 2001 to 0.59 EF in 2020. This will result in a decrease of 3.5 Mcf/year. This impact is similar to the historical change from 1980 to 2001 when the water heaters average went from 0.50 EF to 0.55 EF.

The use per appliance for cooking and clothes drying applications are expected to be relatively stable, as no real efficiency gains are envisioned for these appliances.

Appliance Penetration

EIA estimates the number of gas appliances in use each year. Their forecast envisions that the number of water heaters will increase more than other gas appliances, eventually outnumbering the number of gas space heating appliances (Table 3). This will result in a lower percentage of gas customers that use gas for space heating, decreasing the average use per customer.

	2001	2010	2020
Space Heating	60.0	66.7	74.0
Water Heating	59.1	67.3	76.1
Cooking	38.0	41.5	45.9
Drying	17.0	21.6	26.8

Table 3Number of Residential Natural Gas Appliances in Use(Millions)

Source: Annual Energy Outlook 2004 with Projections to 2025, Energy Information Administration

While most of the decrease in use per customer derives from lower gas space heating penetration for natural gas customers, the percentage of gas customers that cook with gas is expected to decrease as well. Since the use per appliance for cooking is relatively small, this impact is minimal.

The percentage of gas customers that use gas for water heating and clothes drying is expected to increase, helping to offset the declines from reduced penetration of gas space heating and cooking applications. In total, the net effect of future appliance penetration is negative (-2.1 Mcf/yr by 2020).

Household Thermal Efficiency

Homes are expected to continue to improve in overall thermal efficiency, as newer, more insulated homes replace older units and as existing homes upgrade insulation, windows, and doors. EIA assigns a rating for both existing and new construction thermal efficiency. Existing homes in 2001 are rated at 1.00, and this index decreases as the average home becomes more efficient (Table 4). By 2020, the thermal efficiency rating for all homes is forecast to be seven percent better than the 2001 rating.

Table 4 Estimate of Home Thermal Efficiency

	2001	2010	2020
Existing Homes	1.00	0.98	0.97
New Construction	N/A	0.81	0.80
All Homes	1.00	0.96	0.93

Source: Annual Energy Outlook 2004 with Projections to 2025, Energy Information Administration

The amount of natural gas needed to heat homes decreases as the average thermal efficiency improves. By 2020, gas demand per customer could decrease by 2.3 Mcf per year due to thermal efficiency improvements.

Household Square Footage

EIA forecasts that the average home's square footage will increase as larger, new homes are built and additions are incorporated into existing homes. From a base of 1,684 square feet in 2001, the average home is expected to increase to 1,731 square feet in 2010 and to 1,771 square feet by 2020. This increase in average floor space could increase use per customer by 2.4 Mcf/year by 2020.