# A Standardized Cost Effectiveness Analysis
## for
## Market Transformation Projects

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## ABSTRACT

The purpose of this paper is be begin a discussion among energy efficiency organizations about cost effectiveness analysis of market transformation as opposed to utility acquisition projects. The Northwest Energy Efficiency Alliance (Alliance) has standardized cost-effectiveness model called ACE (Alliance Cost Effectiveness) Standardized Model [2]. ACE has two parts, ProCost [1], a life cycle cost tool developed by the Northwest Power Planning Council and an Excel workbook to document the inputs to ProCost. These input included regional factors such as discount rate, future market value of electricity, etc. as well as eight specific inputs for each project. Because a project may have multiple measures, weighted-average values must be defined and documented. ACE has been applied to fifteen Alliance projects.

The long term (by 2010) benefits of the fifteen projects included over 4,000 GWh per year in electrical energy savings and non-electricity benefits valued at $261 million dollars per year. The total regional installed first cost for these fifteen projects was estimated at $1.2 billion dollars of which the Alliance contributed $55 million, less than 5%. The consumers pay a net incremental annual operations and maintenance cost of $15 million per year.

Long-term regional benefit-to-cost ratios for the projects ranged from 1.1 for a residential duct project to 11.7 for an industrial project to insulate electric furnaces growing silicon crystals. For the fifteen projects combined the regional benefit-to-cost ratio is 2.7. This means that the region will gain $2.70 for every dollar invested in the fifteen projects.

## Introduction

This paper defines a market transformation, energy efficiency project and explores how it differs from a utility acquisition project. It also describes the approach used by the Northwest Energy Efficiency Alliance (Alliance) to analyze cost-effectiveness. Then a summary of results from applying the Alliance Cost Effectiveness (ACE) approach to fifteen Alliance projects is presented.

## Market Transformation versus Acquisition

A market transformation project strives to make permanent, long-term changes in the existing marketplace and to assure that consumers recognize the superior benefits of energy efficient options—products or services. Market transformation can conflict with traditional utility conservation acquisition projects that seek to obtain energy savings within the confines of a utility-based program. Market transformation projects work across utility boundaries with existing, regional supplier networks to help deliver products and services to consumers. Market transformation projects may co-fund marketing campaigns and run special promotions

to attract consumers.  They may also provide temporary sales incentives to sales personnel and price subsidies through the supplier.  Utility acquisition projects seek detailed documentation of energy efficient products placed in a specific service area.  Data needs may lead a utility to create its own, temporary high volume product supply channel.  This can hurt the existing market channels that cannot compete with targeted, mass marketing and subsidized pricing.  When a utility ends its acquisition project, it may leave the existing market channels in disrepair and less able to serve future consumers.

## How an Analyst Sees the Impact of a Market Transformation Project

To better understand a Market Transformation project, it is helpful to look at how analyst sees its impact on the market.  If an energy saving product or service is already being sold, then the market will have two parts, non-efficient units and efficient units.  A new market transformation project brings vendors, project contractors, utility regulatory agencies, and other stakeholders together.  Because the analyst needs to account for who gets credit for the energy savings, the process begins with the vendors and contractor predicting how many total energy efficient units will be installed each year during the planning period.  At the Alliance the planning period begins with the contract and ends in 2010.  The analyst sub-divides the energy efficient units into three parts—Baseline, Contract and Market Effects.
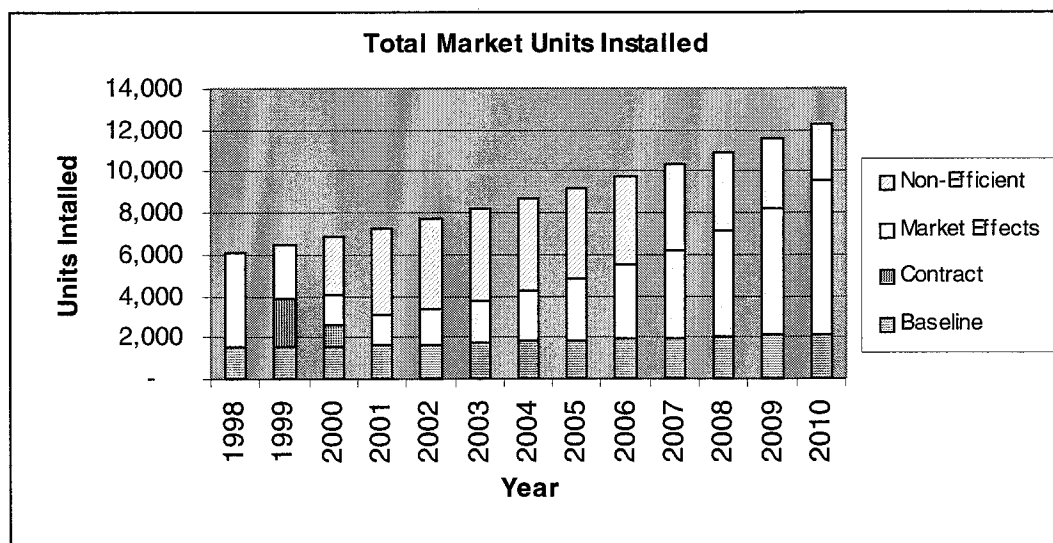


**Figure 1.** Annual Market -- Installed Units by Type

The cost effectiveness analyst to assure that the project does not take credit for what is already happening in the market defines Baseline units.  Contract units are those installed directly by the contractor with funding from the Alliance.  Market Effects units are those indirectly influenced by the project but not given any Alliance funding.

Figure 1 shows an example market before and after a Market Transformation project begins.  In 1998 the market has only two types of units—1,500 efficient and 4,600 non-efficient for a total market of 6,100.

In 1999 when the project begins the analyst predicted that the total market would grow by 6%, making the total number of units in 1999 about 6,500.  The vendor's marketing plan predicts that about 3,800 efficient units would be sold.  Of these the project contractor has

agreed to install 2,300 units under contract to the Alliance and the remaining 1,500 efficient units will be called Baseline units, the same number as were installed in 1998. Subtracting the Baseline units and Contract units from the total of 6,500 leaves 2,700 non-efficient units in 1999.

In 2000 the analyst estimated that the total market would grow by 6% from 6,500 to 6,900. The vendor's marketing plan estimated a total of 4,200 efficient units would be sold in year 2000, leaving 2,700 non-efficient units. The analyst decided to increase the Baseline units by 3% to 1,545. The project contractor has committed to installing 1,000 units in year 2000. Subtracting 1,545 Baseline and 1,000 Contract units from the 4,200 estimated total efficient units, leaves 1,655 units. These units that will be installed and paid for by someone other than the Alliance are called Market Effects units.

In year 2001 the total market grows another 6%, so there is a total market of 7,300 units. The vendor's marketing plan estimated 4,300 energy efficient units in 2001, so the non-efficient units will increase to 3,000. The Baseline units grow another 3% to 1,600 leaving 2,700 Market effects units to be installed. The contract ended in 2000 so there are no direct contract units installed in 2001.

In each of the following years the total market has only three types of units, Non-efficient, Baseline and Market Effects. The total market continues to grows at 6% each year, the vendor's marketing plan estimates total energy efficient sold each year, and the Baseline units are assumed to grows at 3% each year.

## Why a Standardized Cost Effectiveness Approach?

As more and more organizations recognize the value of working with existing supply channels, market transformation projects have evolved away from traditional utility acquisition projects in many important ways. This has lead to multiple different approaches or models for analyzing cost effectiveness. For example, "free drivers" are a minor issue for models based on acquisition projects but market transformation models call these same adopters "market effects" and they represent the vast majority of the claimed energy savings. The cost of an energy efficient option is usually stable during the short period over which an acquisition project operates; but given the long term project period and the high volume of sales, the measure cost will likely decline in a successful market transformation project. In an acquisition project energy savings appear to be available only from the local utility so consumers who might have been willing to purchase a measure from the market will wait until they can participate in the utility program. Acquisition project managers must struggle with estimating and subtracting these "free riders" from their project results. In a market transformation project consumers, not the utility, get the bulk of the benefits from a strong supply network that continues to deliver products on-going basis even after utility involvement is completed. As a result market transformation managers can claim all savings beyond baseline from both the project and post-project adopters. These differences necessitate a new cost effectiveness approach.

## Alliance Cost Effectiveness Model

The Alliance has found it useful to standardized the approach to give everyone involved a consistent set of assumptions in a consistent format. This allows projects to be

compared on an equal basis. The Alliance Cost Effectiveness (ACE) tool has two components, 1) the calculation engine, ProCost [1], a life cycle cost-effectiveness analysis tool developed by the Northwest Power Planning Council and 2) the Excel spreadsheets. The spreadsheets allow the analyst to organize the inputs needed for ProCost and to present the results—total energy savings and benefit-to-cost ratio. There are two types of inputs—regional and project specific.

## Regional Inputs

Regional factors are those inputs necessary to a cost effectiveness analysis that are region wide and equally applied to all projects. These are often regionally weighted values derived from reviewing different utilities, weather zones, economic trends, etc. They are established once a year and then are assumed to remain constant for all projects being considered in that year. Some of these values include overall discount rate, inflation rate, future wholesale electricity prices, choice of planning horizon (2010), electrical transmission loss factor, transmission and distribution avoided upgrade credit, externalities and energy conservation credit. The Alliance uses values specific to the Pacific Northwest, and other regions would need to adjust these factor for their region.

## Project Specific Inputs

ProCost analyzes a single energy saving measure and requires eight measure or project specific inputs—1) installed cost, 2) electricity savings, 3) measure life, 4) non-electric benefits, 5) annual O&M cost, 6) non-periodic O&M, 7) when the non-periodic O&M occurs and 8) the conservation load profile. These inputs will be further defined by using examples.

Projects or programs often have multiple measures, end-uses and applications. But to fit ProCost, these multiple factors must be melded together into a single weighted measure. Furthermore, when running an economic analysis, several different perspectives can be taken depending on who is making the investment—consumer, utility or over-all region. The Alliance is also interested in two time periods—contract period and post-contract period to 2010. The post-contract period is important because this is when the bulk of the market effects occur. As used here, market effects are energy efficient units installed by consumers not participating but indirectly influenced by the project. To complete the calculations, assumptions are required for every measure, end-use, application, perspective, and time period. The following discussion describes the Alliance method for weighting all of the assumptions to derived the eight key inputs required by ProCost.

## Example Project

To help understand the ACE method, a real project is used as an example. Variable Frequency Drives (VFDs) are being installed on evaporator fan motors for refrigerated warehouses. Table 1 shows the primary assumptions for each measure and end-use. Although there is only one measure, VFD, there are two end-uses, fruit and regular warehouses. The analyst needs to calculate a weighted average value for each of the eight ProCost inputs.

**Table 1.** Assumptions for Each Measure and End-use

|  | Measure 1 Fruit | Measure 2 Regular |
|---|---|---|
| Cost ($/HP) (See Table 4) | Varies by year | Varies by year |
| Savings (kWh/HP-year) | 960 | 4,695 |
| Life (years) | 10 | 10 |
| Non-Electric Benefit ($/HP-year) | $ 47.78 | $ - |
| Ann. O&M Costs ($/HP-year) | $ - | $ - |
| Periodic Q&M Cost ($/HP) | $ - | $ - |
| Year incurred | NA | NA |

**Market Size and Baseline Units** Table 2 shows the market size in terms of the number of units installed each year in the PNW from 1998 to 2010. In this case units are defined as horsepower of evaporator fan motor. The baseline number of horsepower units already converted to VFD was established at about 900 in 1999. The higher number in 1998 was not used because it was decided that it was a vestige of a one-time utility program and was not representative of the true baseline market. In this example the total market is assumed to grow at about 3.5% per year. The baseline units are not based on a smooth growth curve but follow an irregular projection estimated by the project contractor and Alliance staff.

**Table 2.** VFD Market Size and Baseline Efficient Units

|  | Market Units (Horsepower) | Baseline Units (Horsepower) |
|---|---|---|
| 1998 | 76,096 | 6,557 |
| 1999 | 78,791 | 911 |
| 2000 | 81,581 | 1,436 |
| 2001 | 84,470 | 1,124 |
| 2002 | 87,461 | 1,528 |
| 2003 | 90,558 | 1,623 |
| 2004 | 93,765 | 1,724 |
| 2005 | 97,085 | 2,759 |
| 2006 | 100,523 | 2,936 |
| 2007 | 104,082 | 3,121 |
| 2008 | 107,768 | 2,285 |
| 2009 | 111,584 | 4,127 |
| 2010 | 115,536 | 3,722 |
| Totals | 1,229,299 | 33,852 |

**Market Penetration of Energy Savings Units** Once the total market size and the baseline number of energy efficient units per year is estimated, the next task is to estimate the number of additional energy efficient units that will enter the PNW market in each end-use (fruit and regular). The contractor estimates how many units he can install over the contract period, 1998 to 2000. Then the contractor and Alliance staff work together to estimate how many market effects units will be installed in the region year-by-year from contract start to

2010. The contract and market effects units are shown in columns 2 and 3 of Table 3. They are in excess of the baseline units estimated in column 3 of Table 2.

**Unit Energy Savings** To derive the total project electrical energy savings and weighted average savings per unit installed, the energy savings for each measure and end-use must be estimated using engineering techniques. Table 1 shows unit energy savings for a single measure, installing a VFD on an evaporator fan motor, but in two different market end-uses, refrigerated warehouses for fruit and regular refrigerated warehouses where product does not lose moisture. The contractor used refrigeration engineering theory to estimate the energy savings from applying a VFD to the evaporator fan motor on a typical fruit warehouse and a typical regular warehouse. In this case the unit engineering savings are 960 kWh/horsepower-year for fruit storage that is usually operated for only part of a year. For regular refrigerated warehouse the typical VFD savings is much higher at 4,695 kWh/HP-year. From these engineering estimates, two project values can be calculated—Total Energy Savings from project start to 2010 for all efficient units installed beyond the baseline (contract and market effects) and Weighted Average Energy Savings, one of the primary ProCost inputs.

**Table 3.** Total Energy Savings by 2010 and Weighted Average Savings

| Savings Table | Fruit Savings/Unit (kWh/HP-Yr) 960 | Regular Savings/Unit KWh/HP-Yr 4,695 | | | |
|---|---|---|---|---|---|
| Contract and Market Effects Units | | | | | |
| | ECM 1 Fruit Units (HP) | ECM 2 Regular Units (HP) | ECM 1 Fruit (kWh/Year) | ECM 2 Regular (kWh/Year) | Total (kWh/Year) |
| 1998 | 80 | 20 | 76,800 | 93,900 | 170,700 |
| 1999 | 2,500 | 1,450 | 2,400,000 | 6,807,750 | 9,207,750 |
| 2000 | 347 | 215 | 332,913 | 1,011,691 | 1,344,604 |
| 2001 | 757 | 630 | 726,637 | 2,956,412 | 3,683,049 |
| 2002 | 1,203 | 429 | 1,155,111 | 2,013,330 | 3,168,441 |
| 2003 | 1,794 | 564 | 1,722,608 | 2,649,523 | 4,372,131 |
| 2004 | 2,573 | 729 | 2,470,229 | 3,420,453 | 5,890,682 |
| 2005 | 2,665 | 927 | 2,558,466 | 4,351,828 | 6,910,294 |
| 2006 | 3,935 | 1,166 | 3,777,745 | 5,474,130 | 9,251,875 |
| 2007 | 5,608 | 1,453 | 5,383,756 | 6,823,497 | 12,207,253 |
| 2008 | 8,835 | 1,798 | 8,481,228 | 8,442,760 | 16,923,988 |
| 2009 | 9,640 | 2,639 | 9,254,075 | 12,388,139 | 21,642,214 |
| 2010 | 14,413 | 2,721 | 13,836,871 | 12,774,422 | 26,611,293 |
| Totals | 54,350 | 14,741 | 52,176,439 | 69,207,834 | 121,384,272 |
| Total Units | 69,091 | | KWh/Year | | 121,384,272 |
| | Weighted Average Savings | | 1,760 | (kWh/HP-year) | |

**Total Energy Savings** Total project energy savings is estimated by taking the unit energy savings times the number of appropriate contractor and market units installed in each

year. For the example project, Table 3 shows the fruit energy savings in column 4 and the regular warehouse in column 5. Near the bottom of the table the total values are added together to get a total energy savings of over 121 million kWh (121 GWh) per year.

**Weighted Average Energy Savings** The first project specific input for ProCost, is the life cycle cost economic analysis tool, is the weighted average electrical energy savings. This must be calculated to account for all factors including all measures, all end-uses and all market penetration assumptions from project start to 2010. In Table 3 this is the sum of all energy savings for both measures (52 plus 69 million kWh/year) divided by the sum of all measures installed beyond baseline (contract plus market effects) (54 and 15 thousand units) so the weighted average electrical energy savings is 1,760 kWh/HP-year.

**Weighted Average Unit Cost** The second major factor required for a cost effectiveness analysis is the installed first cost of the units. Because cost can change over time and because cost is different for different measures and end-uses, a weighted average unit cost must be calculated. This is demonstrated in Table 4. The cost of the VFD installed on an evaporator fan motor is the same for both types of refrigerated warehouses but it is assumed to decrease over time from $400 in 1998 to $265 per motor horsepower by 2007 and beyond. To determine the weighted average cost we need to determine how many VFD horsepower are installed at each year's price and then sum the dollars and divide by the total horsepower. It this case 69,000 horsepower is to installed at a total cost of $19 million so the average weighted cost is $278. However, this is only the consumer cost. It does not yet include the total regional costs—funding by the Alliance, funds from non-profit contributions, government subsidies, local utility administrative costs, etc. These additional costs will be considered below.

**Table 4.** Weighted Average Consumer Cost

| | Installed Cost For VFD on Evap. Motor ($/HP) | Contract and Market Effects Units (HP) | Total Annual Cost |
|---|---|---|---|
| 1998 | $ 400.00 | 100 | $ 40,000 |
| 1999 | $ 385.00 | 3,950 | $ 1,520,750 |
| 2000 | $ 370.00 | 562 | $ 208,039 |
| 2001 | $ 355.00 | 1,387 | $ 492,245 |
| 2002 | $ 340.00 | 1,632 | $ 554,902 |
| 2003 | $ 325.00 | 2,359 | $ 766,581 |
| 2004 | $ 310.00 | 3,302 | $ 1,023,523 |
| 2005 | $ 295.00 | 3,592 | $ 1,059,633 |
| 2006 | $ 280.00 | 5,101 | $ 1,428,308 |
| 2007 | $ 265.00 | 7,061 | $ 1,871,280 |
| 2008 | $ 265.00 | 10,633 | $ 2,817,707 |
| 2009 | $ 265.00 | 12,278 | $ 3,253,734 |
| 2010 | $ 265.00 | 17,134 | $ 4,540,580 |
| Totals | | 69,091 | $ 19,215,799 |
| **Weighted Average Unit Cost ($/HP)** | | | **$ 278** |

**Weighted Non-electric Benefits**  While the weighted average consumer cost and savings are the primary variables driving cost effectiveness, the Alliance has decided to look at other factors including annual operations and maintenance cost in excess of the non-efficient unit, and annual non-electric benefits like savings of water, natural gas and industrial feedstock, as well as increased production per unit.  In Table 1 we see that there is no non-electric benefit for the regular warehouse but there is a $47.78 non-electric benefit for the fruit storage.  Fruit, such as apples stored in a refrigerated, controlled atmosphere, warehouse, loses moisture.  It has also been shown in the Alliance demonstration with side-by-side test sites, that warehouses that slow circulating fan speed when not needed, reduce moisture lose by 0.27%.  Applied to the recent price of apples, this came to a non-electric benefit of $47.78 per evaporator fan horsepower.  However, regular warehouses do not save moisture, so the non-electric benefit is averaged over all units installed at $37.82 per HP.

**Other Weighted Variables**  There is only one measure being applied to two end-uses and its life is assumed to be 10 years in both applications, therefore, the weighted average life is also 10 years.  Annual operations and maintenance (O&M) costs and non-periodic O&M costs are both assumed to be zero.   In other words they are not more expensive than non-VFD fan motors.  This assumption could be argued in that adding hardware, like a VFD, always increases O&M costs.   Again, like all of the other assumptions, the contractor, project coordinator (manager), evaluation coordinator and the cost effectiveness analyst must discuss and decide what assumptions to use.  That is why ACE provides clear documentation of the assumptions so they can be revisited each year as new information comes to light from project operation and evaluation.  Table 5 summarizes the weighted average project specific inputs for the example project.

Table 5. Weighted Average Project Specific Inputs

| Cost ($/HP) | $ | 278 |
|---|---|---|
| Savings (kWh/HP-year) | | 1760 |
| Life (years) | | 10 |
| Non-Electricity Benefit ($/HP-year) | $ | 37.82 |
| Ann. O&M Costs ($/HP-year) | $ | - |
| Non-Periodic O&M Cost ($/HP) | $ | - |
| Year incurred | | |
| Energy Conservation Profile | | |

**Investment Perspectives and Non-Consumer Costs**  To properly analyze the cost effectiveness of a project to install energy savings units, the analyst must consider several investment perspectives and then decide which perspective to use.  The choice of perspective changes the overall cost of an energy efficient measures as well as what benefits can be considered.  The ACE analysis looks at three perspectives—Regional, Alliance (utility) and Consumer.  The Alliance has also chosen to look at two time periods, the contract or venture period (from project start year to project end year) and the total or long term period (project start year to 2010).

Table 6 shows all of the costs related to the project including Alliance funding, local utility administrative cost (not consumer rebates as these are offsets to consumer cost or retail

price), government subsidies, and other funding not already accounted for in the retail consumer cost which includes the manufacturer's profit margin. Table 6 also shows the number of units installed each year beyond the baseline units. The data in Table 6 allows the analyst to determine the total cost and cost per unit associated with each time period. The years 1998, 1999 and 2000 are the contract or venture period and the period 1998 to 2010 is the total or long-term period. Table 6 allows the analyst to look at what costs are appropriate for each of the three perspectives—Total Resource or Regional, Alliance or utility, and Consumer. Total Resource cost includes all costs, Alliance includes only the Alliance funding and Consumer includes only the consumer cost. Table 7 shows the costs and units for each time period and perspective.

**Table 6.** Total Costs and Units

| | Alliance | Local Utility | Government | Other | Consumer | Total Cost | Total Units |
|---|---|---|---|---|---|---|---|
| 1998 | $ 683,626 | $ - | $ - | $ - | $ 40,000 | $ 723,626 | 100 |
| 1999 | $ 770,251 | $ - | $ - | $ - | $ 1,520,750 | $ 2,291,001 | 3,950 |
| 2000 | $ 348,437 | $ - | $ - | $ - | $ 208,039 | $ 556,476 | 562 |
| 2001 | $ - | $ - | $ - | $ - | $ 492,245 | $ 492,245 | 1,387 |
| 2002 | $ - | $ - | $ - | $ - | $ 554,902 | $ 554,902 | 1,632 |
| 2003 | $ - | $ - | $ - | $ - | $ 766,581 | $ 766,581 | 2,358 |
| 2004 | $ - | $ - | $ - | $ - | $ 1,023,523 | $ 1,023,523 | 3,302 |
| 2005 | $ - | $ - | $ - | $ - | $ 1,059,633 | $ 1,059,633 | 3,592 |
| 2006 | $ - | $ - | $ - | $ - | $ 1,428,308 | $ 1,428,308 | 5,101 |
| 2007 | $ - | $ - | $ - | $ - | $ 1,871,280 | $ 1,871,280 | 7,061 |
| 2008 | $ - | $ - | $ - | $ - | $ 2,817,707 | $ 2,817,707 | 10,633 |
| 2009 | $ - | $ - | $ - | $ - | $ 3,253,734 | $ 3,253,734 | 12,279 |
| 2010 | $ - | $ - | $ - | $ - | $ 4,540,580 | $ 4,540,580 | 17,134 |
| Totals | $1,802,314 | $ - | $ - | $ - | $19,577,282 | $21,379,596 | 69,091 |

Total Regional Perspective adds the Contract Period costs from Table 6, Total Cost to get $2,026,491 as shown in Table 7. Long-term costs sum to $16,174,563. For cost per unit, divide by the number of units installed during each time period, 4,612 contract units and 69,091 long-term units. Table 7 shows the Total Region unit cost—contract period $439.40 and long term $234.11. The long-term cost is lower because the consumer cost goes down over time and the contract period includes the Alliance investment. Table 7 also summarizes the unit cost from the Alliance perspective—contract period ($390.79) and long term ($26.09). Consumer perspective for the contract period is $48.61 and long term is $208.02. The Alliance cost is front loaded because it pays for many of the early demonstration installations. This is also reflected in the Consumer perspective where consumer cost is very low during the contract period when it is supplemented by Alliance dollars. The long-term consumer cost is higher reflecting an unsubsidized free market.

**Weighed O&M Costs** Perspective determines what O&M costs are considered. The O&M costs both annual and non-periodic are paid by the consumer and since the consumer is part of the region, the total regional perspective also sees these costs. If the O&M costs for the new energy efficient measure are higher than for the non-efficient option, then the O&M

**Table 7.** Unit Cost by Perspective and Period

| | Cost | Units | Unit Cost |
|---|---|---|---|
| **Total Region Perspective** | | | |
| Contract Period | $ 2,026,491 | 4,612 | $ 439.40 |
| Long Term | $16,174,563 | 69,091 | $ 234.11 |
| **Alliance Perspective** | | | |
| Contract Period | $ 1,802,314 | 4,612 | $ 390.79 |
| Long Term | $ 1,802,314 | 69,091 | $ 26.09 |
| **Consumer Perspective** | | | |
| Contract Period | $224,177 | 4,612 | $ 48.61 |
| Long Term | $14,372,249 | 69,091 | $ 208.02 |

cost is positive. If O&M costs are lower, for example a compact fluorescent light that does not need to be replaced as often, then O&M cost is negative. For our sample VFD project, the O&M costs are assumed to be zero. Alliance perspective does not consider O&M cost.

**Benefits—Non-electric** Along with lower electric bills, there may be non-electric benefits. For example the VFD in a fruit warehouse reduced moisture loss. But the same VFD in a regular warehouse has no non-electric benefits. Non-electric benefits are only claimed by the consumer and the region, the Alliance does not get this benefit.

**Benefits—Electric** All perspectives consider the electricity savings; however, the value of the electricity is not the same for the consumer as it is for the utility or Alliance. In a normal water year, Pacific Northwest industrial consumers pay $0.03 to $0.05 per kWh while residential consumers pay $0.04 to $0.06 per kWh. ACE determines consumer simple payback at both $0.03 and $0.05. For the Alliance and regional perspective, the value of electricity is based on a medium growth forecast of wholesale prices at the Mid-Columbia exchange. Electricity prices for four time segments per month are estimated. To determine how much of the annual electricity is saved during each of the 48 time segments, conservation load profiles have been derived for various sectors (industrial, commercial, residential) and end-uses (space heat, lighting, etc.).

**Table 8.** Summary of the Inputs to ProCost Cost Effectiveness Analysis Tool

| Perspective & Period | Savings (kWh/HP-Yr) | Life (Yrs) | Cost ($/HP) | Ann. O&M ($/HP) | Profile | Non-electric ($/HP) | Non-periodic O&M ($/HP) | Year Applied |
|---|---|---|---|---|---|---|---|---|
| Total Region Long Term | 1,760 | 10 | $234.11 | $ - | Flat | $37.82 | $ - | NA |
| Total Region Contract | 1,760 | 10 | $439.40 | $ - | Flat | $37.82 | $ - | NA |
| Alliance Long Term | 1,760 | 10 | $ 26.09 | $ - | Flat | $ - | $ - | NA |
| Alliance Contract | 1,760 | 10 | $390.79 | $ - | Flat | $ - | $ - | NA |

The analyst must select the appropriate profile for each measure. Then based on savings by 2010, a composite or weighted profile is created to determine the weighted value in dollars of the electricity saved. In the VFD example there was only one measure with a 10-year and it was installed on industrial motors with a Flat conservation load profile.

Table 8 shows the inputs that are considered for each of the perspectives considered by the ACE method. The one perspective and time period that is used to make decisions about cost effectiveness, is the Long Term Total Region Perspective.

**Table 9.** Cost Effectiveness Results for 15 Alliance Funded Projects

| | Cost | O&M Cost | Electric Benefits | Non-electric Benefits | B/C Ratio |
|---|---|---|---|---|---|
| | | ($/year) | GWh/year | ($/year) | |
| Energy Star Windows | $60,765,811 | $ 0 | 279 | $ 0 | 2.8 |
| Energy Star Lighting | $121,598,522 | ($5,522,265) | 399 | $ 0 | 1.7 |
| Energy Star Clothes Washers | $747,318,753 | $ 0 | 901 | $147,088,811 | 2.1 |
| Performance Tested Ducts | $42,240,370 | $ 0 | 120 | $ 0 | 1.1 |
| SGC/Manufactured Housing | $70,959,998 | $ 0 | 179 | $ 0 | 1.5 |
| Building Operator Certification | $6,334,300 | $214,900 | 108 | $ 0 | 1.7 |
| Commissioning Public Bldgs. | $32,378,460 | $ 0 | 131 | $ 0 | 1.5 |
| Evaporator Fan VFDs | $16,174,564 | $ 0 | 122 | $3,961,380 | 2.8 |
| Silicon Crystal Growing | $8,852,309 | $7,040,834 | 289 | $87,202,733 | 11.7 |
| Bac Gen BioWise | $2,266,251 | $6,204,635 | 221 | $22,954,800 | 4.6 |
| Sav-Air | $18,624,396 | $5,486,400 | 350 | $ 0 | 1.4 |
| Fan Speed Reduction | $8,120,751 | $ 0 | 68 | $ 0 | 2 |
| Magna Drive | $34,637,616 | $ 0 | 293 | $ 0 | 2.1 |
| DrivePower | $62,822,624 | $ 0 | 509 | $ 0 | 1.5 |
| Irrigation Scheduling | $11,548,653 | $1,874,809 | 67 | | 1.1 |
| Totals | $1,244,643,378 | $15,299,313 | 4,035 | $261,207,725 | 2.7 |

There are two primary outputs from the ACE method used by the Alliance to make funding decisions. These are the total electricity savings and the benefit-to-cost ratio for the project from the long-term total region perspective. Total electricity savings we have already determined as shown in Table 3 above. For the example project the total savings by 2010 was over 121 GWh/year. The long term benefit-to-cost ratio of 2.8 was calculated by ProCost

using the inputs from Table 8.  As we see from Table 8 above the cost was $234 per HP; therefore, the present value of the benefits including electricity savings and non-electric benefits is $653 per HP of VFD installed.  The Alliance considers any project with a benefit-to-cost ratio greater than 1.0 to be cost effective.

## Cost Effectiveness Results for 15 Alliance Projects

In 2000 a standardized approach was applied to fifteen (about half) of the Alliance funded projects.  The projects analyzed had sufficient information to derive weighted cost and benefit assumptions.  Results for 15 Alliance projects are summarized in Table 9.  The projects have a composite long-term (project start to 2010) regional benefit-to-cost ratio of 2.7 with individual projects ranging from 1.1 for a Performance Tested Ducts to 11.7 for Silicon Crystal Growing.  Total regional investment, all costs to get the efficient measures installed is $1.2 Billion dollars for total annual electric savings of over 4,000 GWh/year by 2010.  Some projects have added O&M costs and one (Energy Star Lighting) has a negative O&M cost. The net total O&M cost per year is $15 million.  On the benefit side, projects have seventeen times ($261 million per year) more non-electric benefits than O&M costs.

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## References

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2. Anderson, Kenneth, "ACE (Alliance Cost-Effectiveness) Standardized Model, A User's Manual," May 15, 2000, Northwest Energy Efficiency Alliance. (Under revision to be published September 2001).