ORNL/TM-2014/133

Weatherization Assistance Program Technical Memorandum Background Data and Statistics On Low-Income Energy Use and Burdens

Approved for public release:
distribution is unlimited.

Joel F. Eisenberg

April 2014

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

DOCUMENT AVAILABILITY

Reports produced after January 1, 1996, are generally available free via US Department of Energy (DOE) SciTech Connect.

Website http://www.osti.gov/scitech/

Reports produced before January 1, 1996, may be purchased by members of the public from the following source:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone 703-605-6000 (1-800-553-6847)
TDD 703-487-4639
Fax 703-605-6900
E-mail info@ntis.gov
Website http://www.ntis.gov/help/ordermethods.aspx

Reports are available to DOE employees, DOE contractors, Energy Technology Data Exchange representatives, and International Nuclear Information System representatives from the following source:

Office of Scientific and Technical Information
PO Box 62
Oak Ridge, TN 37831
Telephone 865-576-8401
Fax 865-576-5728
E-mail reports@osti.gov
Website http://www.osti.gov/contact.html

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ORNL/TM-2014/133

Energy and Transportaton Science Division

WEATHERIZATION ASSISTANCE PROGRAM TECHNICAL MEMORANDUM BACKGROUND DATA AND STATISTICS ON LOW-INCOME ENERGY USE AND BURDENS

Joel F. Eisenberg

Date Published: April 2014

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6283
managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

Contents

SUMMARY SHEET ..... - 1 -
INTRODUCTION ..... - 2 -
ENERGY-RELATED CHARACTERISTICS ..... - 2 -
Defining The Low-Income Population ..... - 2 -
Fuel Types and Efficiency Characteristics ..... - 4 -
ENERGY PRICES AND INFLATION ..... - 8 -
ENERGY EXPENDITURES AND BURDEN ..... - 10 -
Distribution of Low-Income Energy Expenditures ..... - 12 -
Weather Conditions For The Winter Of 2013-14 ..... - 13 -
APPENDIX A ..... - 15 -
APPENDIX B ..... - 18 -

SUMMARY SHEET

- Weatherization-eligible households- 39.5 million

- Average site annual energy consumption for Weatherization-eligible households- 78.2 million British thermal units (MBtu).
- Weatherization-eligible households space conditioning energy consumption per square foot- 30.56 thousand Btu (mBtu).

- Average eligible household energy expenditure for FY 2014 -$1,851
    - For gas-heated households- $1,859
    - For propane-heated households- $2,758
    - For fuel-oil-heated households- $3,008
    - For electric-heated households- $1,593

- Total energy expenditures by eligible households for FY 2014 -$72.3 Billion

- Average space conditioning expenditure per eligible household for FY 2014 - $721

- Energy burden for eligible households in FY 2014- 16.3 percent

- Energy burden for non-eligible households in FY 2014- 3.5 percent

- The price of natural gas increased slightly in FY 2014 to $11.56 per thousand cubic feet (mcf) but is still below the 2009 level of $11.97 per mcf.

- The price of home heating oil has maintained its sharp increase from 2008 levels and is estimated to be $3.75 per gallon.

Electricity prices are estimated to have increased a fraction of a penny to $.124 per kilowatt hour (kWh).

WEATHERIZATION ASSISTANCE PROGRAM
BACKGROUND DATA AND STATISTICS

INTRODUCTION

This technical memorandum is intended to provide readers with information that may be useful in understanding the purposes and context of the Department of Energy's Weatherization Assistance Program (Weatherization). Weatherization has been in operation for over thirty years and is the largest single national residential energy efficiency program. Its primary purpose, established by law, is

"…to increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential energy expenditures, and improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, the handicapped, and children."[1]

The data and statistics in this memorandum provide reasonable and transparent estimates of key low-income energy usage and housing characteristics. The companion appendices at the back of the memorandum explain the methods and sources used in developing the statistics.

ENERGY-RELATED CHARACTERISTICS OF LOW-INCOME HOUSEHOLDS

Defining The Low-Income Population

There are several ways to define the number of households that can be described as low-income. Most of these are based on household income standards defined by various federal programs. For example, eligibility for many programs at the Department of Housing and Urban Development (HUD) is defined as household income at or below 80 percent of the local area median. The

[1] Title 42 of the U.S. Code, Chapter 81, Subchapter III, Part A, 6861.

Department of Health and Human Services Low Income Home Energy Assistance Program (LIHEAP) has historically defined federal eligibility to be household income at or below 150 percent of the Federal Poverty Income Guidelines or 60 percent of state median income, whichever is higher. The Department of Energy Weatherization Assistance Program now defines eligibility as household income at or below 200 percent of the Federal Poverty Income Guidelines.

For purposes of this analysis, the Weatherization guidelines are employed in conjunction with the DOE Energy Information Administration Residential Energy Consumption Survey (RECS),[2] which provides the most reliable energy data regarding household energy use.. According to the latest RECS, in 2009 there were approximately 39.5 million households in the United States that were federally eligible for Weatherization out of 113.6 million households nationwide. Within this low-income population 16.9 million households were categorized as having income at or below the poverty level. The low-income household population is generally distributed around the United States in roughly the same proportions as the non-low-income population, with approximately 16 percent in the Northeast, 23 percent in the Midwest, 41 percent in the South, and 20 percent in the West. A somewhat higher percentage of non-low-income households, about 4 percent more, live in the Northeast and about 6 percent fewer live in the South.

This large eligible population is comprised of a broad range of households in terms of income levels, housing characteristics, and program participation. Nearly 60 percent of the households contained at least one paid worker and approximately 28 percent reported receiving Food Stamps. Thirty three percent received retirement income. Sixty four percent of the eligible households lived in single-family or mobile homes and just under half owned their own homes.

[2] Energy expenditure statistics in this memorandum are based on the public use files of the 2009 RECS, weather-normalized, and adjusted for annual prices as projected by EIA Short Term Energy Outlook.

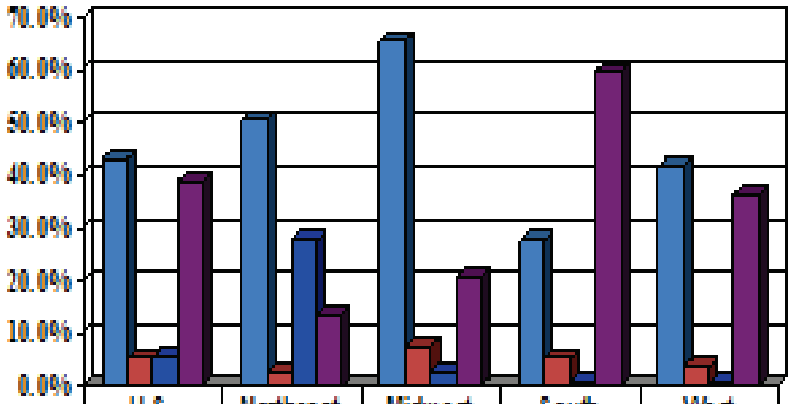
Fuel Types and Efficiency Characteristics

Low-income consumers have a similar profile to other consumers in terms of the primary heating fuel they use, with a slightly higher proportion than the general population using propane for this purpose. The largest single heating fuel type is natural gas, with approximately 43 percent of low-income households employing this fuel. Electricity is used for heating by 39 percent of these households. Home heating oil is the heating fuel of 5 percent of low-income families and propane is also employed for heating by 5 percent. The remaining households heated with other fuels such as wood or used no heating energy at all. This distribution is shown in Graph 1.

Graph 1

PRIMARY HEATING FUEL FOR ELIGIBLE LOW-INCOME HOUSEHOLDS

Percent Of Households At Or Below 200% of Poverty By Region



	U.S.	Northeast	Midwest	South	West
Natural Gas	43.0%	50.4%	65.5%	27.7%	41.7%
Propane	5.0%	2.6%	7.3%	5.3%	3.5%
Fuel Oil	5.4%	27.5%	2.8%	0.8%	0.4%
Electricity	38.7%	13.4%	20.7%	59.7%	36.3%

Source: DOE/EIA Residential Energy Consumption Survey for 2009

The distribution of heating fuel usage varies substantially by region. Most of the home heating oil is used by low-income households in the Northeast whereas electricity is the dominant heating source in the South and natural gas predominates in the Midwest. This has important implications for the average level of residential expenditures and energy burdens in the various parts of the country because home heating oil and propane prices per MBtu are higher and have risen more sharply than those of other fuels. Furthermore, residential electricity prices in the Northeast tend to be well above the electricity national average. The overwhelming predominance of natural gas as the primary heating fuel in the Midwest makes low-income households in that part of the United States extremely sensitive to events in the natural gas markets.

Average energy consumption for low-income households in 2009 was 78 million British thermal units (MBtu) compared to 96 MBtu for the non-low-income households. On the other hand, energy intensity (i.e., Btu consumption for heating and cooling per square foot of conditioned space) showed the reverse pattern. For eligible households, consumption per square foot averaged 31 thousand British thermal units (mBtu) whereas for non-low-income households the average was 24 mBtu per square foot. This reflects the relative inefficiency of the low-income housing stock compared to that of other households. For example, 28 percent of low-income households reported inadequate insulation in their homes whereas 17 percent of non-low-income households reported this condition.

A review of the average energy consumption for low-income households by housing type reveals that households living in large apartment buildings have lower average annual consumption than those in most other building types, 46 MBtu compared to 95 MBtu for those in single family detached homes. It important to note that average consumption per square foot is higher in the small multifamily housing stock- buildings with 2-5 units, than it is in other building types. The average space conditioning consumption was 46 mBtu per square foot for these homes compared to 29 mBtu for single family homes and 37 mBtu per square foot for apartments in large buildings. This highlights a potential efficiency opportunity in the small multifamily housing stock.

TABLE 1				
AGE OF HEATING SYSTEMS AND REFRIGERATORS BY PROGRAM ELIGIBILITY RECS 2009				
Age of Equipment	Refrigerators		Heating Systems	
	Low-Income	Non-Low-Income	Low-Income	Non-Low-Income
Under 2 Years	11.9%	12.4%	10.0%	9.4%
2-4 Years	22.6%	23.0%	13.1%	15.4%
5-9 Years	34.4%	35.6%	20.9%	25.4%
10-19 Years	25.3%	24.7%	27.1%	29.1%
20 Years or more	5.6%	4.1%	28.1%	20.7%

The RECS data indicate substantial energy efficiency opportunities in the low-income housing stock in terms of both heating systems and refrigerators if one uses the age of the equipment as a rough proxy for inefficiency. Over 30 percent of the refrigerators in the low-income households were 10 years old or more. Fifty five percent of heating systems in low-income homes were 10 years old or more. Non-low-income households also presented significant efficiency opportunities based on this criterion.

The number of households reporting that they replaced their primary refrigerator in the four years prior to and including the survey was approximately 24 percent for low-income households and 25 percent for non-low-income households. Both household types received minimal assistance in the form of public aid, manufacturer rebates, energy provider incentives or weatherization programs for refrigerator replacement.

The percentage of owner-occupied households that reported replacing their primary heating system in the previous four years was about 18 percent for both low-income households and non-

low-income households. Of the latter, just less than 5 percent of all households received some form of rebate, tax credit or other subsidy. For low-income households, just under 4 percent received some form of aid, with about 40 percent of this coming from a weatherization program.

Another significant efficiency opportunity reported in the RECS data pertains to the level of insulation in American homes. The share of owner occupied non-low-income homes reporting little or no insulation was 14 percent. For owner occupied low-income homes the comparable share of homes with little or no insulation was 24 percent.

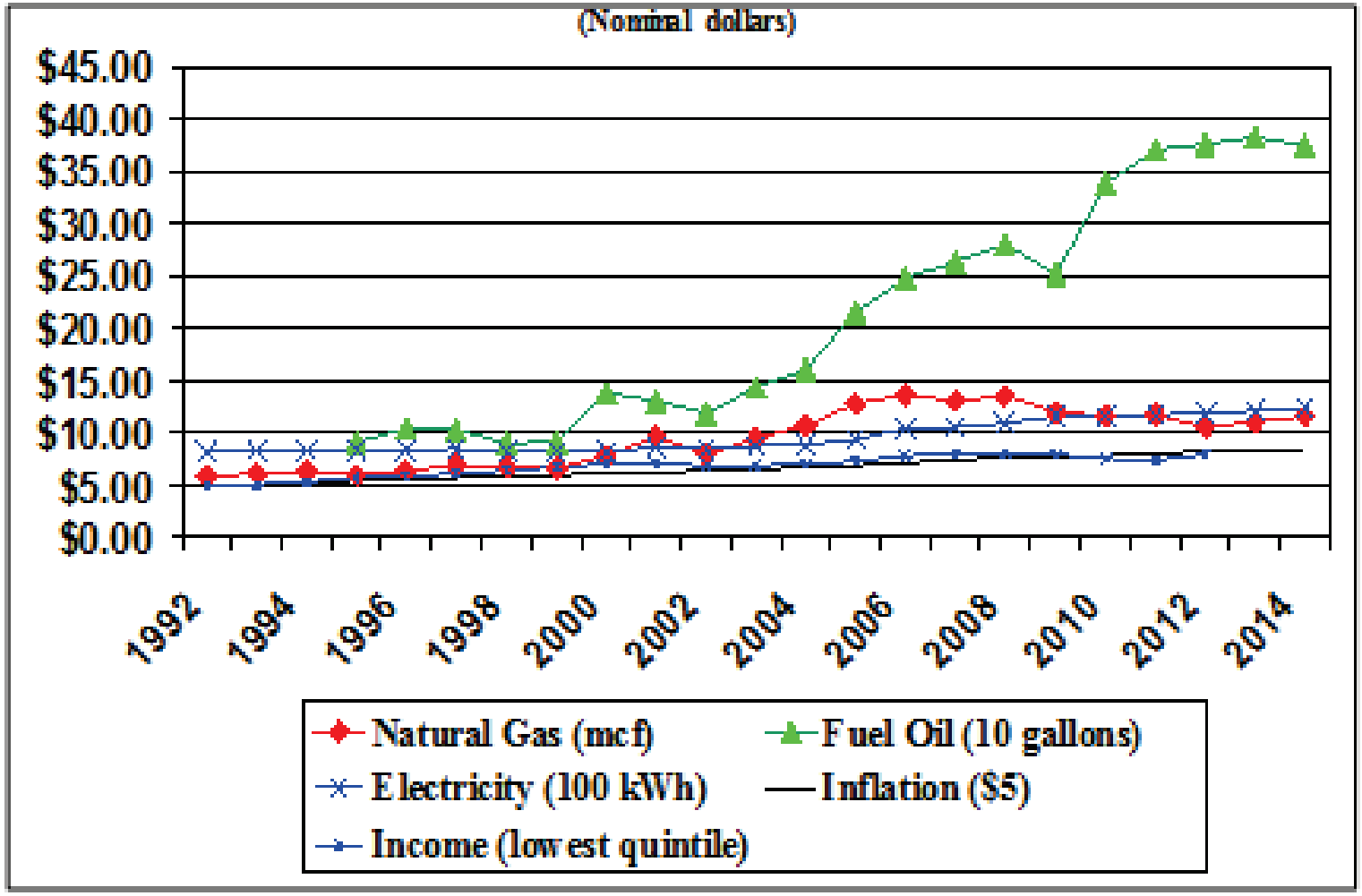
Though the percentage of low-income homes with poor or no insulation was substantially higher than that of non-low-income homes, the percentage of homes that reported adding insulation in the 10 years prior to the survey was only 18 percent for owner occupied low-income homes compared to 20 percent for owner occupied non-low-income homes. In both cases the majority of households received no financial assistance to add insulation. Of the low-income homes, just over two percent reported some financial aid for this purpose with slightly more than half of this coming from a weatherization program. By contrast, for non-low-income homes just less than two percent reported some form of assistance paying for insulation with well over half of this coming from tax credits. The statistics here are reported for the period immediately prior to and including 2009. It can be expected that there will be a substantial increase in the percentage of low-income homes receiving assistance reported in the next RECS survey which will cover the period of the American Reinvestment and Recovery Act (ARRA) when over $5 Billion was committed to the Department of Energy's Weatherization Assistance Program.

ENERGY PRICES AND INFLATION

The energy inflation picture over the long term reflects energy prices rising faster than the rate of general inflation and also faster than low-income household incomes. The data for low-income households indicate an actual decline in incomes during recent years as a result of the Great Recession. According to the Bureau of Labor Statistics, average income for the lowest quintile of the U.S. population increased by 58% since 1992 while inflation rose by 67 percent. Over this period, electricity prices have risen 51 percent, natural gas rose 96 percent and heating oil climbed 312 percent. Please see Graph 2 for details.

During the past ten years, there has been severe price inflation for home heating oil and a slow but steady rise in electricity prices. Natural gas prices have been slowly increasing after dropping as supplies increased sharply in 2008.

Graph 2
RATE OF INCREASE IN RESIDENTIAL ENERGY PRICES BY FUEL TYPE
Since 1992



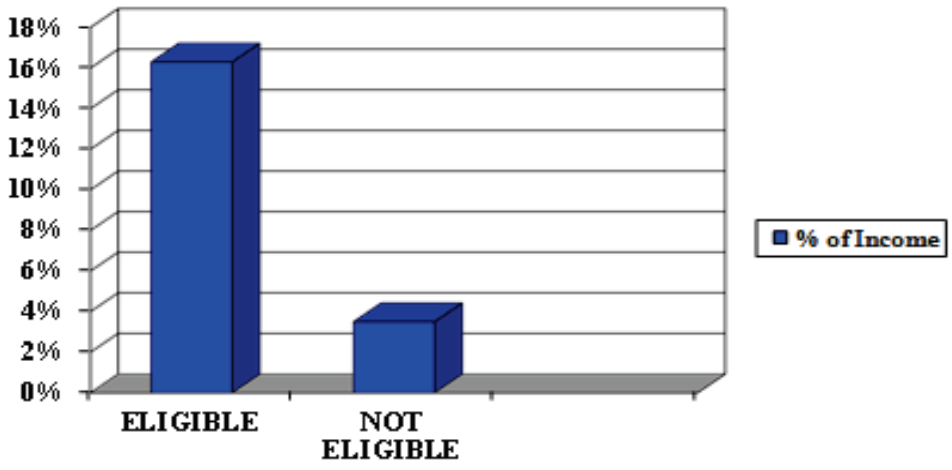
Sources: DOE/EIA Short Term Energy Outlook, November 2013, Bureau of Labor Statistics, Bureau of the Census

ENERGY EXPENDITURES AND BURDEN

The average annual weather-normalized expenditure for low-income households estimated for FY 2014, (October 2013-September 2014) is $1,851 of which $721 is estimated to be for primary heating and cooling expenses. This compares to estimated residential energy expenditures of $2,284 for non-low-income households, of which $906 is estimated for primary heating and cooling.

Low-income households have lower average residential energy usage and lower residential energy bills than do non-low-income households but this difference is not in proportion to household income. The income of low-income households as provided in the 2009 RECS and adjusted for inflation was estimated at $18,773 compared to $71,755 for non-low-income households. In FY 2014 the estimated mean energy burden of low-income households, defined for each household as residential energy expense divided by household income, was therefore estimated to be 16.3 percent for low-income households compared to 3.5 percent for non-low-income households as shown in graph 3.

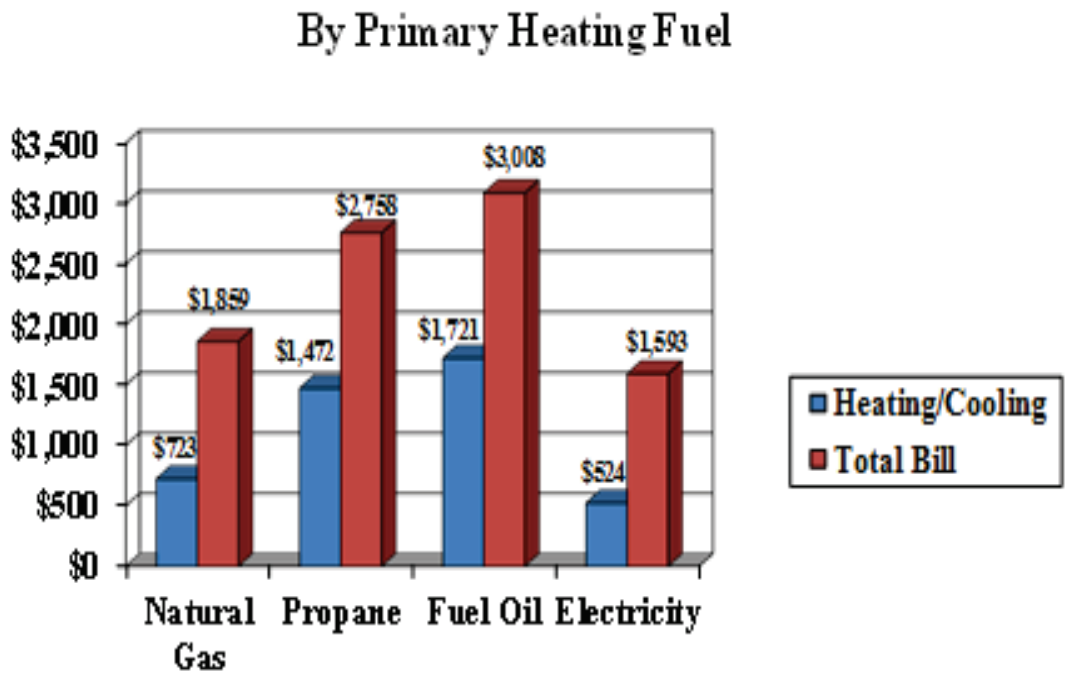
Graph 3
ESTIMATED ENERGY BURDEN
BY INCOME GROUP
2013-2014



Source: Tabulation based on EIA STEO October 2013, 2009 RECS

As one examines the energy bills of eligible low-income households several features stand out. Households that employ fuel oil as their primary heat source have the highest energy bills, followed by those that heat with propane. The average energy bill for the former was estimated at $3,008 for FY 2014 while that of the latter was $2,758. This compares with $1,859 for households heating with natural gas and $1,593 for households heating with electricity. Please see Graph 4 for details of heating and total residential energy expenditures by primary heating fuel.

Graph 4
EXPECTED ENERGY EXPENDITURES FOR 2013-2014
Eligible Low-Income Households

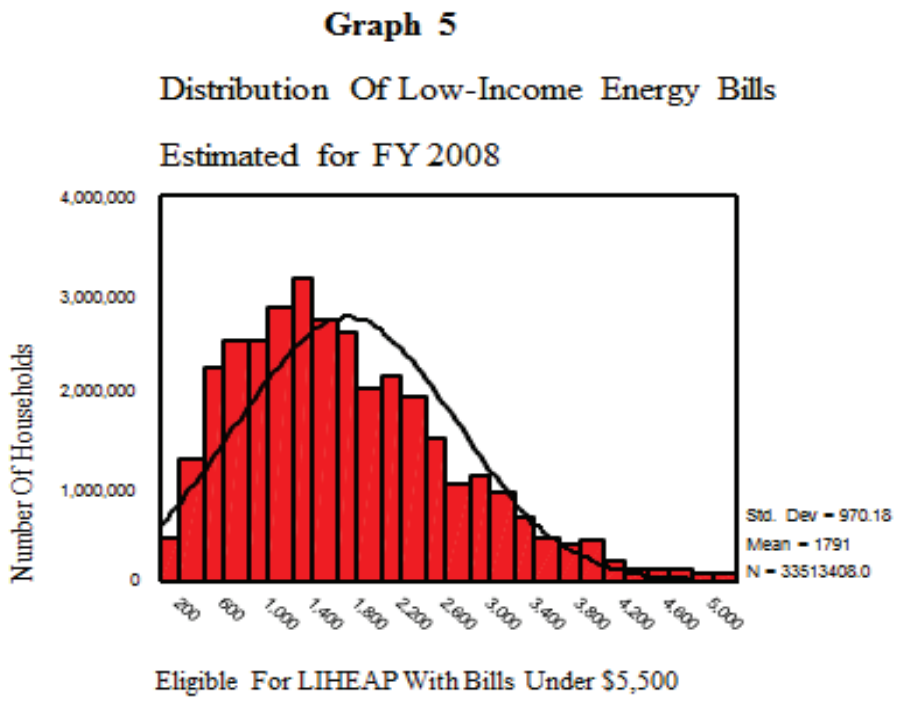


Source: Tabulation from EIA October 2013 STEO & 2009 RECS

Given the concentration of low-income households heating with fuel oil in the Northeast it is no wonder that the estimated average energy expenditure for low-income households for FY 2010 is higher there than elsewhere at $2,335. This compares to $1,940 for such households in the Midwest, where less expensive natural gas predominates and to $1,802 for those in the South, where heating loads are lower. Those low-income households living in the West have a projected average expenditure of $1,374. The very large size of these Census regions masks the considerable diversity of weather conditions and energy expenditures on a smaller Census division or state scale.

Distribution of Low-Income Energy Expenditures

The previous discussion has highlighted averages of energy expenditure by fuel type, both nationally and by region. It is important to keep in mind that nationally, and in each region and state low-income energy expenditures vary considerably even among households using the same heating fuel and living in the same type of building . Causes for these variations are several including variations in building energy efficiency, number of household members, and household behavior. This results in a broad distribution in energy usage and energy burdens as depicted in Graph 5 which shows a typical bell curve distribution of low-income energy expenditures with a long tail. This means that there are often a considerable proportion of low-income households with energy bills and burdens that are below the average and others that have bills and burdens that considerably exceed the averages. The latter may be particularly good targets for Weatherization if they can be identified through energy consumption data.



Weather Conditions For The Winter Of 2013-14

The Energy Expenditure data presented to this point have been weather-normalized, that is to say, adjusted to standard 30-year weather historical conditions. This facilitates standardized comparison of expenditures from year to year. Quite clearly, in this unusual winter the cost of heating will be higher than normal due to the colder weather that has impacted both the demand for heating energy and its price. Table 2 shows the heating degree days nationally and by Census Division provided by the National Oceanic and Atmospheric Administration for this year's heating season through February of 2014. On a national basis, it indicates heating demand that is 12 percent higher than last year and 5 percent higher than normal. On a Divisional basis, there are certain parts of the country that have been particularly hard hit. These include the East North Central Division that has suffered heating degree days 12 percent above normal, the West South Central Division where heating degree days have averaged 13 percent colder than normal and the West North Central and East South Central Divisions where heating degree days have exceeded the 30-year norm by 9 percent.

TABLE 2

GAS HOME HEATING CUSTOMER WEIGHTED HEATING DEGREE DAYS

JULY 1, 2013 THROUGH FEBRUARY, 2014

Division	MONTH OF FEB			CUM				
	TOTAL	DEVIATION FROM		TOTAL	DEVIATION FROM		PERCENT FROM	
		NORM	LST YR		NORM	LST YR	NORM	LST YR
NEW ENGLAND	1115	85	106	4754	156	515	3	12
MIDDLE ATLANTIC	1096	116	117	4534	219	542	5	14
E N CENTRAL	1315	253	232	5417	578	844	12	18
W N CENTRAL	1343	264	248	5648	482	763	9	16
SOUTH ATLANTIC	652	14	-1	2958	118	337	4	13
E S CENTRAL	697	66	70	3154	267	497	9	19
W S CENTRAL	502	73	120	2234	252	541	13	32
MOUNTAIN	764	-39	-103	3873	-313	-88	-7	-2
PACIFIC	363	-49	-99	1682	-403	-343	-19	-17
UNITED STATES	896	103	88	3854	173	409	5	12

APPENDIX A

Method for Estimating Low-Income Energy Expenditures

The method used to estimate energy expenditures by low-income households is based on the integration of two products from the Department of Energy's Energy Information Administration: the Residential Energy Consumption Survey (RECS) for 2009 and the Short Term Energy Outlook (STEO) for October or November in various years. The former is the most recent EIA survey of U.S. households in an occasional series dating back to 1978 that provides detailed data on housing and energy characteristics, demographics, and energy consumption and expenditures verified through billing data. There are records on 12,083 individual households in the RECS data base. The STEO provides EIA's monthly estimate of energy prices for the 18-month period immediately ahead in addition to actual prices for the previous year.

The RECS public use files identify the location of each household by Census Region, of which there are four, and by Census Division, of which there are nine. Heating and cooling degree days are provided for each household for 2009 based on the population-weighted data for each Census Division and income is provided in 24 categories. The survey provides actual fuel bills for each household and uses statistical techniques to allocate the usage and expenditures among major usage categories such as heating, cooling, hot water heating, refrigeration, etc. Long range climate normals for heating and cooling degree days for each of the Census divisions were calculated using statistics provided by the National Climatic Data Center of the National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service. These data were employed to calculate an adjustment factor for each division so that RECS data on heating and cooling expenditures for 2009 could be adjusted to reflect normal conditions.

Annual price adjustment factors were similarly calculated using quarterly price projections by division for natural gas and electricity and by region for propane and heating oil as provided by the STEO for each Fall. The quarterly prices were weighted by consumption for each quarter to calculate an annual price adjustment factor for the historical record for 2009 and for the price projections for each year thereafter through FY 2014. The baseline 2009 energy prices used to

calculate multipliers were derived from the historical STEO database. This methodology provides a conservative and internally consistent approach to the estimation problem.

The estimate of an individual household's expenditure for a given year n was then calculated using the following formula in SPSS:

(((Dolngsph * hddfact) + Dolngwth + Dolngoth) * pmngY) + (((Dolpsph * hddfact) + Dollpwth + Dollpoth)*pmlp Y) + (((Dolkrsph*hddfact)+Dolkrwth+Doldroth)*pmfoY) + (((Dolfosph*hddfact)+ Dolfowth + Dolfooth)*pmfoY) + (((Dolelsph * hddfact) + (Dolelcol * cddfact)+doleloth+ dolelrfg + dolelwth)* pmelY) where:

'Dol' signifies the expenditure for 2009,

'ng' represents natural gas

'p' represents propane

'kr' represents kerosene

'fo' represents fuel oil

'el' represents electricity

'hddfact' is the heating degree day adjustment factor for normalization

'cddfact' is the cooling degree day adjustment factor for normalization

'sph' is space heating

'wth' is water heating

'oth' is other appliances and uses

'col' is cooling,

'rfg' is refrigerator

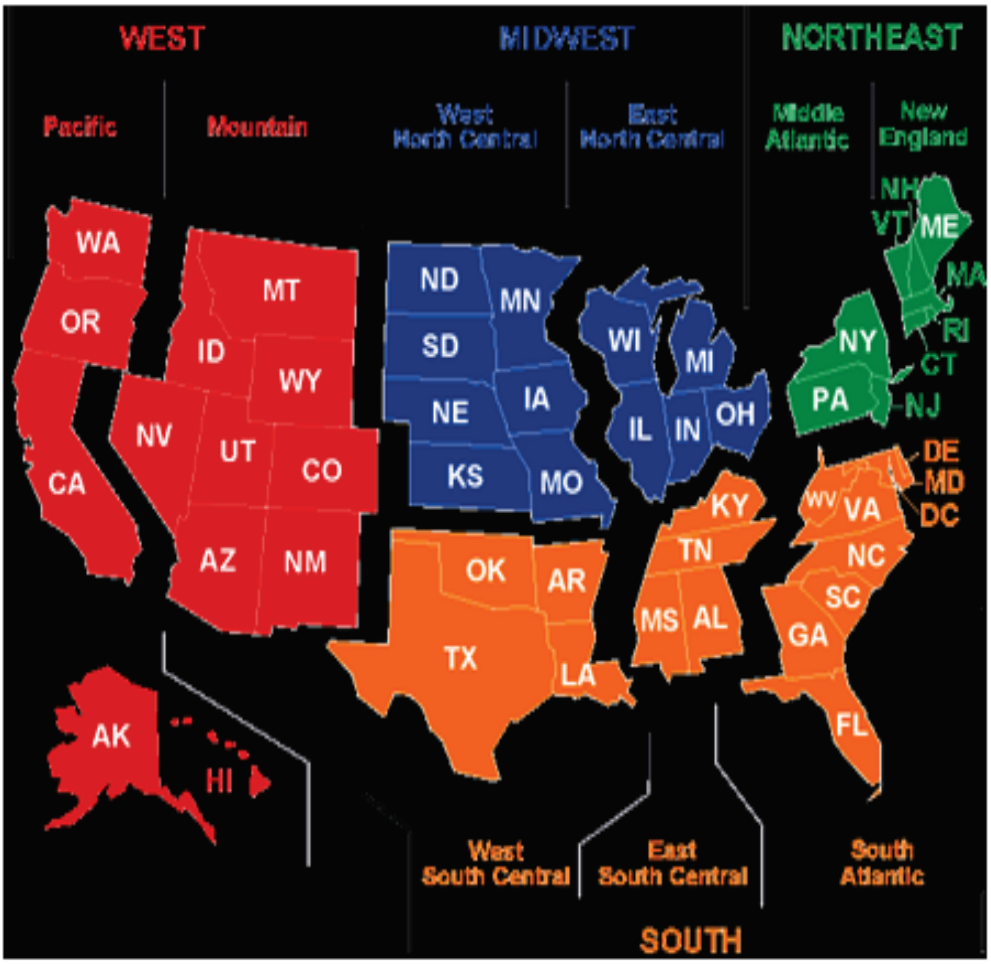
'pm' is price multiplier

'Y' is the fiscal year

Regional estimates were then made using the sort functions of SPSS to select households by region and qualification of eligibility for LIHEAP and the 'Explore' statistical function to derive means, medians, and standard deviations by primary heating fuel type for total expenditures as

well as heating and cooling expenditures for each year. Statistics were generated on a weather-normalized projected basis for FY 2009 through FY 2014

MAP OF CENSUS DIVISIONS AND REGIONS



APPENDIX B

List of References

Eisenberg, J, March 2010, "Weatherization Assistance Program Technical Memorandum Background Data and Statistics," Oak Ridge National Laboratory, Oak Ridge, TN.

Energy Information Administration, 2009 *Annual Energy Outlook For 2010, Early Release,* Washington D.C.

Energy Information Administration, *Residential Energy Consumption Survey for 2009*, Public Use Microsample, Washington D.C.

Energy Information Administration, *Short Term Energy Outlook, November, 2013,* Washington D.C.

Energy Information Administration, *Short Term Energy Outlook, October, 2012,* Washington D.C.

Energy Information Administration, *Short Term Energy Outlook, November, 2011,* Washington D.C.

Energy Information Administration, *Short Term Energy Outlook, October, 2010,* Washington D.C.

Energy Information Administration, *Short Term Energy Outlook, October, 2009,* Washington D.C.

U.S. Census Bureau, 2012, *Income, Poverty, and Health Insurance Coverage In The United States*, Washington D.C.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 2007, Historical Climatology Series 5-1, Monthly*, State, Regional, and National Heating Degree Days*, Asheville, NC.

U.S. Department of Health and Human Services, "2014 Poverty Guidelines," available at http://aspe.hhs.gov/poverty/14poverty.cfm (accessed April 24, 2014).

U.S. National Weather Service, Climate Prediction Center, 2007, *Experimental Monthly Total Degree Day Forecast*, Camp Springs, MD.