EXECUTIVE SUMMARY OF ELECTRIC AND GAS EFFICIENCY AND DIRECT USE RENEWABLE ENERGY RESOURCES AVAILABLE IN THE ENERGY TRUST OF OREGON SERVICE TERRITORY

Prepared by Energy Trust of Oregon Staff based on Studies Performed by Ecotope, Inc.
April 2004

1. EXECUTIVE SUMMARY

The goal of this project is to provide the Energy Trust of Oregon, Inc. (Energy Trust) with an analysis of potential energy efficiency and direct application renewable energy measures[1] that could provide electricity savings for Oregon consumers in PGE and PacifiCorp service territory and gas savings for commercial and residential consumers in Northwest Natural Gas service territory.[2] This analysis includes estimates of the potential savings and costs associated with these measures over a ten year period. The purpose of this information is to inform the development of resource strategies, action plans, and budgets for all efficiency programs combined, and the development and selection of individual programs.

Ecotope, Inc. (Ecotope), working with the American Council for an Energy Efficient Economy (ACEEE) and the Tellus Institute, reviewed existing data sources to identify and evaluate those electric efficiency and direct application renewable measures that could potentially provide savings opportunities through Energy Trust-sponsored programs in the residential, commercial and industrial sectors. Ecotope also did the entire gas efficiency study themselves. These firms reviewed existing technologies and emerging conservation approaches[3] for both electricity and gas to identify those measures most applicable, productive and cost-effective in the Energy Trust's service territory.

Conservation measures were developed from a variety of literature and from measures used in other natural gas conservation and efficiency programs throughout the country. The specific sources used for each measure are included in the individual spreadsheet workbooks provided to the Energy Trust. Measures were first reviewed for technical feasibility and appropriateness to the climate and local conditions. Applicable measures were then analyzed to calculate the potential life cycle costs and benefits, and to determine the technical potential for savings. For this report, the technical potential is defined as the total savings that could be expected if every building that could benefit from a particular measure is actually treated. Where efficiency opportunities are driven by equipment turnover or new construction, the turnover or new construction over ten years was the basis for the estimate.

It is important to note that this document estimates the cost of design, installation, and hardware for efficiency measures. Program-related costs are not included, because they can vary significantly based on program design issues that are outside the scope of this study. These will be incorporated by Energy Trust staff based on the specific designs of programs.

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[1] i.e., renewables that generate useful heat but not electricity, and are therefore part of the Energy Trust's efficiency funding
[2] Under the funding agreement between the Energy Trust and Northwest Natural for gas efficiency, industrial consumers are not eligible.
[3] An emerging technology is one that is not yet available in the equipment market in large quantities and at a reasonable price, but is close. Less attention was paid to emerging technologies, but a few with major implications were considered.

The intent of this document is to *approximate* the cost and savings from a wide variety of measures in a consistent way. More precise estimates are developed for some measures as programs are designed and evaluations reviewed.

The detailed reports on this project and the spreadsheets provided to the Energy Trust identify and provide quantitative estimates of electricity use and measures of activity (such as number of households or total floorspace) in the target markets. While this document is not intended to be a program design manual, some indications for program design that surfaced from the research are provided.

2. METHODOLOGY

2.1. Establish a Baseline

A baseline was estimated by housing and facility type. The number of homes, square feet of facilities, number of industrial employees, and some other factors were also estimated. By dividing the energy use by the number of these things, we developed initial estimates of energy use intensity. We also reviewed information on the current saturation of specific efficiency measures. Data came from the US Census, Pacificorp, PGE, Northwest Natural Gas, program and customer data set, and a variety of other surveys. Additional industrial data came from proprietary national databases.

For new construction, the baseline was developed based on forecasts of load growth and typical construction practices.

2.2. Compile and Analyze Lists of Measures

Lists of efficiency measures were developed in cooperation with Energy Trust staff and other efficiency experts. Measures were selected for inclusion on this list based on the following criteria:

- Reduces electric or natural gas energy consumption without significantly reducing service or utility levels to end users;
- Currently commercially available or nearly so;
- Appropriate to the service territory, climate, and local building practice;
- For new construction or renovation, the measures are more efficient than energy code requirements;
- A delivery infrastructure exists or can be established.

The measures identified in the initial list of measures were analyzed for cost and savings performance in the Energy Trust service territory. Data on measure costs, benefits, technological maturity, and applicability were collected.

Typical costs and savings associated with individual measures were estimated using the results of prior evaluations and engineering analyses, plus additional analysis performed by the study team. Measures were divided into "existing" measures, which are now available off-the-shelf, and "emerging" technologies, which are expected to be commercially available soon, but are now either not widely available, not yet proven reliable or currently too costly. Costs and savings were quantified for both groups. Generally, savings and costs were estimated for a specific facility or housing type. Savings and cost are also estimated separately for new construction and for existing buildings or facilities.

2.3. Resource Assessment

2.3.1. Data Collection

To develop the inputs required for this study, the team utilized a wide variety of resources. A literature review was conducted to collect equipment and labor costs and energy benefits. This review was augmented by internal data developed by the team members for use in prior projects. Where available, the Northwest Power Planning Council's (NPPC) Regional Technical Forum (RTF) data was utilized in the residential sector to collect costs and energy benefits. In addition, the NPPC libraries provided cost and benefit data for many of the commercial sector measures. In some cases, technical papers or data provided by manufacturers was used. The data source(s) used for each measure are noted in the Notes and Sources section of each measure workbook.

To determine the applicability of measures to the Energy Trust service territory and to assess market conditions, economic and census data was collected from Economy.com and from the U.S. Census Bureau and the Department of Housing and Urban Development. Population estimates were also collected from the Portland State University Center for Population Studies and from the Manufactured Housing Association.

Where available, public documents prepared by the individual utilities were used to generate electricity and gas end use or device saturation and penetration rates for the Energy Trust service territory. Where not available, these rates were extrapolated from county- or state-level data.

2.3.2. Prioritized List of Conservation Measures

The results of our assessment are provided in the form of separate spreadsheets for the residential, commercial and industrial sectors. For each measure or package of measures, we developed cost and savings estimates (including peak load savings), as well as an estimate of overall achievable energy savings over the next ten years. To generate both the costs and savings impacts over time, we assumed that the measure was applied to all potential candidates over the course of ten years. These calculations could change considerably as specific programs are developed, but provide an overview of the maximum potential available from each measure. As a final step, the list of measures was prioritized by overall cost-effectiveness.

2.3.3. Indicate Approximate Cost-Effectiveness of Measures

The incremental cost of the equipment examined in the measure over that required by the relevant energy code was used where applicable in new construction, renovation and replacement, and over existing equipment for retrofit situations. Where appropriate, differences in operations and maintenance cost and in installation costs are also considered.

Measure savings are considered to be the savings that accrue throughout the life of the measure. The methods used in this study do not account for variations in the value of savings by time of day, week, and year. Energy Trust staff will perform more detailed cost-effectiveness screening, incorporating these factors, prior to including measures in programs. Thus, the cost-effectiveness information in this study is only used to indicate the approximate quantity of cost-effective savings.

To compare and prioritize measures, we developed a levelized cost of saved energy (CSE) for each measure or package of measures. The cost is amortized over an estimated measure lifetime using an average discount rate (in this case a real discount rate of 3 percent/year, which is the standard value used by Energy Trust), and added to any net annual operating and maintenance cost (or benefit) to estimate an annual net "levelized" cost for the measure. This annual net measure cost is then divided by the annual net energy savings in kilowatt-hours or therms from measure application (again relative to a standard technology) to produce the CSE estimate in dollars per kWh or therm saved. The cost-effectiveness criteria employed in this study $0.05/lifetime kWh and $0.50/lifetime therm, levelized.

2.3.4. Determine Savings Potential

In order to determine total savings potential we assumed that the measure would be applied to 100% of situations for which it was applicable and for which no related measure was applied. For retrofit measures, we assumed that 10 percent of the population would be addressed each year for a period of ten years. For replacement measures, we first calculated a replacement rate and then assumed that the measure was applied to all of the replacements for which it was appropriate. For new measures, we assumed that all of the applicable new construction was treated every year for ten years. Growth rates were developed based on US Census Bureau data.

We also limited savings by considering market potential, infrastructure, climate, energy use, energy costs, and other variables that impact the usefulness of each of the measures in the particular market served by the Energy Trust.

The savings potential of cost-effective measures is therefore a subset of the total savings potential.

3. SUMMARY OF RESULTS

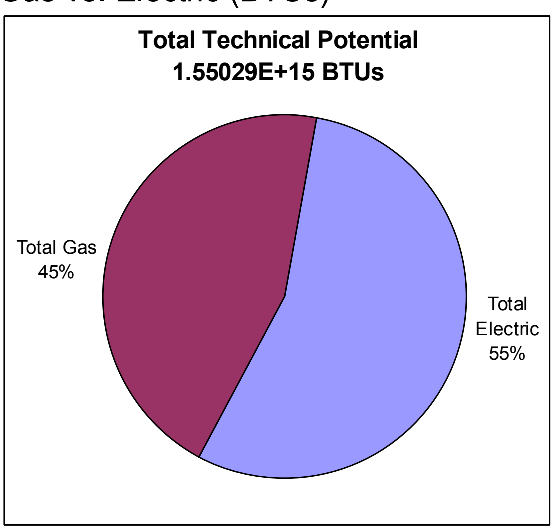
This section is designed to provide an overview of the most significant results from the study. The results in this section that are shown in pie charts are based on measures that pass the determined cost-effectiveness screen thresholds. The line charts show total savings including measures that are not cost-effective. This may be of interest because some of these measures could become cost-effective over time as costs decrease if volume increases or sales channels become more efficient.

3.1. Total Technical Potential

3.1.1. Electric vs. gas efficiency potential

In order to compare the total technical potential for energy savings from both electric and gas the total savings from both resources are converted to British Thermal Units (BTUs). The potential for savings is only slightly greater for electric than gas resources (See Exhibit 1-1) despite the fact that the service territory of Northwest Natural Gas is significantly smaller than the combined service territories of PGE and PacifiCorp.

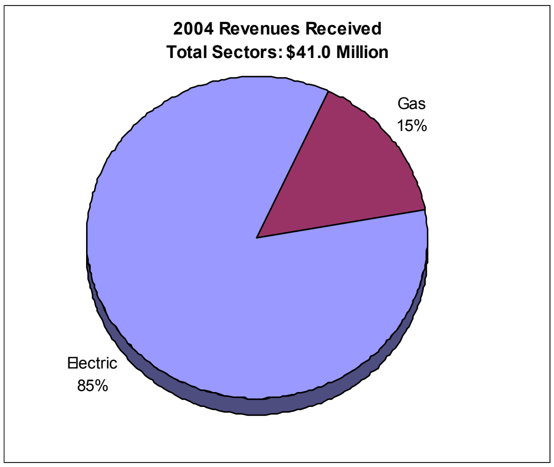
Exhibit 1-1: Technical Potential-
Gas vs. Electric (BTUs)

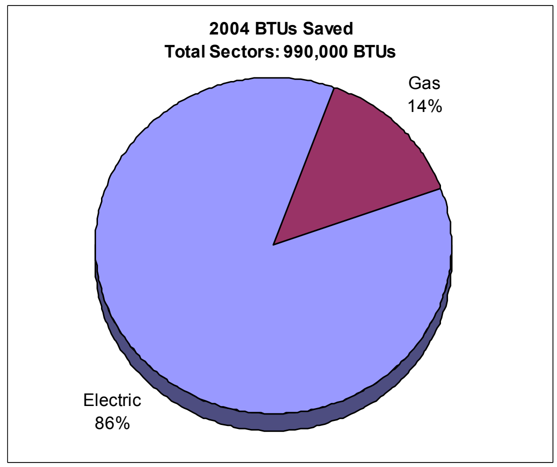


3.1.2. Comparison of efficiency potential by fuel to revenues by fuel

Only 15% of the total $41.0 million dollars in revenues received for 2004 are projected to come from the gas sector, while the other 85% come from the electric sector (See Exhibit 1-2). In 2004 the projected energy savings are 990,000 BTUs. Fourteen percent of these savings are attributed to gas while 86% are attributed to electric. Therefore, forecasted BTU savings are roughly proportional to funding in comparing electricity to gas.

Exhibit 1-2: Gas vs. Electric Revenues and Savings

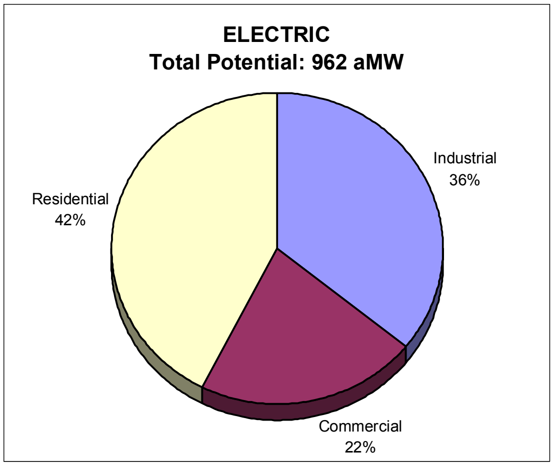


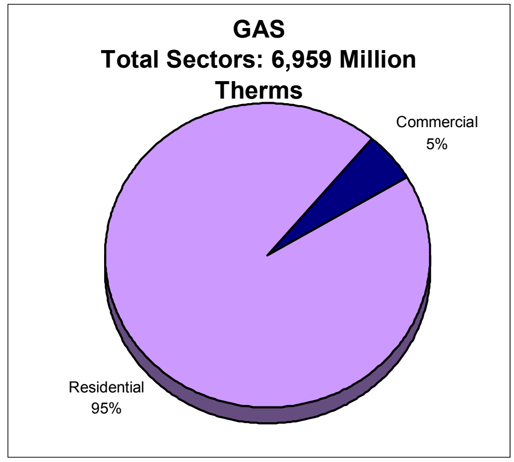


3.1.3. Cost-effective efficiency potential

There is a total cost-effective electrical efficiency potential of 962 aMW. This potential is derived from efficiency measures that break down as follows: 36% from industrial, 42% from residential, and 22% from commercial (See Exhibit 1-3). Gas has a total technical potential for savings of 6,959 million therms. Of this total 95% is from residential savings while the other 5% is from commercial savings. While Northwest Natural Gas does serve industrial customers the Energy Trust is not currently funded to offer gas efficiency programs to industrial customers, so industrial gas conservation potential was not included in this study.

Exhibit 1-3: Total Efficiency Technical Potential, Electric vs. Gas

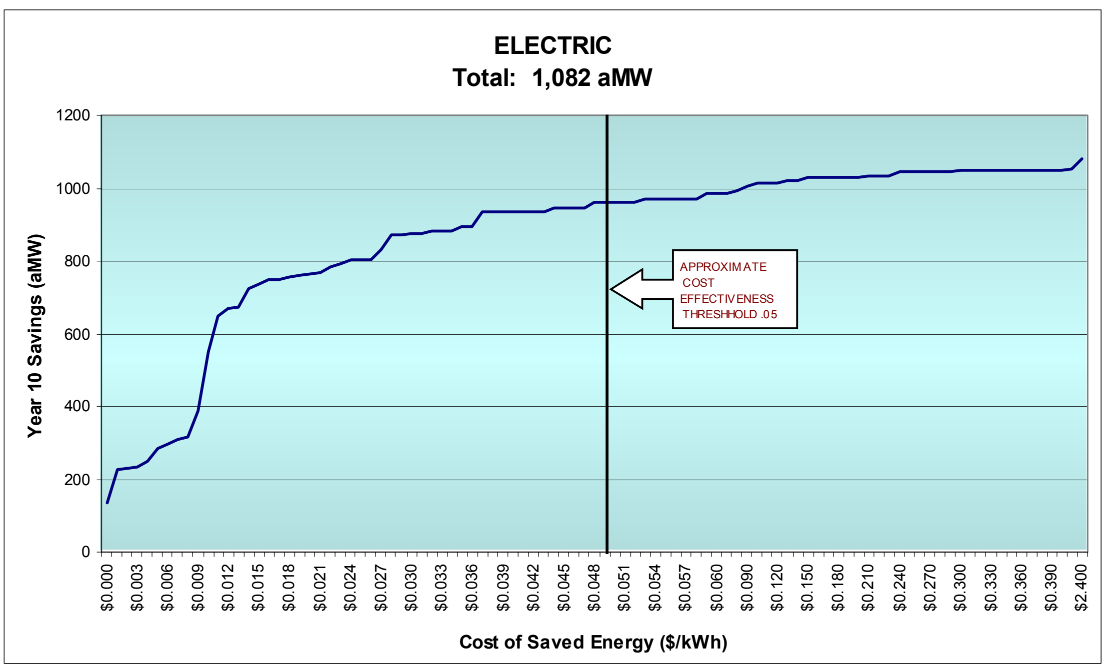




3.1.4. Total efficiency potential

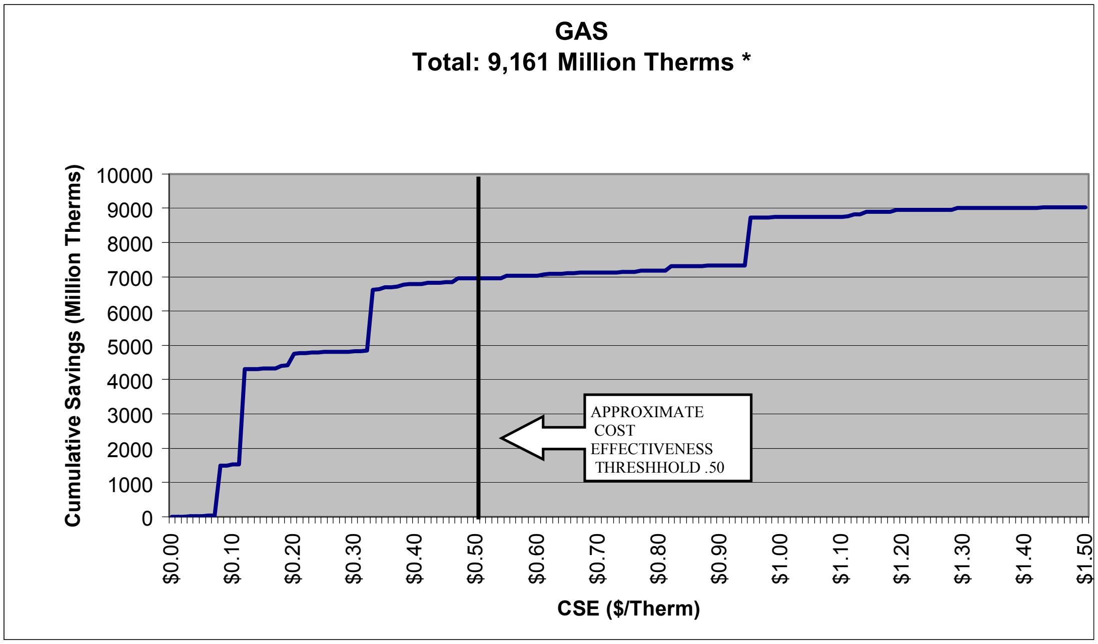
Savings that can come from electric efficiency measures total 1082 aMW (See Exhibit 1-4). About 90% of the savings can be achieved under the approximate cost effective threshold of $0.05/kWh.

Graph 1-4: Total Electric Technical Potential



For gas efficiency, a significant fraction of the savings is near or above the cost of sourcing and delivering the same amount of gas. This is based on a relatively modest estimate of future gas price increases. Gas prices are highly uncertain. For gas, 9,161 million therms can be conserved by implementing all potential efficiency measures (See Exhibit 1-5). Around 76% of the total potential fall under the cost effectiveness threshold. Some of these measures may not be cost-effective once load shape is considered, particularly those with year-round savings such as water heating. Gas savings are most valuable in the winter.

Exhibit 1-5: Total Gas Technical Potential



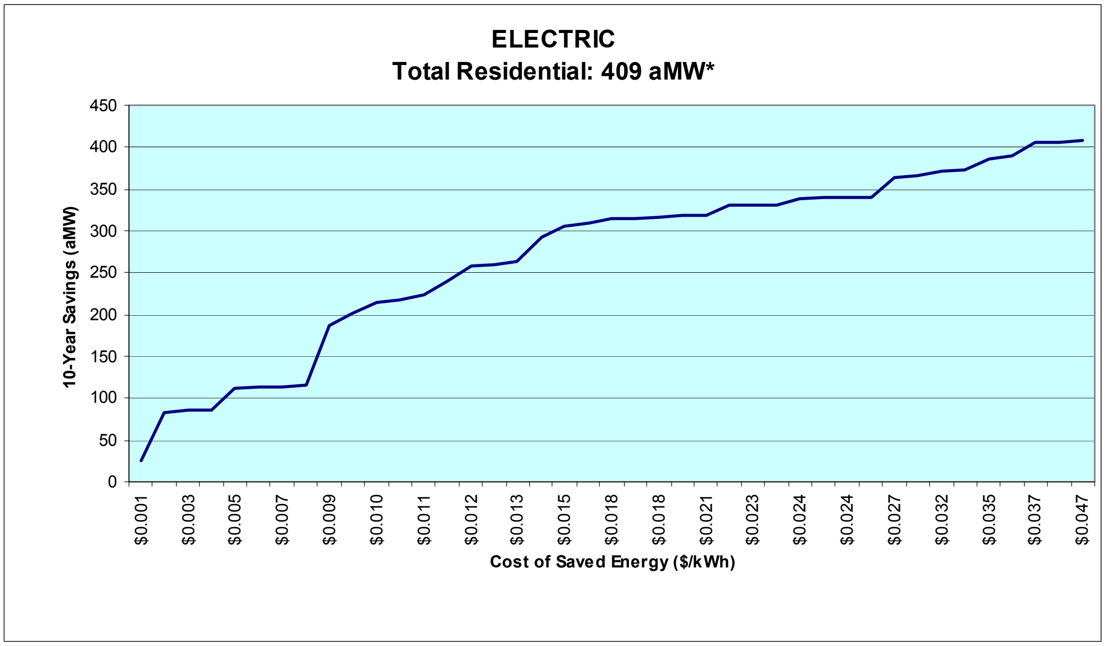
*In order to improve readability, the graph does not include the tiny fraction of savings costing more than $1.50/Therm

3.2. Residential Sector

3.2.1. Total residential technical potential

All of the total technical potential of 409 aMW from residential electric efficiency measures can be achieved under the cost effectiveness threshold of $0.05/kWh (See Exhibit 1-6). Note that efficiency upgrades to single family window replacements were included as one measure in this graph, but in a more detailed analysis these upgrades were found to be not cost-effective on average. They are still included in the 2003-4 Home Energy Savings Program, but justified as an experimental marketing activity; we will see if they draw enough participants to the program that also install other measures to justify continuing to pay a small incentive . We did not include window retrofit (i.e., replacing a functional window primarily to save energy), only the incremental cost of more efficient-than-typical replacements.

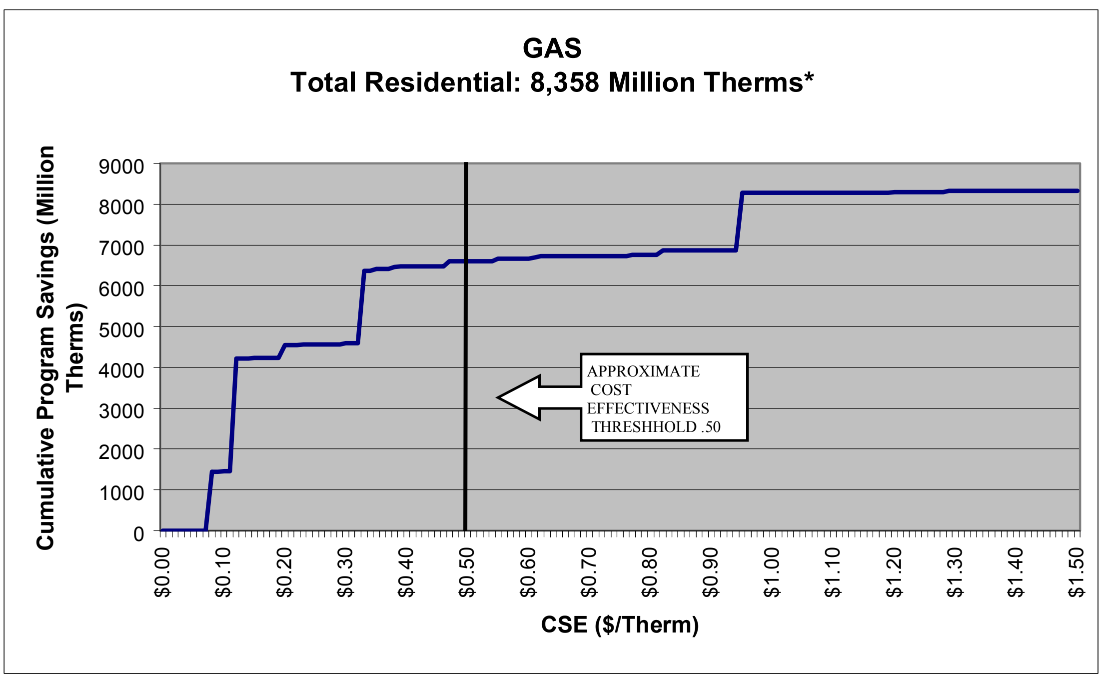
Exhibit 1-6: Technical Potential, Residential Electric Efficiency



* All of the savings on this chart come in under the $0.05/kWh cost-effectiveness threshold.

The total technical potential for residential gas efficiency is 8,358 million therms (See Exhibit 1-7). Of this total, 79% (6602 million therms) can be saved by efficiency investments that fall below the approximate cost effectiveness threshold.

Exhibit 1-7: Technical Potential, Residential Gas Efficiency

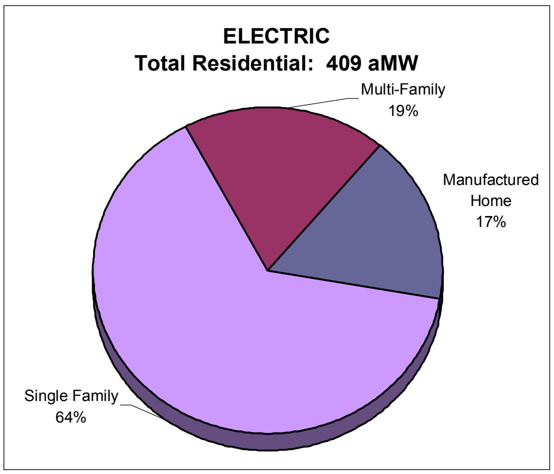


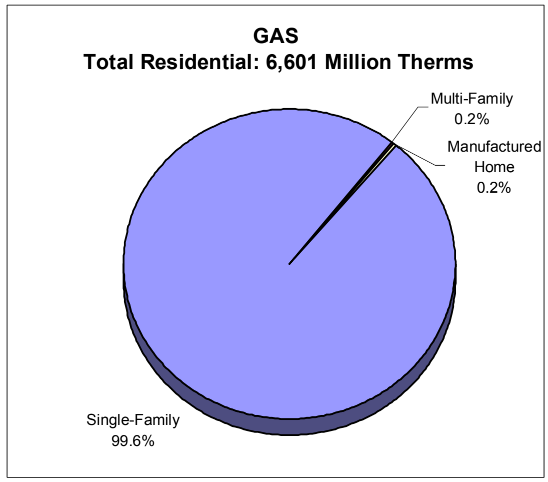
*In order to improve readability, the graph does not include the tiny fraction of savings costing more than $1.50/Therm

3.2.2. Residential savings by housing type

Residential efficiency measures break down into single-family, multi-family, and manufactured home categories (See Exhibit 1-8). Of these three, more than half of the potential measures (64%) can be implemented in the single-family home category. In comparison, almost all of the entire potential for residential efficiency measures for gas is in the single-family housing category.

Exhibit 1-8: Total Efficiency Technical Potential, Residential Electric vs. Residential Gas

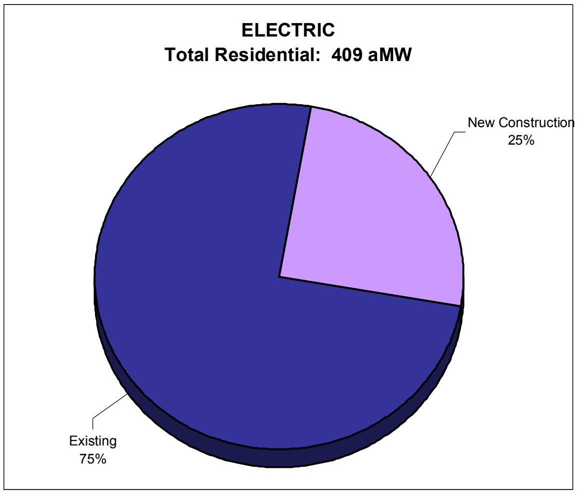


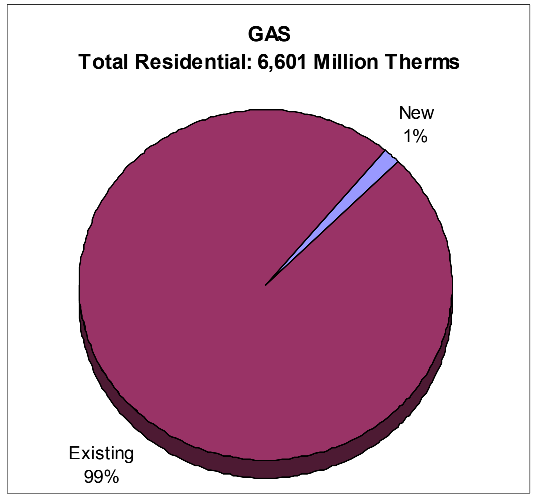


3.2.3. Residential potential for existing dwelling compared to new construction

The technical potential for residential efficiency for both electric and gas is dominated by measures that can be implemented on existing residences as opposed to measures that can be undertaken via new construction projects over the next ten years (See Exhibit 1-9). Potential for gas savings is especially high at 99% in existing residential buildings. For comparison, the total potential residential electric savings from existing buildings are at 75%. The estimate of gas new housing savings in these charts is probably an understatement. Nevertheless, Oregon's aggressive building efficiency code leaves only modest opportunities in new homes, and many are with typically electric measures such as lights and appliances.

Exhibit 1-9: Technical Potential, Residential Efficiency

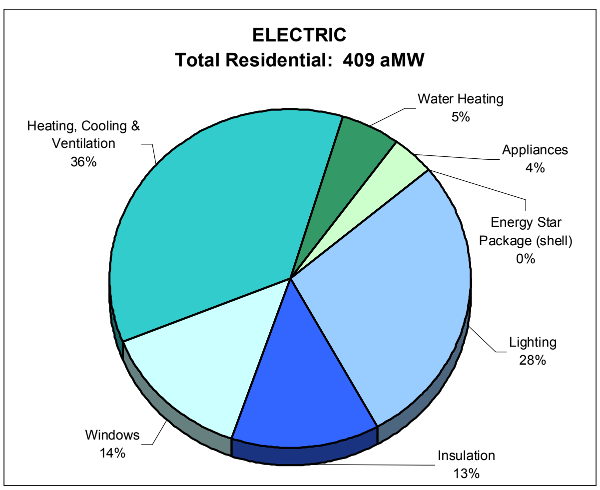


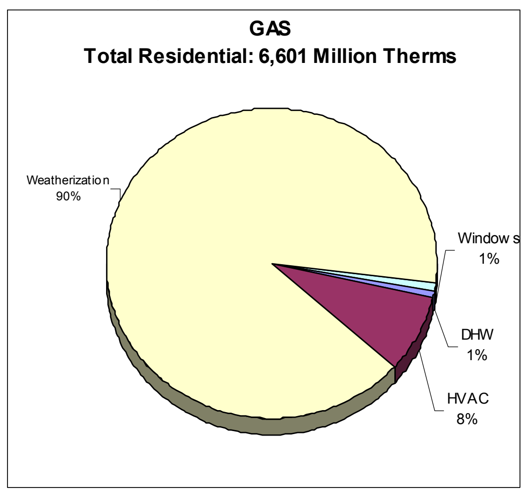


3.2.4. Residential savings by measure type

Individual efficiency measures to maximize savings potential for electric and gas in residential differ significantly (See Exhibit 1-10). While residential electric savings could come from a wide variety of measures, residential gas savings are predominantly from weatherization (insulation). This is true for existing housing and to a lesser extent for new homes too. This is a result of the greater variety of electric home appliances, the greater electric market share for some appliances (e.g., dryers) and the relatively large amount of weatherization in electric dwellings that has already been done.

Exhibit 1-10: Technical Potential, Residential Efficiency, Specific Measures



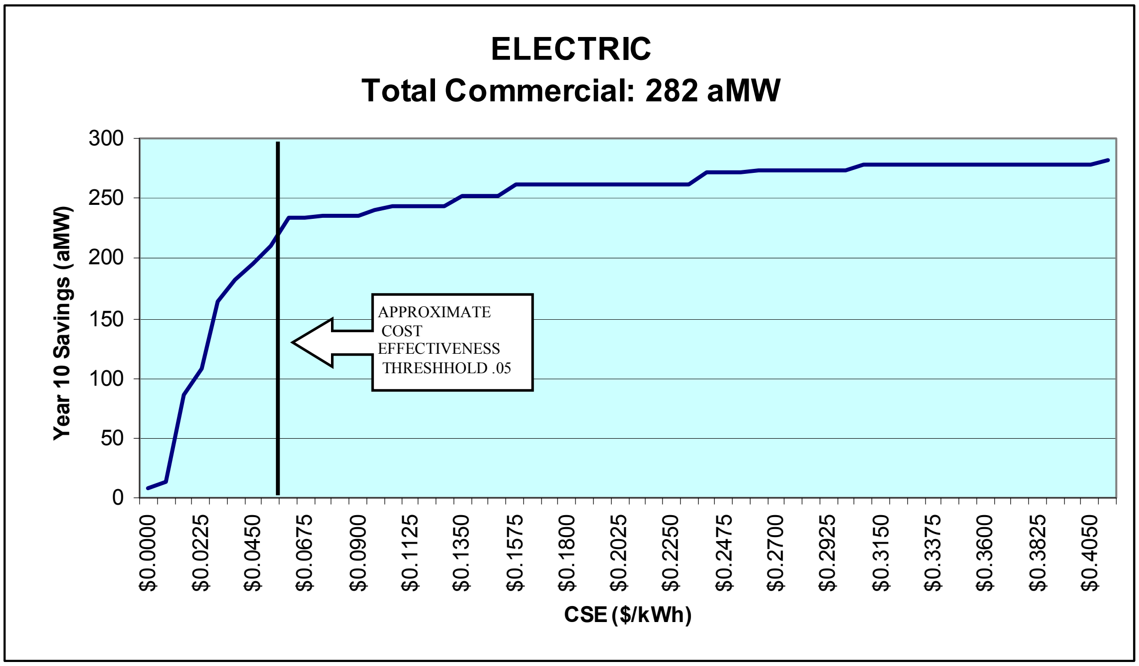


3.3. Commercial Sector

3.3.1. Total commercial technical potential

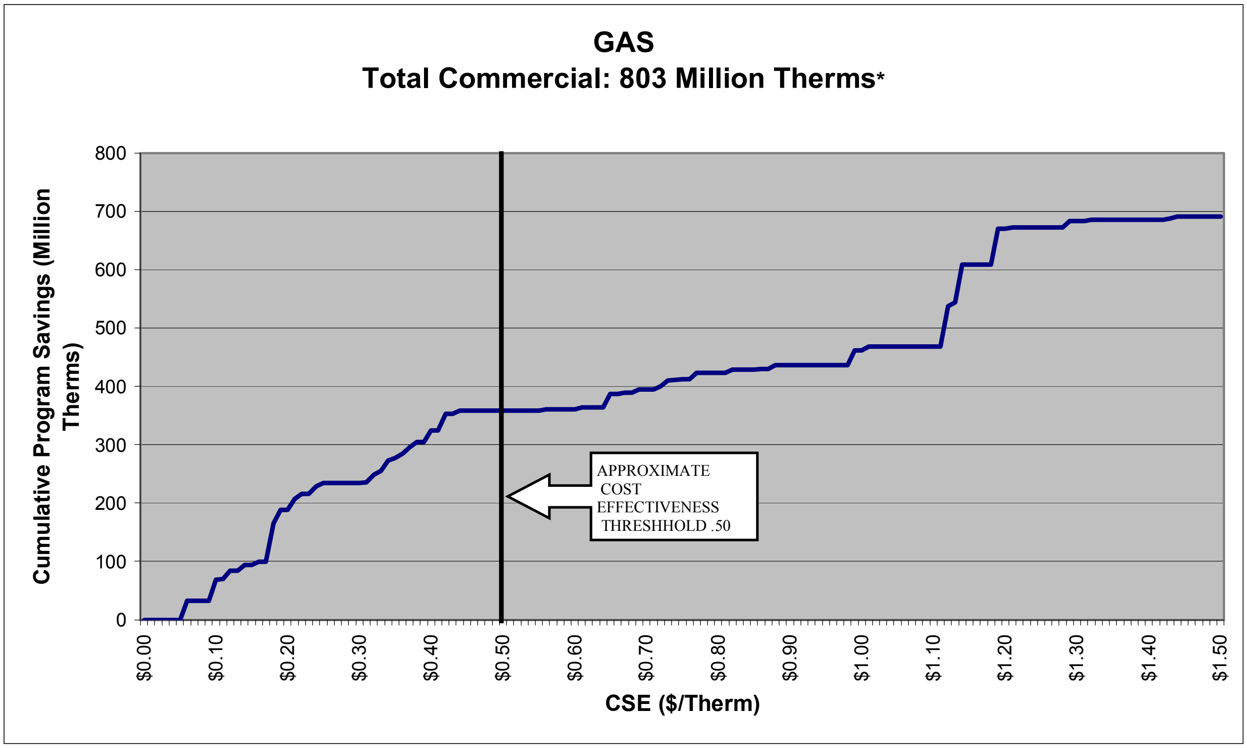
Much of the total potential efficiency from electrical measures can be achieved at lower cost than the cost effectiveness threshold (See Exhibit 1-11). A few individual electric efficiency measures go a long way towards achieving the maximum potential efficiency in the commercial sector. The graph demonstrates that while there are many measures that cost more than the cost-effectiveness threshold, they collectively contribute a modest amount of savings.

Exhibit 1-11: Technical Potential, Commercial Electric Efficiency



Less than half of the total potential efficiency from commercial gas measures can be implemented at lower cost than the cost effectiveness threshold (See Exhibit 1-12). However the amount of savings that cost less than the threshold is significant.

Exhibit 1-12: Technical Potential, Commercial Gas Efficiency



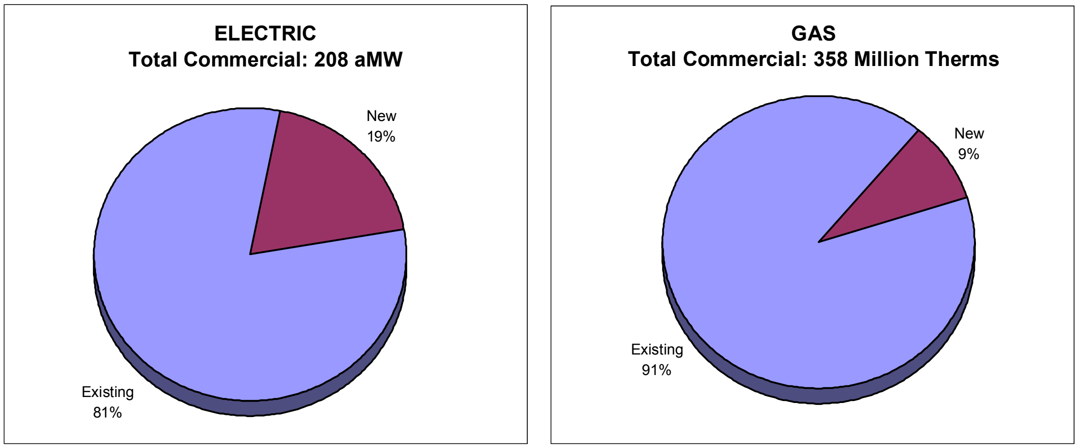
*In order to improve readability, the graph does not include the last 100 Therms of savings costing more than $1.50/Therm.

3.3.2. Commercial savings from new compared to existing buildings

Commercial savings consist of a total of 208 aMW of electric potential and a total of 358 million therms for gas (See Exhibit 1-13). Commercial potential makes up 22% of electric savings potential and 5% of gas savings potential. Both electric and gas savings potentials are primarily attributable to existing commercial facilities.

Most of the cost-effective gas and electric potential for savings in the next ten year comes from existing buildings. One important reason is Oregon's relatively advanced building energy code. Code savings are assumed in the baseline for this analysis, and are therefore not included in the graphs.

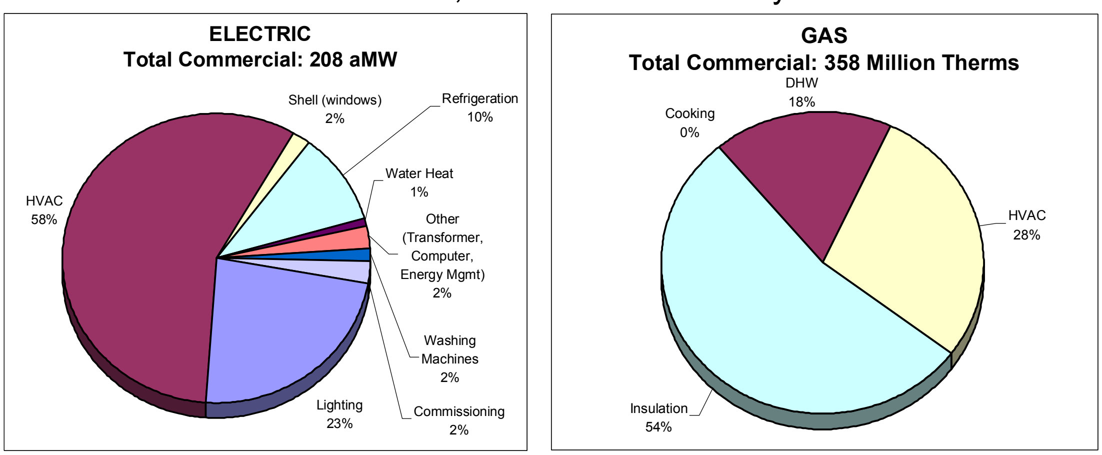
Exhibit 1-13: Technical Potential, Commercial Efficiency



3.3.3. Commercial savings by measure types

Of the total cost-effective technical potential, 42% is attributable to measures with HVAC, 58% is from wastewater measures, and 23% is from lighting (See Exhibit 1-14). For commercial gas more than half of the total potential is from insulation measures while HVAC and hot water measures make up the other half.

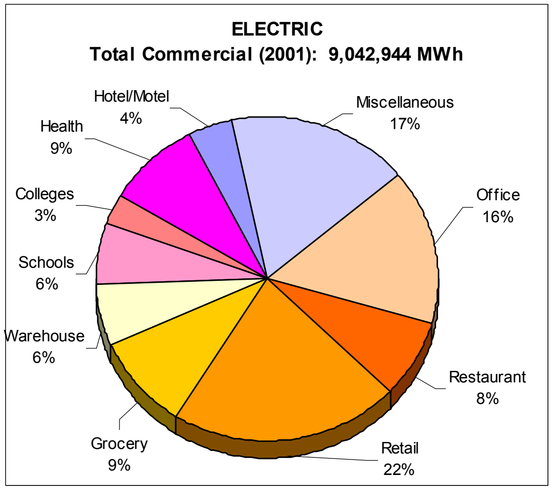
Exhibit 1-14: Technical Potential, Commercial Efficiency Measures

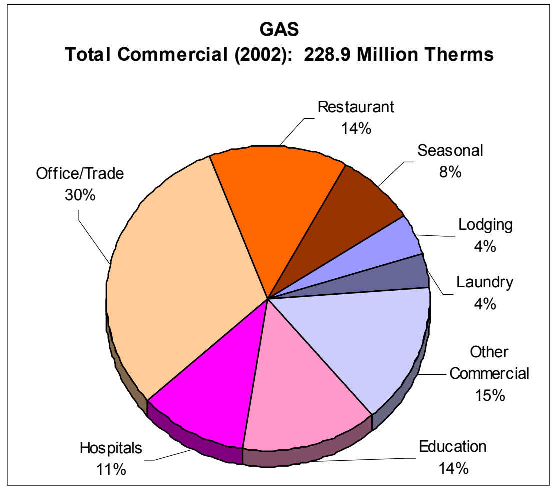


Commercial savings by building type

The technical potential for commercial savings is distributed across a variety of building types for both electric and gas efficiency (See Exhibit 1-15). The most important blocks come from office and retail buildings. Buildings that defy categorization (other) are a large fraction of building stock, and therefore have a large share of estimated savings.

Exhibit 1-15: Technical Potential, Commercial Building Type

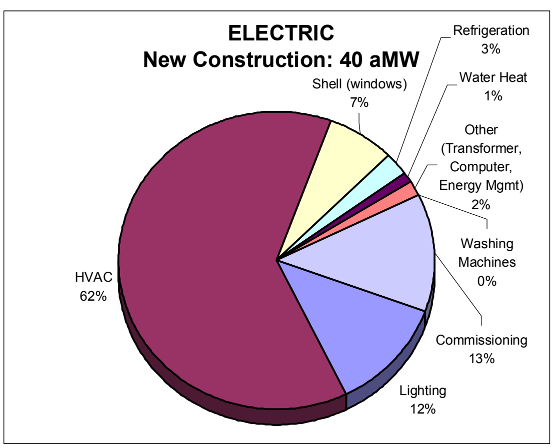


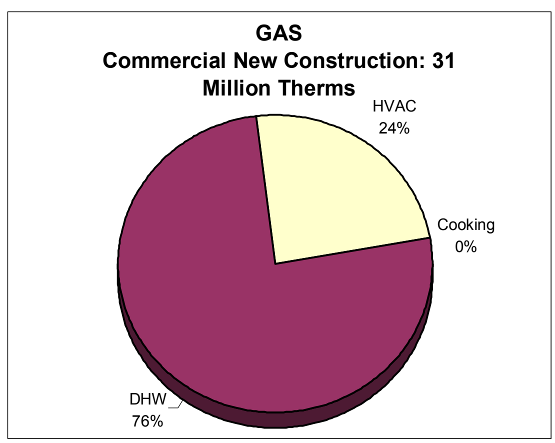


3.3.4. Commercial new construction savings by measure type

The potential for efficiency for new construction measures for electric and gas are both a small proportion of the total potential (See Exhibit 1-16). Most of the electric savings opportunities are in HVAC (heating, cooling and ventilation) windows, lighting and in commissioning buildings and equipment. Commissioning means assuring that the equipment operates as intended in the design. Gas measures are mostly for heating and hot water, although there are some cooking opportunities. The 0% for cooking means that the savings don't add up enough to register once the numbers are rounded.

Exhibit 1-16: Technical Potential, New Construction Commercial Efficiency Measures

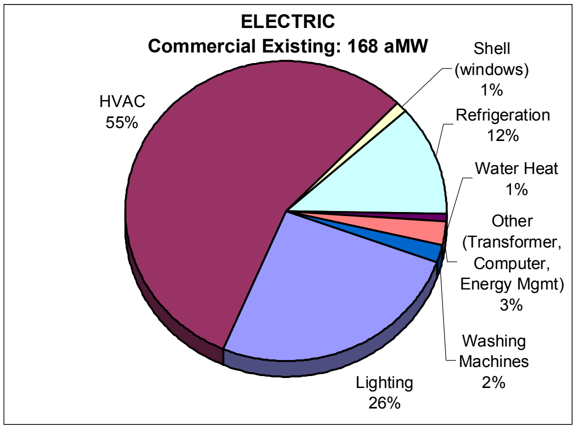


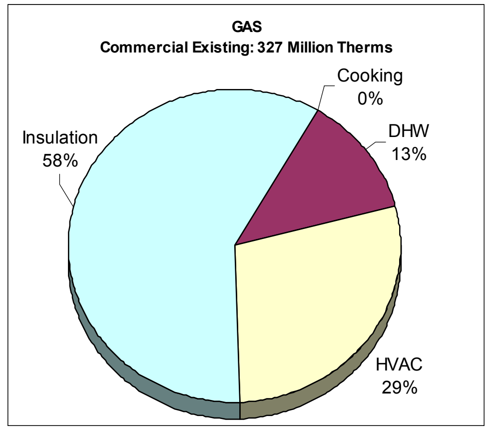


3.3.5. Commercial existing building savings by measure type

The picture for existing commercial electric and gas measures more closely resembles the total potential for commercial electric and gas savings (See Exhibit 1-17). HVAC measures make up 55% while lighting measures make up 26% of the total 168 aMW electric potential. Likewise insulation makes up 58% and water heat makes up 29% of the total 327 million therm gas potential.

Exhibit 1-17: Technical Potential, Existing Commercial Efficiency Measures





3.4. Industrial Sector

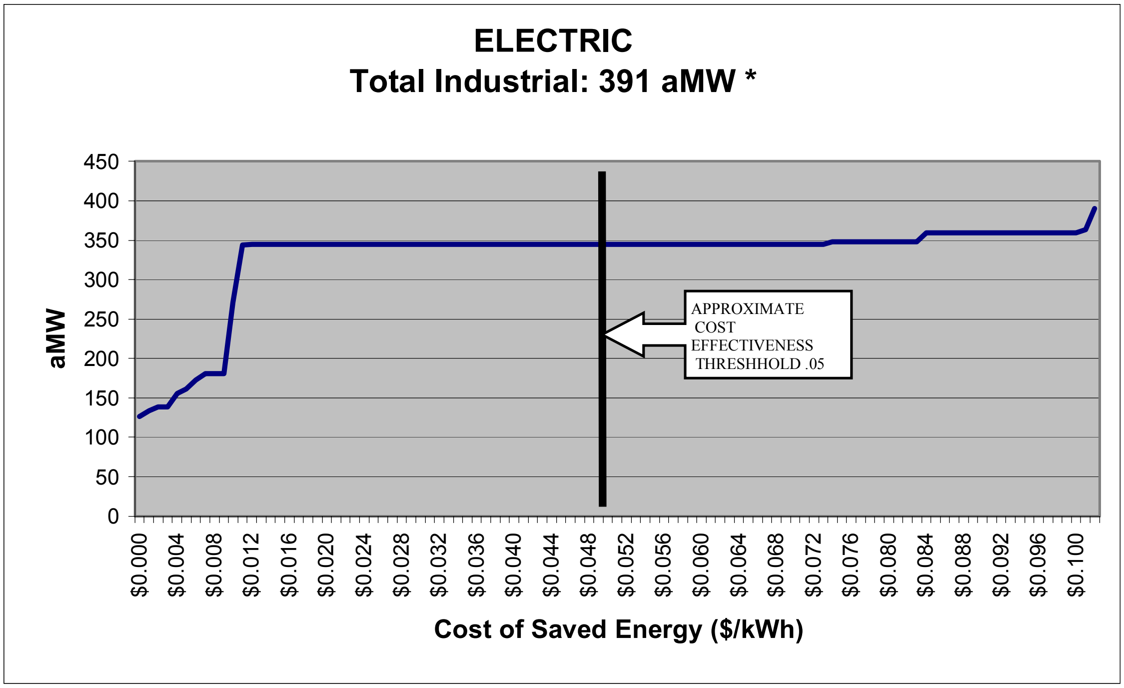
It is important to view the industrial supply estimate as a rougher cut than for the other sectors. It is notoriously difficult to analyze industrial efficiency potential. The future of many large plants in Oregon is uncertain, as is the siting of new plants. This creates further uncertainty about savings opportunities. Therefore, the Energy Trust contracted for a modest analysis, hoping to develop reasonable aggregate answers by looking at some representative opportunities. In its programs, the Energy Trust is already identifying major efficiency opportunities that were not considered in this study. However, further analysis may not lead to timely improvements in precision.

For industry we only looked at electric savings because the Energy Trust is not funded to pay for gas industrial efficiency.

3.4.1. Industrial technical potential

The majority of industrial electric energy savings cost less than 5 cents/kWh (See Exhibit 1-18).

Exhibit 1-18: Technical Potential, Industrial Electric Efficiency



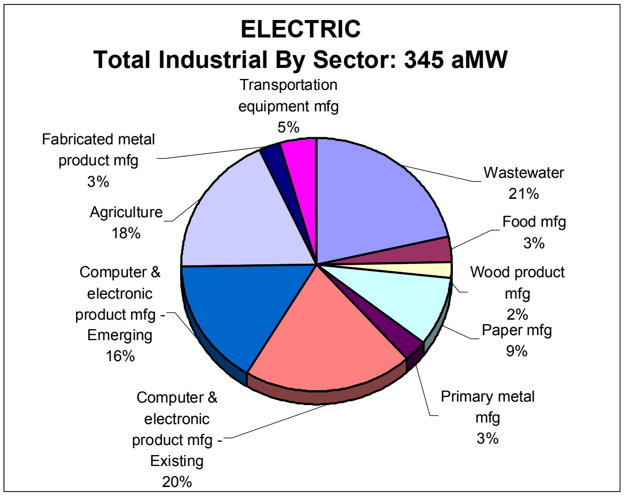
*The best cost of saved energy is -$96.50 for advanced motor design. The last few data points on the x-axis represent a CSE drawn out to $2.50/kWh.

3.4.2. Industrial potential savings by industry type

Different industries have different potential for savings (See Exhibit 1-19). Computer and electronic product manufacturing combined constitute 36% of the total industrial potential. This category has been broken into existing and emerging categories in the chart with shares of 16% and 20% respectively. The size of this category is interesting, in that computer and electronics industries have been relatively modest participants in historic process efficiency programs. The largest measures implemented have been for lighting and chiller control.

Wastewater offers large savings potential with a 21% share of all industrial savings.

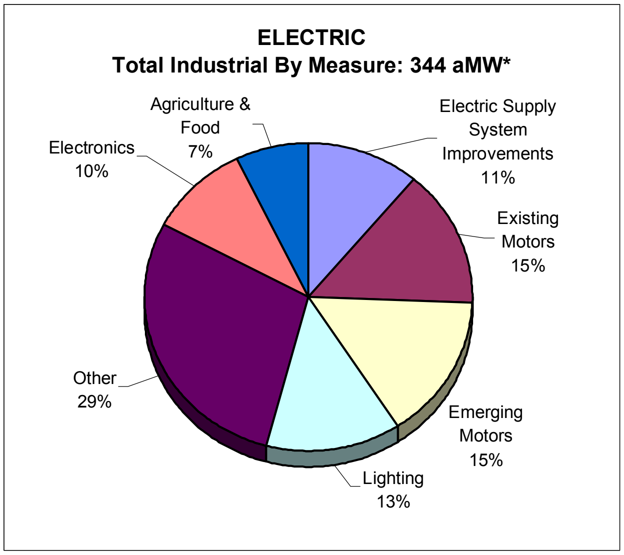
Exhibit 1-19: Technical Potential, Industrial Savings by Industry



3.4.3. Industrial savings by measure type

Within industrial, a total 30% of the potential for electric savings from specific measures fall into the motors category which is divided into general efficiency measures focused on existing motors and motor/drive systems (e.g., pumping, compressed air) and emerging motor design improvements (See Exhibit 1-20). The "Agriculture and Food" and "Electronics" categories consist of special process measures for those sectors that are not in the other categories. In addition, 29% of measures are in the "other" category, which includes duct/pipe insulation, generic operation and maintenance, and sensors and controls. A significant share of the "other" savings is thought to come from chiller pipe insulation. National studies indicate that many industrial facilities have not installed relatively low-cost insulation on their chilled water pipes. Reports from Oregon on this issue are sketchy.

Exhibit 1-20: Technical Potential, Industrial Savings by Measure



*Number does not equal 345 aMW probably due to rounding issue.

A more detailed breakdown by measure type is available in the detailed report.