ENERGY EFFICIENCY PROGRAM INCENTIVES: A REVIEW OF POLICIES AND APPROACHES

Contents:

- **Energy Efficiency Program Incentives: A Review of Policies and Approaches**
- **PSE Comments on EE Program Incentives Study**

This document contains both the final **Energy Efficiency Program Incentives: A Review of Policies and Approaches Report** and the Puget Sound Energy (PSE) **Comments on EE Program Incentives Study** equivalent to an Evaluation Report Response (ERR). PSE program managers prepare an ERR upon completion of an evaluation of their program. The ERR addresses and documents pertinent adjustments in program metrics or processes subsequent to the evaluation.

ENERGY EFFICIENCY PROGRAM INCENTIVES: A REVIEW OF POLICIES AND APPROACHES

Submitted To:

Mr. Eric Brateng
Energy Efficiency Services Department
Puget Sound Energy
PO Box 90868 (EST-10W)
Bellevue, WA 98009-0868

Submitted By:

EMI

Energy Market Innovations, Inc.
83 Columbia Street, Suite 303
Seattle, WA 98104
T 206.621.1160
www.emiconsulting.com

May 31, 2011

This page intentionally left blank

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

EXECUTIVE SUMMARY

This report summarizes findings from research conducted by Energy Market Innovations, Inc. (EMI) to review and assess the current design of financial incentives for energy efficiency at PSE. This report reviews general practices related to incentive design, documents the current approach to incentive setting used by PSE, assesses the alignment of this approach with the methodologies used by the Northwest Power and Conservation Council (NWPCC), and compares PSE incentive levels with several peer utilities.

Objectives

The overall objective of this research is to address a requirement contained within the agreed conditions for approval of PSE's 2010-2011 Biennial Electric Conservation Targets under RCW 19.285, Docket No. UE-100177 and in the Agreed Modifications to Electric Settlement Terms for Conservation in Docket No. UE-011570, Section K. (7) (c), which reads:

> *"Incentives and Conservation Program Implementation — PSE must offer a cost-effective portfolio of programs in order to achieve all available conservation that is cost-effective, reliable, and feasible. Programs, program services, and incentives may be directed to customers, retailers, manufacturers, trade allies or other relevant market actors as appropriate for measures or activities that lead to electric energy savings. Incentive levels and other methods of encouraging energy conservation need to be periodically examined to ensure that they are neither too high nor too low. Incentive levels and implementation methods should not unnecessarily limit the acquisition of all available conservation that is cost-effective, reliable, and feasible. PSE shall work with the CRAG to establish appropriate penetration levels consistent with Council methodology and the Energy Independence Act."*

Approach

The following tasks were completed to conduct this review:

- Literature Review – EMI reviewed over 200 documents related to the relationship of amount and type of incentives and their impact on program participation and selected the 32 most relevant articles to the PSE Incentive Project for inclusion in this study.
- Documentation of PSE Approach to Incentive Design – EMI reviewed available documents and conducted interviews in order to thoroughly document PSE's approach toward incentive design.
- Review of Energy Independence Act and NWPCC Methodology – EMI reviewed key pieces of Washington state law, NWPCC documents, and interviewed NWPCC staff.
- Review of Peer Utility Incentive Levels – EMI compared PSE incentive levels for measures representing 75 percent of PSE savings in the residential and commercial and industrial suites of programs (about 70 percent of overall savings in PY2010) with six peer utilities.

Summary of Findings

Utility-sponsored programs designed to procure energy efficiency resources have long relied upon the use of financial incentives (e.g., rebates, grants, etc.) as a way to influence customer purchase decisions related to energy-consuming equipment (e.g., lighting lamps and fixtures, heating equipment, refrigerators, furnaces, etc.). The intention of these rebates is generally to address financial barriers (i.e., high equipment cost, high installation cost, etc.) that might otherwise preclude customers from buying equipment that is more energy efficient. The design of utility rebates have typically been calculated as a way to:

- Minimize first costs
- Reduce simple payback periods
- Offset incremental (increased) capital costs
- Offset incremental (increased) design or installation costs

Through a review of the literature on conservation program incentive setting, a review of NWPCC council methodology related to incentives, and a comparison of PSE's incentives with those of six peer utilities, EMI has determined that PSE puts considerable thought and attention into its incentive level design. Our research, including discussions with energy efficiency experts such as Ed Vine and Pierre Landry, outside the scope of this work, indicates that there is no consensus on best practices for how to set proper incentive levels, and that most utilities do not have rigorous methods or processes for defining incentive levels.

Through the documentation of PSE's current incentive setting process coupled with the data from the literature review task, the peer utility comparison task, and past research EMI has conducted in the area of incentive setting, EMI believes that PSE's incentive setting process is in alignment with the Agreed Conditions For Approval of Puget Sound Energy, Inc.'s 2010-2011 Biennial Electric Conservation Targets Under RCW 19.285, Docket No. UE-100177 and Agreed Modifications to Electric Settlement Terms for Conservation in Docket No. UE-011570, Section K. (7) (c). Specifically, EMI believes that overall incentives at PSE are:

- Periodically examined;
- Kept at as reasonable level (neither high nor too low); and
- Not unnecessarily limiting the acquisition of all available conservation that is cost-effective, reliable, and feasible.

Given that there is significant evidence, both in and outside the scope of this particular project, that there is no consensus on best practices for how to set proper incentive levels, EMI is unable to provide a list of specific best practices because they *just do not exist*. However, we did uncover a set of key points that represent the current thinking on incentive setting processes that are worth consideration and are discussed in detail within the document.

1. INTRODUCTION

This report summarizes findings from research conducted by Energy Market Innovations, Inc. (EMI) to review and assess the current design of financial incentives for energy efficiency at PSE. This report reviews general practices related to incentive design, documents the current approach to incentive setting used by PSE, assesses the alignment of this approach with the methodologies used by the Northwest Power and Conservation Council (NWPCC), and compares PSE incentive levels with several peer utilities.

1.1. Report Objectives

The overall objective of this research is to address a requirement contained within the agreed conditions for approval of PSE's 2010-2011 Biennial Electric Conservation Targets under RCW 19.285, Docket No. UE-100177 and in the Agreed Modifications to Electric Settlement Terms for Conservation in Docket No. UE-011570, Section K. (7) (c), which reads:

> *"Incentives and Conservation Program Implementation — PSE must offer a cost-effective portfolio of programs in order to achieve all available conservation that is cost-effective, reliable, and feasible. Programs, program services, and incentives may be directed to customers, retailers, manufacturers, trade allies or other relevant market actors as appropriate for measures or activities that lead to electric energy savings. Incentive levels and other methods of encouraging energy conservation need to be periodically examined to ensure that they are neither too high nor too low. Incentive levels and implementation methods should not unnecessarily limit the acquisition of all available conservation that is cost-effective, reliable, and feasible. PSE shall work with the CRAG to establish appropriate penetration levels consistent with Council methodology and the Energy Independence Act."*

1.2. Methodology

In order to conduct this analysis, EMI developed and executed a research approach consisting of the following tasks:

- Literature Review – EMI reviewed over 200 documents related to the relationship of amount and type of incentives and their impact on program participation. EMI selected the most relevant 32 articles to the PSE Incentive Project for further review and inclusion in the annotated bibliography that is included as Appendix A. The main research question, which guided our review of the literature, was: What is the impact of incentive level and incentive type on program participation? To ensure a broad base of expertise, we searched a range of sources including academic fields such as environmental economics, psychology, and energy policy research as well as work carried out by peer consulting firms and research labs within the energy efficiency and utility industries. For each article included in our annotated bibliography, EMI includes four subsections: overview of the article, description of the methods used, highlights from the article of relevance to the PSE Incentive Project, and a description of the limitations of the article's findings.

- Documentation of PSE Approach to Incentive Design– EMI reviewed a number of documents and workbooks related to the incentive setting process. Some of this documentation was provided before the interviews were conducted; others we learned about during the interviews and requested after the interviews were complete. Such documents included the following:
    - Full docket of program filings with the WUTC for 2011 including Exhibit 4 on Measures, Incentives, and Eligibility
    - Cost-effectiveness workbook from New Program Development and Evaluation (NPDE) staff
    - AutoFund workbooks used to calculate commercial grants
    - Supporting documentation for the AutoFund workbooks
    - Relevant studies and presentations from other firms who have worked with PSE in recent years
    - C&I Retrofit-Funding Level Review documents from October 2010
    - Example "Business Cases"
    - Measure:Metrics tracking documentation

EMI also conducted in-depth interviews with ten PSE staff involved in the incentive development process and with knowledge of PSE program offerings. The PSE NPDE group, in collaboration with PSE staff, selected these ten individuals to participate in the study. EMI conducted in-depth interviews with each employee, including program managers and other staff working within or consulting with the Business Energy Management (BEM) and Residential Energy Management (REM) teams. The group is comprised of subject matter experts covering the majority of PSE programs from both the commercial and residential sectors.

- **Review of Energy Independence Act and NWPCC Methodology** – EMI reviewed key pieces of Washington state law, NWPCC documents, and reviewed PSE documents related to incentive setting. These included the following:
    - Energy Independence Act
    - Rules to implement the Energy Independence Act
    - NWPCC Sixth Power Plan
    - Regional Technical Forum detail on conservation supply curves
    - Communication with Charlie Grist, Senior Analyst at NWPCC

- **Review of Peer Utility Incentive Levels –** In order to compare PSE incentives to peer utilities, EMI performed the following steps:
    - Selected six peer utilities based on discussions with PSE staff:

Seattle City Light (SCL)	Avista (Washington and Idaho)
Snohomish PUD (SnoPUD)	Energy Trust of Oregon (ETO)
Tacoma Power (Tacoma)	Con Edison of New York (ConEd)

- Five of these utilities were selected because of their proximity to PSE. These five utilities possess a resource mix similar to that of PSE, a history of administering energy efficiency programs, and are located in the Pacific Northwest. Additionally, EMI reviewed incentives at Consolidated Edison of New York (Con Ed), an east coast utility that has a similar portfolio of energy efficiency programs, possesses a diverse resource mix, and sells both electricity and gas to its customers.
- Selected measures accounting for the largest energy savings in PY2010; these measures collectively account for 75% of savings for each of the Residential Energy Management (REM) and Business Energy Management (BEM) portfolios at PSE.
- Identified similar measures at the peer utilities; this process included searching on utility websites, reviewing utility conservation plans and program- related regulatory filings, reviewing program application and marketing materials, and telephone calls to speak with program staff.
- Where numerical representation was possible, EMI identified the range of financial incentives at the six peer utilities for direction comparison with the incentives at PSE. When program structures did not allow for direct comparison, EMI compared and contrasted these structures with those of PSE.

1.3. Report Organization

This report is organized into 6 sections. Section 2 provides themes from the literature review. Section 3 characterizes the approach to incentive design in place at PSE. Section 4 describes the Energy Independence Act and NWPCC methodology as applicable to incentive setting. Section 5 details our comparison of PSE incentives with those of peer utilities. Lastly, Section 6 summarizes our findings.

2. OVERVIEW: FINANCIAL INCENTIVES TO SECURE ENERGY EFFICIENCY RESOURCES

In this section, we provide an overview of financial incentives used in utility-sponsored energy efficiency programs. We first provide an overview of the rationale for incentives, followed by a brief summary of relevant literature. EMI reviewed 32 articles in detail and created an annotated bibliography capturing the key information from these articles (see Appendix A).

Utility-sponsored programs designed to procure energy efficiency resources have long relied upon the use of financial incentives (e.g., rebates, grants, etc.) as a way to influence customer purchase decisions related to energy-consuming equipment (e.g., lighting lamps and fixtures, heating equipment, refrigerators, furnaces, etc.). The intention of these rebates is generally to address financial barriers that might otherwise preclude customers from buying equipment that is more energy efficient. The design of utility rebates have typically been calculated as a way to:

- Minimize first costs
- Reduce simple payback periods
- Offset incremental (increased) capital costs
- Offset incremental (increased) design or installation costs

As a rule of thumb, when incentive levels are discussed in the literature, the average incentive appears to be one-half of incremental costs. However, one of the most vexing questions within the energy efficiency industry is related to understanding the precise relationship between incentive levels and market adoption of energy efficient equipment and practices. Although there is a long history of utilities providing incentives to drive efficiency, there is a noticeable dearth of literature on incentive setting and the optimization of this relationship. This is perhaps the most notable observation from this literature review. Most of the literature dealing with incentives is either theoretical or speculative in nature. In narrowing the identified literature to that which was most relevant, we found that studies on important topics were often completed more than a decade ago. Unfortunately, no substantive literature could be found that discussed the energy efficiency program incentive setting process or best practices with incentive type and levels. The industry would benefit from current and holistic program evaluations that include an assessment of the types and levels of financial incentives.

The following sections, based upon our review of available literature, include discussions on the following:

- Motivation for utilities to supply financial incentives
- Impact of incentives on program results
- Additional non-financial program interventions

2.1. Why Utilities Supply Financial Incentives

Incentives fill multiple roles in the market which include: decreasing up front costs, helping overcome high internal rates of return, providing good feelings, and providing impetus for market transformation.

Customers are, up front, cost averse (Mills n.d.; Mosenthal et al., 1999; Train & Atherton, 1995). Incentives, especially in the form of rebates, *reduce up front costs* for the customer and can drive an adoption decision that might not otherwise be made. In a study of efficient appliance adoption, Train & Atherton (1995) found that customers viewed up front rebates as at least three times the value of financing incentives. Immediate positive cash flow, with direct payments on customer bills, may be more influential than the level of incentive (Mosenthal et al. 1999). Incentives lower the perceived price (up front costs) of new technology, which can drive accelerated turnover. For color televisions, Bayus (2010) found that a 10% decrease in new television costs would accelerate turnover by 14 months while a 20% decrease would accelerate turnover by 18 months.

Perhaps even more important to customers than up front costs are the payback periods that they perceive in adoption (Oxera, 2006; Summit Blue Consulting, 2008). Customers tend to have high internal discount rates, requiring very short payback periods for investments in efficiency. Incentives that *reduce the payback period* sufficiently can overcome this barrier. Customer consideration of payback periods is transitive and not sophisticated. For example, the decision to replace an air conditioning unit is affected by the costs of the energy to operate it, but the timing of the replacement is not (Fernandez, 2000 & 2001).

The presence of a financial incentive can lead to customers selecting a more efficient technology, all other matters being equal (Aalbers et al., 2007). Customers may perceive a *positive effect* from the incentive that is not rationally tied to the cost of the efficient technology. However, some customers may perceive an incentive with suspicion, as if it were a ploy to drive them to purchase a technology of lesser quality (Erickson, 2003).

The most notable effect that financial incentives have on the market is their role in *driving market transformation*. Sandahl et al. (2006) suggests that incentives need not stay constant over the life of a program, but they should decrease after a period of steady incentives with their marketing program continuing to drive adoption after the incentive is no longer available. When incentives are offered to a large enough market, at sufficient amounts, for a sufficient period of time, they can be removed and the market will still adopt the more efficient technology (Erickson, 2003).

2.2. How Levels of Incentives Affect Program Results

Many program managers would like to know the magic number to set their incentive level at in order to achieve the desired market participation rate. However, customers aren't rational and every program is different. Research has not found incentives to be consistently tied to program participation at any specific level. However, program evaluation has shown that levels of incentives should be program specific and sometimes technology specific. In addition, the market has been found to be most sensitive to changes in levels of incentives at extremes of incentives, such as moving from 100% of incremental costs to 80%.

Because incentives are used to motivate customers to participate in a program to reduce their energy consumption (or energy demand), the relationship between incentives and market participation rates is of keen interest to program administrators. Unfortunately, *incentive levels cannot be consistently tied to participation* (Hirst & Sabo, 1991). Camera (1989) found a near linear relationship between the portion of capital costs covered by the utility and customer participation in demand side management programs in the Northeast. However, Schick (1990, as cited in Hirst and Sabo, 1991) found participation rates ranging between zero and eight percent regardless of the utility portion of initial capital costs. More recently, Train and Atherton (2010) found a non-linear relationship between incentives and participation. Doubling incentives led to an increase in participation rates by just a few percent over all participants and by about one-quarter for those participants who were not free-riders. Free-ridership can be pronounced and is a concern that needs to be strongly considered; Chandra et al. (2010) found that 26% of purchasers of hybrid electric vehicles who received an incentive rebate would have purchased a hybrid or other high efficiency vehicle without any incentive.

Researchers have found that *market participation dependence on incentives is program specific*. For example, when looking at the effect of rebates on ENERGY STAR appliance adoption, Datta and Gulati (2009) found rebates to have a significant effect on efficient clothes washer adoption, but no significant effect on efficient refrigerator or dishwasher adoption. It is possible that customers have a different perspective of the value of ENERGY STAR appliances of different types. Ward et al. (2011)[1] found that customers have a willingness to pay $250-$350 more for an ENERGY STAR refrigerator; customer willingness to pay combined with the incentive would need to equal or exceed the incremental cost.

Consumer *sensitivity to incentives is most pronounced at the extremes*; extremes being when the incentive goes from zero to some level of incentive and when the incentive decreases from 100% to some lower level of incentive (Nadel & Geller, 1996; Mosenthal et al., 1999). Within a moderate range of incentives, from 10% to 70%, market participation was less sensitive to the incentive level.

2.3. Additional Non-Financial Program Interventions

Financial incentives cannot drive market transformation alone because the market actors are not rational. Therefore, financial incentives must be accompanied by other interventions, such as those that overcome barriers of lack of trusted information to fill the knowledge gap and those that align efficiency with social norms.

To be effective, financial *incentives must be accompanied by interventions that fill a knowledge gap*. The combination of information and incentives can be powerful; Nadel and Geller (1996) found that commercial and industrial programs combining information and incentives achieved participation rates of more than 90% while rebates alone reached just 4-25% of the market. Customer knowledge about the costs and benefits of efficiency varies over technologies; a study in the U.K. showed that knowledge gaps

[1] Ward, David O., Clark, Christopher D., Jensen, Kimberly L., Yen, Steven T. and Russell, Clifford S., (2011), Factors influencing willingness-to-pay for the ENERGY STAR® label, Energy Policy, 39, issue 3, p. 1450-1458

were higher for insulation than for light bulbs and refrigerators (Oxera, 2006). Going further, EPA (2010) shows that direct and upstream incentives can drive some desirable effects, but that information, technical assistance, and bundled incentives also have a place in efficiency programs.

Customers have responded to simple information about their consumption as related to their peers; relating consumption to peers can improve efficiency by making saving energy a norm. Behavioral research has shown that customers are *heavily influenced by peers and perceived social norms* (Lutzenhiser, 2009). Customers prefer graphical information, and they like to set goals and participate in a competitive environment (ACEEE, 2010). When presented with Home Energy Reports under the OPOWER (smart grid) program, customers adopt energy efficient behaviors and technologies without incentives (Alcott, 2009). Along the same lines, customers have been found willing to pay for greater visibility and refinement of their energy consumption data (ACEEE, 2010).

3. PSE APPROACH TO INCENTIVE DESIGN

PSE uses an approach to design incentives that is intended to ensure consistency within the market while, at the same time, enabling the company to achieve its energy efficiency resource goals. PSE staff, with its long history of implementing energy conservation programs, is making a concerted effort to offer cost-effective measures, programs, and an overall portfolio for its customers.

Overview of Approach

The general process flow for developing incentives at PSE is outlined in Figure 1 on the following page and described more fully in the remaining sections. The measure incentive setting process as depicted in Figure 3-1 is well thought out and is based on the specifics of each program. The incentive development process at PSE begins with either a new measure or review of an existing measure. Energy Efficiency Services (EES) staff members undertake an in-depth assessment aimed at determining how the measure will be received in the relevant market(s) given specific incentive levels. The responsible staff members(s) typically make several considerations including cost-effectiveness, peer utility practices, market information, and other external factors. Upper management reviews of the measures internally and regulatory processes have the potential to affect incentive levels; yet both of these processes typically happen at a high-level.[2] The level of regulatory review is at the discretion of the Conservation Resources Authority Group (CRAG). The final output is a specific incentive structure for the measure.[3] The CRAG is notified of any modifications to incentives that occur.

The process of developing an incentive structure for energy efficiency measures offered by PSE is, in general, consistent throughout the portfolio of BEM and REM programs. In general, five steps are taken to ensure a measure is implemented in a cost-effective manner, and that the incentives are structured in a manner that achieves the greatest impact and aligns with regulatory requirements. These five steps include the following: [4]

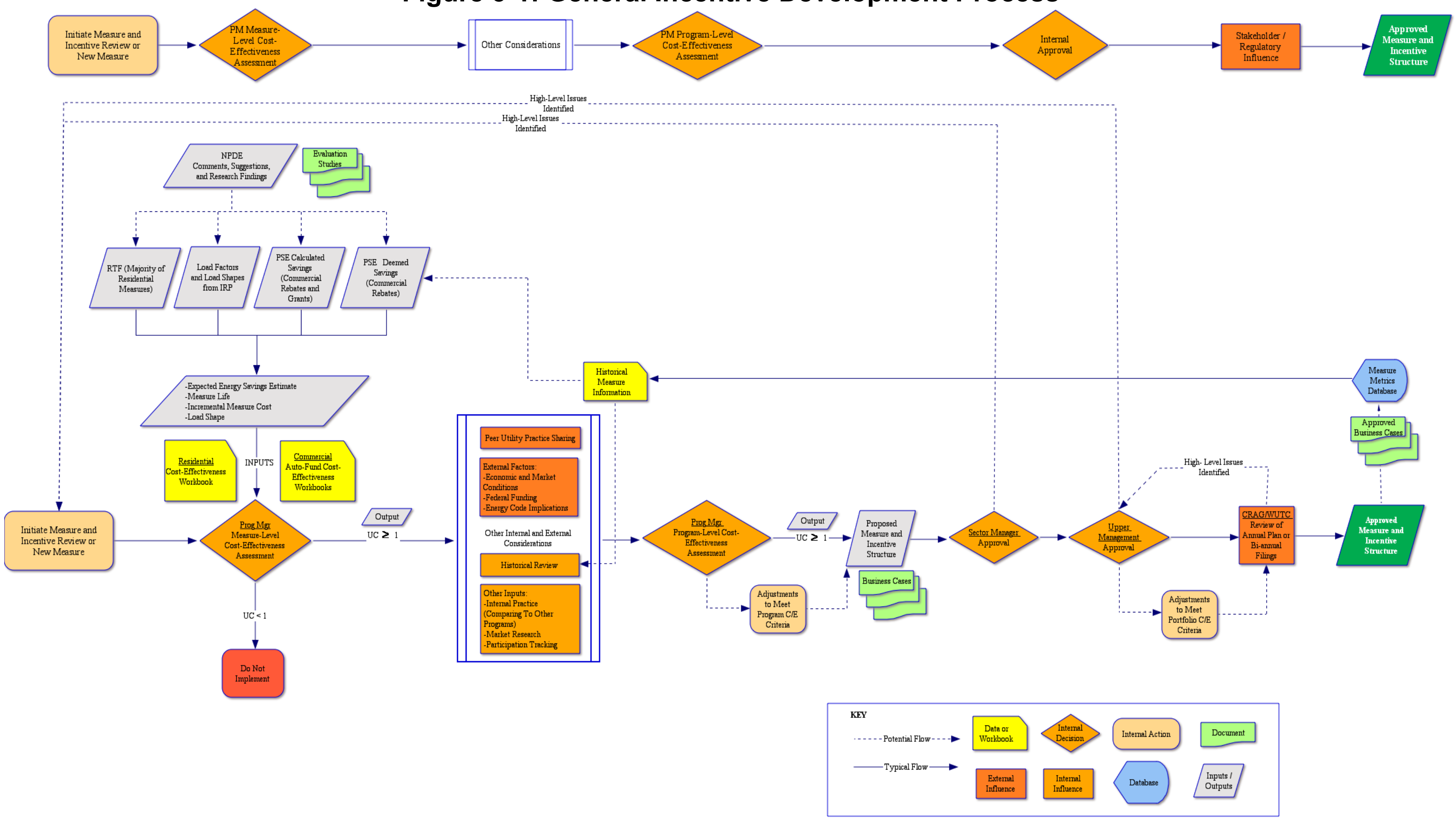
1. Classification of measure to select applicable cost-effectiveness tool
2. Determination of measure cost-effectiveness
3. Consideration of measure market, peers and external factors
4. Review of measure incentive level by internal staff
5. Influence of stakeholder/regulatory review

[2] Both of these reviews offer opportunities for adjustments of incentives.

[3] The *incentive level* is a specific dollar amount (whether in the form of a grant or a rebate) paid to the end-user or other party for the installation/purchase of an energy efficiency measure or service. At times, however, the incentive is not a predetermined dollar amount and involves calculations based on specific criteria. We have labeled these criteria the *incentive structure*. In other words, the *incentive structure* is more comprehensive than incentive level, and includes the guidelines, eligibility rules, and incentive levels related to the installation of specific energy efficiency measure or service.

[4] EMI recognizes that some unique program structures call for deliberate deviation from this general process.

Figure 3-1: General Incentive Development Process



NOTE: The TRC test is not dependent on *incentive levels*, rather it is dependent largely on *measure costs*. *Incentive levels* are a major contributor to the UC ratio, while *measure costs* do not factor into that test.

3.1. Initial Classification

The first and most basic step in determining incentive levels at PSE is the initial classification of a measure as meriting a grant or rebate. Business Energy Management (BEM) programs (commercial and industrial programs) consist of both grants and rebates. By nature, grants are calculated separately per project and determined through specific formulas at the time of the project, while rebates, in general, are assigned a specific dollar amount per unit on a standard basis. However, the initial determination of the deemed rebate amount may have been determined through the same formulas used for by the grant program. This is discussed in more detail below.

Another initial and closely related classification to make, for both commercial and residential rebate programs, is whether the measure in question is an existing or new measure. Existing measures typically have deemed values attached to them, a history of incentive levels to draw upon, and at times, additional market research or other information that can be useful in the determination of incentive structures. In contrast, new measures may have very little data to draw upon. The inputs to the cost-effectiveness tools may vary, accordingly.

3.2. Measure Cost-Effectiveness Determination

The tools used by program managers and others who are involved with the development of incentives at PSE include a set of "Auto-Fund" workbooks for the BEM team and the Cost-effectiveness workbook for the Residential Energy Management (REM) team.

The Washington Utilities and Transportation Commission (UTC) requires PSE to use the Total Resource Cost (TRC) test as its "primary cost-effectiveness test." Program managers, the NPDE and others incorporate this test into the cost-effectiveness workbooks, yet the incentive level does not affect the outcome of this test since the benefits to the participant and the cost to the utility balance to zero. The Commission also requires PSE to provide calculations of the Utility Cost (UC) test [also known as the Program Administrator Cost (PAC) test].[5] Program Managers, NPDE and others have incorporated this test into the cost-effectiveness workbooks as well. The UC test measures the net value of energy efficiency programs to PSE where the benefits are avoided costs and the costs are program overhead cost and incentive cost. As such, incentive levels may be adjusted to ensure this test is passed. It was beyond the order of this work to assess each individual incentive level to verify the UC test is passed. However, EMI believes that program staff is making a concerted effort to ensure the UC is passed for each measure and the portfolio as a whole, as illustrated in Exhibit 2 of the PY2011 filings and filed internally with NPDE and the Budget and Administration Team and other data provided by the NPDE team.[6]

[5] The commission also requires PSE to calculate the Ratepayer Impact Measure (RIM) test, and the Participant Cost (PC) test. However, they are not applicable to the incentive-level setting process.

[6] See Docket #100177. Available here: http://www.wutc.wa.gov/rms2.nsf/vw2005OpenDocket/B577179AC9E2E371882577ED006017F5

Incentive Structure Theory: Rationale/Assumptions for Program-Specific Structures and Rules
The details on measures, incentive levels, and eligibility rules are outlined in detail in an attachment to the PY2010-11 portfolio filing to the UTC (Exhibit 4: Measures Incentives and Eligibility). Exhibit 4 provides detailed information on all measures and incentives available to PSE customers. However, the underlying theory for how these structures were developed is not discussed in Exhibit 4. The general theories guiding the development of PSE's incentive structures were explained in detail during EMI's interviews with key staff members.

To discuss these theories for cost-effectiveness we have divided the measures into four distinct groups as shown in Table 3-1. These four groups represent 85% of the total electric portfolio and 97% of the overall gas portfolio in terms of PY2010 energy savings.[7]

Table 3-1: Four Studied Program Categories by Sector and Overall Weight

Program Group	% Sector Weight (kWh Savings)	% Overall Weight (kWh Savings)	% Sector Weight (Therms Savings)	% Overall Weight (Therms Savings)
BEM Grants	50.2%	28.1%	31.9%	15.1%
BEM Rebates	26.8%	15.0%	16.4%	7.7%
BEM RCM	12.3%	6.9%	47.4%	22.4%
REM Rebates	96.2%	34.7%	97.5%	51.5%
Total BEM	89.2%	49.9%	95.8%	45.1%
Total REM	96.2%	34.7%	97.5%	51.5%
Overall Weight Total	**-**	**84.6%**	**-**	**96.6%**

BEM Grants
The Commercial Retrofit Program achieves a significant percentage of the electric (28%) and gas savings (15.1%) at PSE. This program comprises a significant portion of the BEM Grants group.[8] Grant amounts are determined through an automated calculation in the AutoFund workbooks that ensures cost-effectiveness. The AutoFund workbooks were first developed several years ago to provide a set of locked formulas that are used to calculate custom grants.[9] Information about each measure can be inputted into the AutoFund to automatically calculate an amount to offer. This workbook is a key tool for staff working on commercial programs and has been refined over the years to ensure it is up-to-date and based on current market conditions. The inputs to these workbooks include the following:

- Energy savings estimates
- Measure cost
- Measure life
- Load shape

The BEM staff updated the structures of commercial grants in response to increasing avoided costs, rising measure costs in the 2008-2009 program cycle, and increasing feedback from customers seeking more

[7] Other programs exist in the portfolio, such as the Large Power User Program. However, the scope of this project does not allow for review of all programs. We concentrate on these four programs because they represent a majority of the PSE EES portfolio.
[8] The BEM Grants group of programs also includes grants for New Construction, Schedule 258.
[9] Three separate workbooks exist based on different fuel types: electric, gas, and combined electric and gas.

transparency. Program staff on the BEM team closely examined these market conditions and identified several conditions worth more consideration including the following:

- 95% of grant projects from 2000-2009 had a customer payback period of less than 8.5 years (after the incentive)
- Higher avoided costs (30% for electric space heat, 25% for lighting and 5% for miscellaneous) were projected for 2010-2011
- Lack of transparency for customers and trade allies, commonly referred to the "black box"
- Bundling and fuel switching leads to funding of measures with very long paybacks (e.g. Measure Life = 15 years, Payback = 50 years)
- Simpler, more transparent formula desired[10]

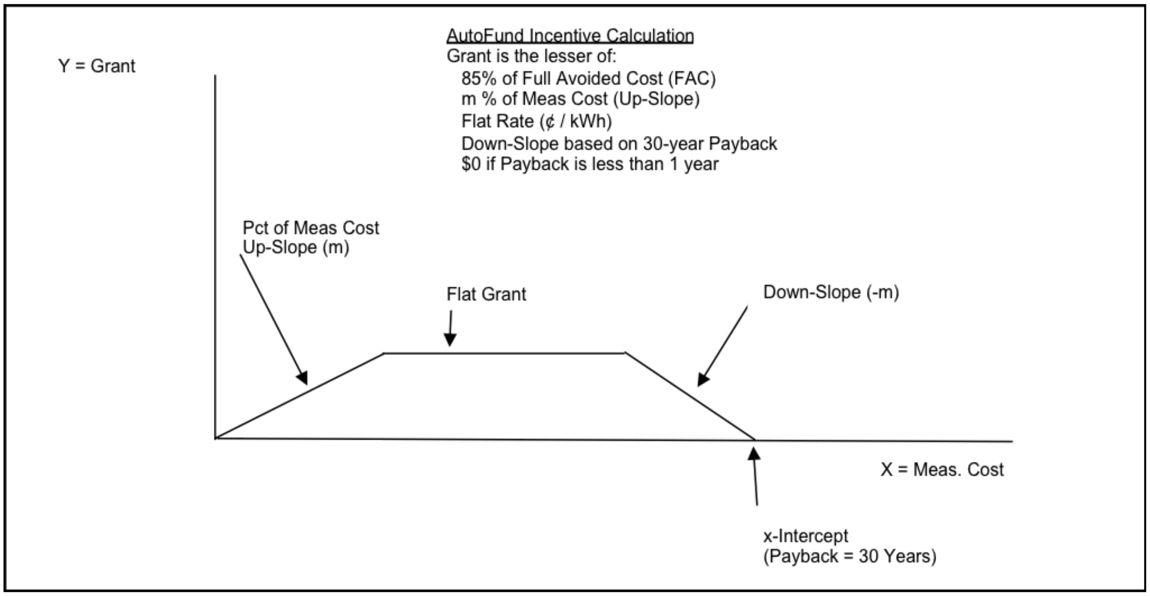
As a result of these findings, the BEM Team ultimately proposed a more optimal structure for the company and its customers. A new formula based on this BEM Team review went into effect in March of 2010. The change resulted in lower incentives per kWh and per therm for some projects. The reduction in incentives improves the UC. Overtime, pricing might become more competitive as contractors adjust to the lower incentive structure.

In the fall of 2010, an assessment of the program performance with the new formula was conducted. The conclusion of this assessment for the lighting grants for the BEM programs is stated as follows: "The new funding level supports continued high program participation while bringing the $/kWh back in line with previous years. Therefore the $0.20 kWh incentive " (for lighting projects or $0.30 for non-lighting projects), "should remain."[11] A similar conclusion is drawn for the non-lighting programs. For the gas programs, the full impact of the new funding formula has not yet been determined.

In general, the new funding formula results in a reduced incentive for less cost effective projects. The curve in Figure 3-2 provides a visual depiction of the formula. The curve consists of the "up-slope" covering a specific percentage of the measure cost up to a new funding cap where a grant goes flat, and a declining grant amount – the "down-slope" – that goes to zero for measures with a 30-year payback (before incentives). To interpret this curve, it is helpful to think of measure cost in terms of dollars per kWh or dollars per therm. More cost effective measures will fall to the left end of the x-axis and less cost effective measures will fall toward the right end.

[10] The review undertaken by the BEM staff is discussed in more detail below in Section 3.3.
[11] From the PSE EES C&I Retrofit-Funding Level Review. October 2010.

Figure 3-2: General AutoFund Grant Calculation Example (Electric)



Source: AutoFund Workbook Source Info from Follow-up data request for Joel Jackman, Consulting Engineer. PSE EES.

The AutoFund workbooks were adjusted for the 2010-2011 program cycle to reflect the new formula. The current formula for electric custom grants is shown in Table 3-2, which lists the essential criteria applied to the AutoFund Grant Calculation method. There are similar formulas for gas and combined gas and electric projects. The formula for natural gas incentives is similar to the non-lighting calculation, with a "flat rate" of $5.00 per therm.

Table 3-2: BEM AutoFund Grant Calculation for Non-Lighting and Lighting Projects

Non-Lighting AutoFund Grant Calculation	Lighting AutoFund Grant Calculation
Grant is the lesser of: • 85% of Full Avoided Cost (FAC) • Up to 70% of Measure Cost (Up-Slope) • Flat Rate (30¢/kWh) • Down-Slope based on 30-Year Payback • $0 if Payback is Less Than One Year	Grant is the lesser of: • 85% of Full Avoided Cost (FAC) • Up to 50 % of Measure Cost (Up-Slope) • Flat Rate (20¢/kWh) • Down-Slope based on 30-Year Payback $0 if Payback is Less Than One Year

BEM Rebates

Unlike the grant program, the Commercial Rebates and Small Business Lighting Programs have not undergone significant changes in recent years in terms of incentive structures. We have grouped these two programs together under the category: BEM Rebates. Incentives offered to the commercial sector under these programs are prescriptive in nature, according to the program manager. The program manager emphasizes that a great deal of resources go into documenting, researching and calculating the incentive level. Most recently, the rationale for the development of incentives has been tracked by the Budget and

Administration Team in the Measure:Metrics (M:M) Database and through the "Business Cases" that are used as a decision tool. These business cases document information related to the measure (these are discussed in detail below). These Business Cases were highlighted several times in reference to the programs in the BEM Rebates group.

The AutoFund workbook is used by staff working on both of the programs within the BEM Rebates group to determine incentive levels for new measures and to reexamine existing incentive levels measures as necessary. The Market Manager for Commercial Rebates and his staff begin by running new measures through the AutoFund developed for the grant program to identify the ideal amount to offer, although as the next section makes clear, other factors such as market conditions and incentive levels at peer utilities are also considered. Other rebates are developed for measures that have gone through AutoFund many times in the past. Looking backward, program staff can get an idea of typical measure savings, funding levels and measure costs by reviewing what AutoFund has determined PSE should pay in the past. Then, the savings may become a standardized savings amount based on typical costs. These inputs eventually may lead to a prescriptive rebate. Much of it is based on the "backward look". In some cases AutoFund may indicate that a grant may not be needed to motivate the customer, particularly for measures with less than a year payback. AutoFund does not determine whether the measure will be implemented or not. If a measure has *less than a year payback*, AutoFund indicates that this measure should not receive a grant; however, short payback measures with high TRC may be provided with an incentive in rare circumstances.

The reexamination process happens annually at a minimum, although it may happen more regularly at times, if necessary. The exact period between examinations will vary by measure and is based on competing priorities.

REM Rebates

For the most part, incentive structures for residential rebates are designed and work similarly to those for commercial rebates. The programs that offer rebates to residential customers include Residential Low Income Weatherization, Multifamily New Construction, Single Family New Construction, Multifamily Existing, and Single Family Existing. The vast majority of the incentives paid through these programs are rebates.[12] They are typically prescriptive in nature and largely calculated using the deemed savings values from the Regional Technical Forum (RTF). Some measures are "direct install," where there is no cost to eligible customers. A few measures, such as those for common area projects are calculated. All other measures are assigned a specific dollar amount based on one of the following factors:

- Per measure
- Per structure
- Per square or linear foot

The NPDE staff has developed a cost-effectiveness workbook that is used to calculate the TRC and UC for measures for the residential sector.[13] This workbook is used by staff working on all of the programs within the REM Rebates group to determine incentive levels for new measures and to reexamine existing incentive levels measures as necessary. Similar to the process used by the BEM Rebates group, the reexamination process happens at least annually, although it may happen more regularly at times, if necessary. The exact period between examinations will vary by measure and is based on competing priorities.

[12] EMI recognizes that some REM programs offer some "calculated" incentives in addition to rebates such as those for common area projects in Multifamily New Construction.

[13] This is a different workbook than the AutoFund. Both workbook names are those used by PSE staff.

Resource Conservation Manager (RCM) Program

EMI staff also interviewed a Supervising Engineer working on the RCM to gain understanding of how incentives are structured and delivered for this unique program. The RCM program was formally launched in 2003. The program was then revised in 2008-2009 to function more like a rebate program and to be correlated back to the AutoFund formulae. For this reason, we have included it in this review.

In 2010, the RCM program comprised 22% of the overall gas savings (47% of overall BEM gas savings) for the utility and 7% of the electric savings (12% of overall BEM electric savings). It offers several benefits to commercial and industrial customers, school districts, and public-sector government agencies. The major cost of the program is a salary for a new employee at the customer site, referred to as the RCM. The incentive for this program is the grant that helps fund this staff time as well as providing support services such as monthly and interval data, training and program implementation support. The fundamental concept of the program is that the low-cost, no-cost behavioral activities that customers undertake will generate enough savings to pay for the cost of the project. The target audience consists of customers with a minimum of 500,000 feet of facility space. Each customer is expected to meet a 3% savings target in the first year, and 5% in the second and third years. The deliverables are documentation of the actions taken to achieve savings the savings targets including allocation of staffing, a resource management plan, and facility action plans.

Although historically incentive levels for the RCM Program were not based on a specific formula, in recent years, the AutoFund was used to establish the incentive at $28,000 per year for the first “start-up” year. This is based on an average of $80,000 salary per FTE. Customers can also receive up to this amount in the second and third year as a “performance incentive” for their sustained savings achievements. A salary survey was conducted to determine the measure cost of the program (primarily the salary of an RCM) and to help set the specific incentive levels. The grant formula is set at 35% of the cost (the salary of the RCM) to the customer, but can be prorated based on the customer profile. This differs from the 70% maximum offered in other BEM grants (see above). The grant is a smaller percentage than for other C&I grants because PSE provides value-added services, such as resource accounting software, support and training, assistance with data, and more. These costs are relatively high for the RCM program (~35%), as it relies heavily on the value-added services, which are clearly part of the incentive to participate in the program. For example, the software cost is $7,500 per software license and the energy interval services is estimated at $18,000 per customer depending on the number of facilities.

In addition, the formula used to determine the 35% maximum incentive allows for some under-performance, as PSE staff realizes all RCM participants may not achieve the deliverables for the program. This gives PSE some leverage and accounts for the risk should savings from some customers fall lower than the goals for their specific projects. Several other assumptions are built into this formula as well including:

- For Electric customers: 1 FTE at $80,000 is worth about 500,000 kWh of energy savings
- For Gas customers: 1 FTE at $80,000 is worth about 50,000 Therms
- For Gas/Electric customers: Formulas are prorated to determine allocation
- First year savings goals for the customer are based on previous 12 months energy baseline
- Second and third year savings goals are based on the previous year savings

3.3. Consideration of Market, Peers, and External Conditions

The process for setting incentive levels at PSE typically involves the consideration of factors other than cost-effectiveness, although not necessarily in a consistent manner across the whole portfolio. Rather, each measure will have its own unique set of relevant and available knowledge and data. Nonetheless, many of the PSE staff interviewed mentioned the same types and sources of information beyond cost-effectiveness including market analysis, incentives at peer utilities, research by key organizations, and external conditions. The placement of these considerations along the process is illustrated in the middle box in Figure 1. However, it is important to note that these considerations do not happen in a silo and may actually occur anywhere throughout the process flow.

Market Analysis

Market research can play a role in the development of both types of incentives and the incentive structure. For example, one recent study for the REM group carried out by Definitive Insights, included a discrete choice analysis of survey data and contains several findings that could impact the structure of incentives. The most pertinent finding was that: "…there is a point in the rebate curve (typically somewhere between 40% and 70% rebate levels), below which, higher rebates yield higher acceptance rates, but above which acceptance rates for the higher efficiency appliance does not increase substantially as rebated levels go yet higher."[14] This is consistent with literature reviewed by EMI related to incentive setting discussed in Section 2. It is yet to be seen how exactly the study conducted by Definitive Insights will impact incentives at PSE, but it does provide some guidance on the point where the marginal impact may not be worth additional incentives.

Similarly, engineers working with the BEM group have been tracking the impact of the recent changes to the custom grant offer mentioned above. As mentioned above, in October 2010, these engineers completed a review of the BEM grants to understand the impact of the new funding formula on commercial grant recipients. The primary purpose of this review was to understand how the new formula was being received in the market. Although there were a range of simultaneous external influences in 2010 challenging the ability to comprehensively assess the impact of the funding formula modifications – including American Recovery and Reinvestment Act (ARRA) and Washington State Office of Superintendent of Public Instruction (OSPI) funding – the review did provide PSE with some general findings related to participation rates. The findings of this review include, but are not limited to, the following for lighting measures (similar findings for non-lighting and gas measures):

- "The number of lighting projects in 2010 was greater than any previous years…"
- "Savings per measure were thought to be decreasing potentially indicating the customers' willingness to pay for higher payback…" and perhaps less potential for simple lighting retrofits
- "The $0.20 per kWh is having an impact and appears to be the appropriate current incentive level."

Clearly, program staff members in both groups are interested in understanding the market impacts of their programs. The above cases illustrate that participation of programs and impact on the market of specific incentive levels are being examined; however, EMI has not found this to be a regular routine. In fact, most program staff members spoken to were not familiar with any market research on the relationship

[14] This excerpt is from memo titled, "Trends in the Preferences That Customers Express for Different Rebate/Discount Levels," dated May 5, 2011. In Task 4 this finding will be compared to the findings from our literature review.

between participation in their programs and specific incentive levels/structures or other market studies on customer behavior. Some staff members stressed that research into uptake of specific incentive levels and structures, similar to the Definitive Insights research, would at least be useful in validating what they are currently using as incentive structures, if not useful in planning future incentive structures.

Peer Utility Practice/Industry Standards Assessment

Although the process has not been formalized, PSE staff does look outward to peer utilities and other industry groups for information on incentives. One of the factors most commonly mentioned by staff involves the assessment of incentive structures for similar measures at peer utilities, primarily those found in the Northwest. Several managers mentioned they have relationships with managers at other utilities in the region including SnoPUD, Tacoma Power and Seattle City Light. Some managers say they even look beyond the Northwest to others around the country using sources such as DSIRE and ESource. Such assessments include comparing actual incentive levels and/or inputs and criteria used to create incentive structures. It may also involve one-on-one discussions, or less frequently, regional coordination. However, most managers would like to see more support for regional coordination efforts and more data on what incentives peer utilities offer to their customers.

Research and Data from Key Organizations

Some program managers mentioned that the incentive setting process has taken into account research and historical data from industry organizations for information on measure types and costs, savings estimates, load shapes, specific market conditions, and incentive structures. These data have often been utilized when reviewing or determining incentive levels, although there is little consistency with their use. Such organizations mentioned in the interviews included the following:

- ESource
- Database of State Incentives for Renewable Energy (DSIRE)
- ENERGY STAR
- Consortium for Energy Efficiency
- RTF
- Other Industry-specific organizations

EMI understands that the tools and studies these organizations have made available have been used in various capacities and with mixed results in the past. For example, program managers report mixed results with ESource, the independent research company that offers advice and information services to utilities and other energy market players. Although the utility is no longer a member, some managers claim they really miss this service, as they provided unique studies (e.g. regression analyses) on specific inputs to the cost-effectiveness workbook. Others claim, however, that for their programs, everything available through ESource was also available simply by searching the web.

External Conditions

Staff also mentioned other external factors that have affected incentive structures in recent years including building codes, economic conditions, and the ARRA programs. The impact of these factors on incentive structures has varied widely by program, and there is no general pattern of such effects. However, it is important to recognize that federal funding levels, the housing and building market, and establishment of new building codes can have impacts on how well a specific incentive-level is received.

3.4. Internal Review

The program staff interviews indicate that other EES staff members may impact any given incentive level through a number of different avenues. Primarily, this happens within the team working on the specific program where the measure being assessed falls. This involves looking back at the history of the programs, looking across to other programs, and receiving input from upper management and NPDE.

Historical Review and the M:M Database
Staff relies on historical measure data, which is stored in a central location. In certain cases, staff also tracks participation trends to understand incentive levels and structures that function well while remaining cost-effective. Staff often referred to this process as “looking backward,” and it happens in a number of forms. Many mentioned that significant effort is also taken to “look forward” to forecast based on historical trends. Every program lead mentioned how measure information is now being stored in the M:M Database. This database has been used to centralize all measure attribute information and provides stakeholder/regulatory accountability. It was also mentioned as a tool used for program planning, including the development of incentive structures. However, we have learned through other documentation that it does not track measure performance, aggregate savings amounts or program costs.

Internal cross-team collaboration
Program managers look at what other programs have to offer for similar measures. Many measures may already exist for another market or sector and can be used as a guidepost in the development of an incentive for a similar measure in a new market. Managers work with their team to build understanding about effectiveness of specific incentive structures for specific measures based on shared knowledge.

Portfolio-level cost-effectiveness determination
After a new or revised measure and its incentive structure is proposed by the program manager, additional internal steps are taken to ensure *portfolio*-level cost-effectiveness and to verify calculations and other metrics used to determine the value of the measure. However, upper management and NPDE indicate that a great deal of trust is placed in tools used and the engineers and managers that carry out the calculations. It is rare that calculations specific to individual measures are examined with close scrutiny by upper management, since senior level staff members are closely monitoring incentive levels and involved in due diligence review of calculation methodologies. However, if upper management has differing information or other ideas on sources of information, an incentive structure may need to be adjusted.

Evaluation research
The NPDE team may conduct research that affects specific inputs into the calculations of incentives. This research may happen as part of a routine program evaluation or other studies with the RTF. Program managers mentioned how studies carried out by the NPDE team will affect their program operations, and at times, the design of the actual incentive structures.

4. ALIGNMENT WITH ENERGY INDEPENDENCE ACT AND NWPCC METHODOLOGY

This section provides an assessment of PSE incentive designs relative to the Energy Independence Act and the methodology used by the Northwest Power and Conservation Council (NWPCC). This assessment is undertaken in order to meet the Agreed Conditions for approval of the recent filing under docket UE-011570 of PSE's energy conservation programs with the Washington Utilities and Trade Commission (WUTC) which specify:

> "*Incentive levels and implementation methods should not unnecessarily limit the acquisition of all available conservation that is cost-effective, reliable, and feasible. PSE shall work with the CRAG to establish appropriate penetration levels consistent with Council methodology and the Energy Independence Act*."[15]

As an initial point of clarification, we note that penetration levels cannot be "established," per se. Market penetration levels may be *influenced,* however, by the design of utility-sponsored energy efficiency programs. In the assessment provide below, we review and summarize information available relative on each of the following:

- Energy Independence Act
- Northwest Power and Conservation Council Methodology
- Alignment of PSE Approach with Regional Methodologies

4.1. Energy Independence Act

Initiative 937 was passed by Washington State voters in 2006 and set up a requirement that utilities develop conservation targets consistent with NWPCC methodology. This initiative was codified in the Energy Independence Act Chapter 19.285 RCW. Under the Energy Independence Act (Chapter 19.285 RCW), utilities must develop cost-effective ten-year and biennial conservation targets consistent with the most recent power plan published by the NWPCC. Failure to meet the conservation target will result in administrative cost of $50/MW (adjusted for inflation).

In order to implement the new law, both the Washington Department of Commerce and the Washington Utilities and Transportation Commission were obligated to promulgate rules for utility compliance; these rules were codified in the Washington Administrative Code (WAC). Rules promulgated by both the Department of Commerce and WUTC rely on the definition of cost-effective already codified in RCW 80.52.030.

> *(7) "Cost-effective" means that a project or resource is forecast:*

[15] See "Agreed Conditions for Approval of Puget Sound Energy, Inc.'s 2010-2011 Biennial Electric Conservations Target UnderRCW 19.285." Docket No. UE-011570.

(a) To be reliable and available within the time it is needed; and

(b) To meet or reduce the electric power demand of the intended customers at an estimated incremental system cost no greater than that of the least-cost similarly reliable and available alternative project or resource, or any combination thereof.

- Chapter 480-109 WAC – The Washington Utilities and Transportation Commission (WUTC) promulgated rules (Chapter 480-109 WAC) to implement the Energy Independence Act for investor-owned utilities, including PSE. Penetration rates and incentives are not explicitly addressed by this rule; neither are costs and benefits to be used delineated. Under these rules, utility ten-year conservation targets must be based on either its most recent IRP or its proportionate (per sales) share of the regional conservation estimations from the NWPCC Sixth Power Plan. The biennial conservation target, which may be a point or range, must be based on a calculated pro rata share of the ten-year conservation target. Equations used by the utility to determine its biennial share must be provided to the WUTC. Both the ten-year and biennial conservation targets must be provided in a report from the utility to the WUTC by January 31, 2010 and every two years thereafter. Any deviation from the assumptions or methods used by the NWPCC must be detailed in this report.

- Chapter 194-37 WAC – As an additional point of reference, the Washington Department of Commerce promulgated rules under the Energy Independence Act for consumer-owned utilities (Chapter 194-37 WAC). While not directly applicable to PSE, this document provides a point of reference for interpretation of how utilities can respond to the Energy Independence Act. This rule is more detailed than the rule promulgated by the WUTC.

Specific costs and benefits to be used in determining cost-effectiveness are provided in section (6)(a). In addition, this rule directly addresses incentives in reference to situations where conservation targets are not met in section (11).

(11) A utility may document shortfalls in meeting its biennial conservation target due to lack of customer participation. Documentation of such shortfalls shall include a demonstration that:

(a) A broad array of marketing and program options were provided to customers throughout the biennium; and

(b) The utility offered throughout the biennium to pay customers an incentive in an amount equal to the utility's full avoided cost over the lifetime of measures, up to one hundred percent of the incremental cost of measures. Any such shortfall cannot be automatically deducted from the utility's conservation potential assessment for the subsequent biennium.

4.2. Northwest Power and Conservation Council Methodology

Assumptions and methods in the NWPCC power plans were developed by the NWPCC with input from the Regional Technical Forum (RTF); a contractor, Strategic Energy Group (SEG), worked with NWPCC to develop conservation metrics for the industrial sector. Calculators, spreadsheets, and other supporting data are updated more regularly than the power plan and are available online for public use. While the entirety of the Sixth Power Plan can be useful for understanding the relationship of conservation (and indirectly, incentives driving conservation) and the overall forecasted resource mix of the Pacific Northwest, two chapters (4, 9) and three appendices (E, H, and I) are particularly applicable. A portion of Chapter 4 explicitly addresses some of the issues faced by utilities attempting to comply with Washington state law by remaining consistent with NWPCC methodology. The NWPCC notes that the region is not uniform, so each utility faces individual constraints, and that a short-term conservation effort can result in a substantively different outcome than long-term planning.

Two key areas of the NWPCC methodology indirectly affect the incentive setting process at utilities: cost-effectiveness and market penetration.

Cost-effectiveness

The NWPCC uses the Total Resource Cost (TRC) to determine cost-effectiveness. The TRC includes all benefits and all costs of a conservation measure regardless of which party pays the costs or enjoys the benefits. The NWPCC uses the following costs and benefits in its calculations of cost-effectiveness.

Costs:

- Full incremental measure costs (material and labor)
- Applicable on-going and periodic O&M expenses
- Utility administrative costs (program planning, marketing, delivery, on-going administration, evaluation)

Benefits:

- Direct energy and capacity savings
- Avoided T&D losses and value of deferring T&D expansion (if applicable)
- Non-energy benefits (e.g. water savings)
- Environmental externalities

To get to full incremental costs, the NWPCC does make some assumptions about who will bear the burden of cost, but these assumptions are only used to approximate a total cost. In Appendix E of the Sixth Power Plan (and updated in 12/2009 online), the Regional Technical Forum provides Financial Assumptions including the estimated portions of conservation costs to be born by different parties in the process. For all sectors, the administrative costs are assumed to be 20% of the initial capital costs and born equally by the wholesale and retail electric providers. In addition, for all sectors, the customer is expected to bear 100% of the operation and maintenance costs and 35% of the initial capital costs of the measure (see Table 4-1). The financial life of measures varies by sector for customers, but it is expected to be one year for wholesale and retail providers – meaning that providers are not expected to finance their portion. Initial capital costs are assumed to be incremental costs based on NWPCC methodology for calculating costs and benefits of conservation.

Table 4-1: Key financial assumptions for initial capital costs (RTF)

	Customer	Wholesale Electric	Retail Electric	Customer Interest Rate	Customer Financial Life
Residential	35%	20%	45%	3.9%	15
Commercial	35%	10%	55%	6.7%	20
Industrial	35%	10%	55%	7.6%	20
Agriculture	35%	10%	55%	7.6%	5

This table illustrates the total cost of an efficiency measure is a combination of 65% of the overnight costs of the measure plus 35% of the overnight costs financed for the customer financial life at the customer interest rate.[16] A $100 dollar measure for a residential customer would then be expected to cost about $111 due to the 15-year loan at 3.9% interest for the customer's $35 portion of the cost. Charlie Grist, Senior Analyst at the NWPCC, advises that this table of assumptions is not to be interpreted as NWPCC suggesting that utilities provide 45-55% of the capital costs of programs in the form of incentives.[17]

Market Penetration

In this context, market penetration rates refer to the share of the market reached by a measure by a certain point in time. Ramp rate is the term used to refer to the rate of change in penetration from one point in time to the next. The Regional Portfolio Model (RPM) used by the NWPCC assumes that market penetration will move to 85% for each measure by the end of the 20 year period; each individual measure has a different rate (ramp rate) to get to 85%, with some achieving quick penetration and others taking the full 20 years. The NWPCC uses a different algorithm for including lost opportunity programs (such as new building construction or appliance replacement at turnover) and discretionary programs (non-lost opportunity programs such as consumer electronics or lighting),

The NWPCC has summarized their assumptions for ramp and penetration rates into three key points.[18]

(a) Maximum ramp up/ramp down rate for discretionary is 3x prior year for discretionary, with upper limit of 85% over 20 year planning period
(b) Ramp rate for lost-opportunity is 15% in first year, growing to 85% in twelfth year
(c) Achievable potentials may vary by type of measure, customer sector, and program design (e.g., measures subject to federal standards can have 100% "achievable" potential

4.3. Alignment of PSE Approach

Incentive setting is indirectly affected by the cost-effectiveness and market penetration determinations. The methods used by the NWPCC for both are described above, and PSE's methods are compared here.

[16] "Overnight costs" are the costs of an item or technology with no financing.
[17] Per phone conversation
[18] http://www.nwcouncil.org/energy/powerplan/6/supplycurves/I937/CouncilMethodology_outline%20_2_.pdf

Cost-effectiveness Determination

Importantly, incentive payments are not included within the TRC cost effectiveness test. These payments are viewed as a transfer payment within the economic system and, because this test is used to calculate the cost effectiveness of a program at a societal level, these transfers do not affect program cost effectiveness.

During the program planning process, incentives are set by PSE *after* programs are included as part of the resource block. PSE adjusts incentives to ensure that the Program Administrator Cost (PAC) test, in PSE's case the Utility Cost test, also shows cost-effectiveness of measures. The same workbooks used to calculate the TRC are used for this purpose within PSE. Section 3 describes the incentive setting process at PSE in more detail.

Market Penetration

According to the conservation potential studies performed by the Cadmus Group, twenty-year market penetration rates are set equivalent to those assumed by the NWPCC. This conservation potential was included in the IRP and used as a basis for the development of the ten-year and biennial conservation potential. So long as PSE does not modify the penetration rates for the shorter time horizon, the long-term market penetration should be consistent. Note that the NWPCC observed that ramp rates and penetration rates could be affected by shorter planning horizons.

5. COMPARISON OF PSE INCENTIVES WITH PEER UTILITIES INCENTIVES

In the peer utility comparison task, EMI targeted measures comprising 75% of PY2010 electric savings for both the residential and C&I portfolios.[19] This amounted to twelve residential measures and 34 C&I measures. We present only those measures from the peer utilities that are most similar to those offered by PSE. Taken as a whole, the selected measures represent 70% of the overall EES portfolio. We did not determine whether the same measures at other utilities are as significant in terms of attribution of savings but we hypothesize this to be the case.

It should be noted that nominal financial incentives do not paint a complete picture of energy conservation measures. Measures often include a mix of interventions with the customer, including marketing, information, and technical assistance. In some cases, interventions may include more complicated financial interventions, such as low or no interest loans. A much more nuanced analysis would be required to compare measures in this holistic fashion than allowed by the present scope.

5.1. Residential Measure Comparison

In total, twelve measures in the PSE PY2010 tracking data accounted for the top 76% of the electric savings in the PY2010 residential portfolio. However, EMI excluded the Low Income Weatherization measure because utilities fund these programs at 100% of cost. We also combined the two energy efficient window retrofit incentive measures, which had the same incentive level but different limits on total rebate to the customer. Due to these two modifications, ten residential measures are used in the peer utilities comparison.

For all residential measures examined, PSE offers nominal financial incentives within the range of those offered by peer utilities. In this section, these ten measures are broken down into four categories: refrigerator decommissioning, lighting improvements, window retrofits, and heat pumps.

Utilities offer payments for refrigerator decommissioning; this payment is to cover the cost to remove older, less efficient refrigerators.[20] Five of the peer utilities and PSE use $30 as their cost for this measure; ETO has a payment of $50. It is unclear why ETO pays more, but the decommissioning process is free to customers regardless, as all utilities pay 100% of the cost of the service. Because there are only two point values for incentives, no figure is shown for this measure.

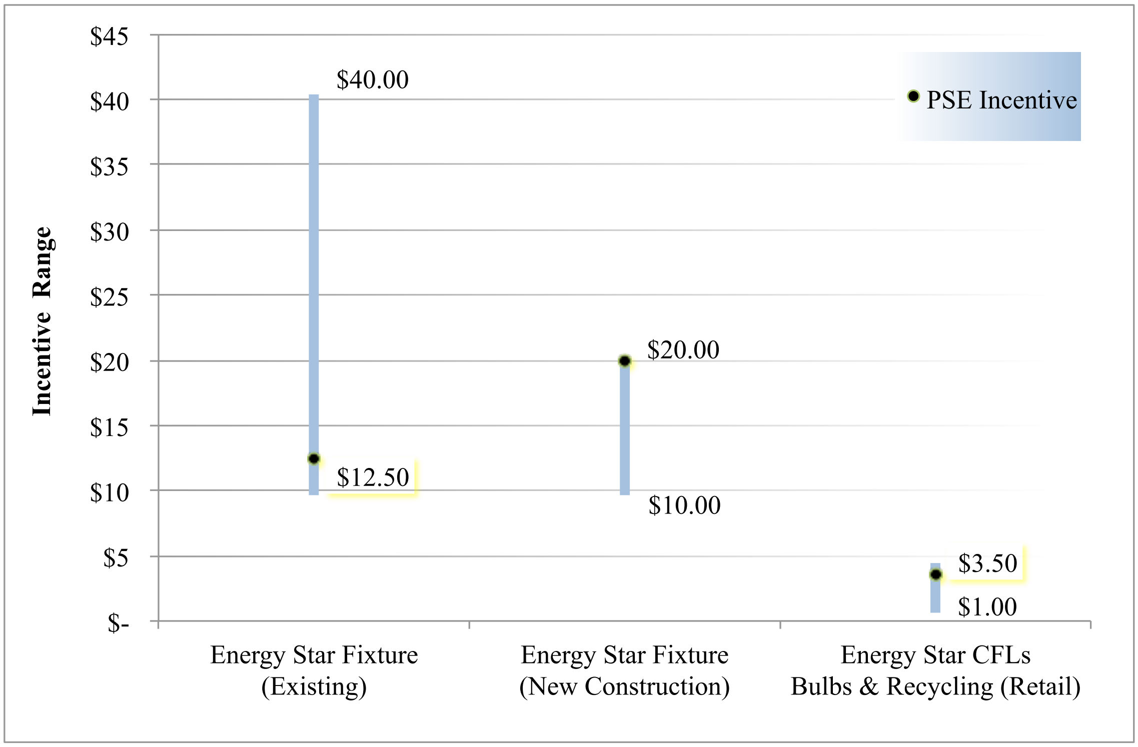
Figure 5-1 shows the range of financial incentives offered by PSE and peer utilities for measures to encourage adoption of residential compact fluorescent lamps (CFLs). One of these measures, Energy Star CFL Bulbs and Recycling accounts for 50.6% of residential electric savings at PSE. PSE offers an

[19] Given the timeframe of the project and since the majority of the Energy Efficiency Services budget is allocated toward electric programs and a significant portion of gas savings come from the RCM program (22%), EMI focused the peer utility review on the electric portfolio. EMI does see value in further researching the gas furnace measures offered under the Single Family Existing Program, since these measure make up a large portion of the gas savings.

[20] We term this offer a “payment” since it represents the total price of the refrigerator decommissioning process paid by the utility for the service. The incentive is 100% of the cost for the customer.

incentive at the high end of the peer range for this lighting measure as well as Energy Star CFL fixtures for new homes. However, ConEd pays a significant amount more (an additional $27.50) than PSE and the other utilities for Energy Star CFL fixtures for existing homes. The reason for this may be that the ConEd incentive is for 4-pin-based Energy Star fixtures, whereas this is not specified by PSE or the other peer utilities.

Figure 5-1: Market Comparison: Residential Lighting Measures (per unit)



Another residential lighting incentive, the Multifamily Direct Install Program, is not shown on this graph because PSE pays 100% of the cost. However, three of the peer utilities also offer free CFLs to multifamily customers; another utility recently discontinued their program; and a third utility pays $2 per CFL bulb for multifamily installations of CFL bulbs.

The range of financial incentives for retrofitting with more efficient windows in existing residential and multi-family (>5 units) buildings (non low-income) is shown in Figure 5-2. The range of incentives at peer utilities (per square foot) for retrofitting to double-pane windows that at least meet the U .30 is $2.25 to $6.00 in existing residences and $34.00 to $5.00 for multi-family customers.[21] The PSE incentive was at the top of this range for residences ($6.00 per square foot) and it is at the top of the range right for multi-family ($4.00 per square foot for gas customers and $5.00 per square foot for electric customers). However, PSE does not currently offer an incentive for non-low income residential windows. PSE offers an incentive to electric multi-family customers of $7.00 per square foot for triple-pane window retrofits to replace single or double-pane windows, but comparable offerings were not found at peer utilities. Also,

[21] PSE only considers multi-family as those with five or more units; all residences with four or fewer units are considered residential. Some peer utilities have separate incentives for small multi-family units (<5 units). To be consistent with PSE definitions, small multi-family units are not considered separately here.

PSE and peer utilities cap window incentives, leading to effective financial incentives at rates lower that the per square foot savings offered. For example, PSE's effective average incentive for single family existing is $2.90 per square foot under the current $500 cap and was $4.60 per square foot under the $1000 cap in place early in 2010.

Figure 5-2: Market Comparison: Residential Window Retrofit (per square foot)

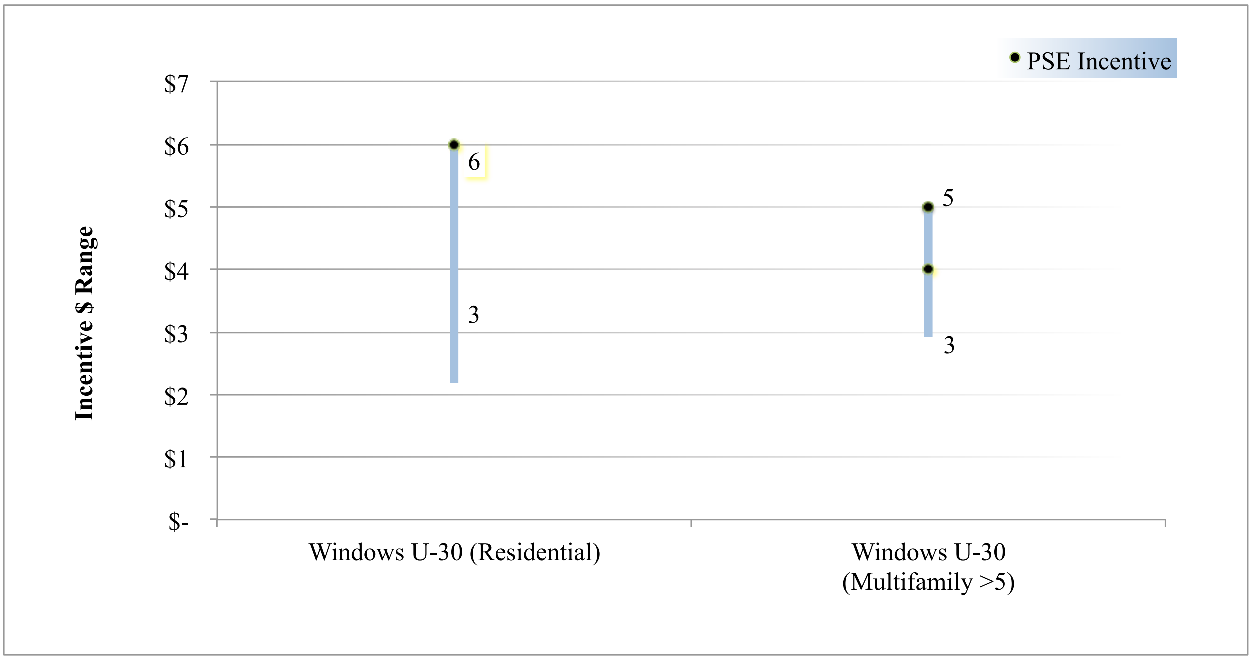
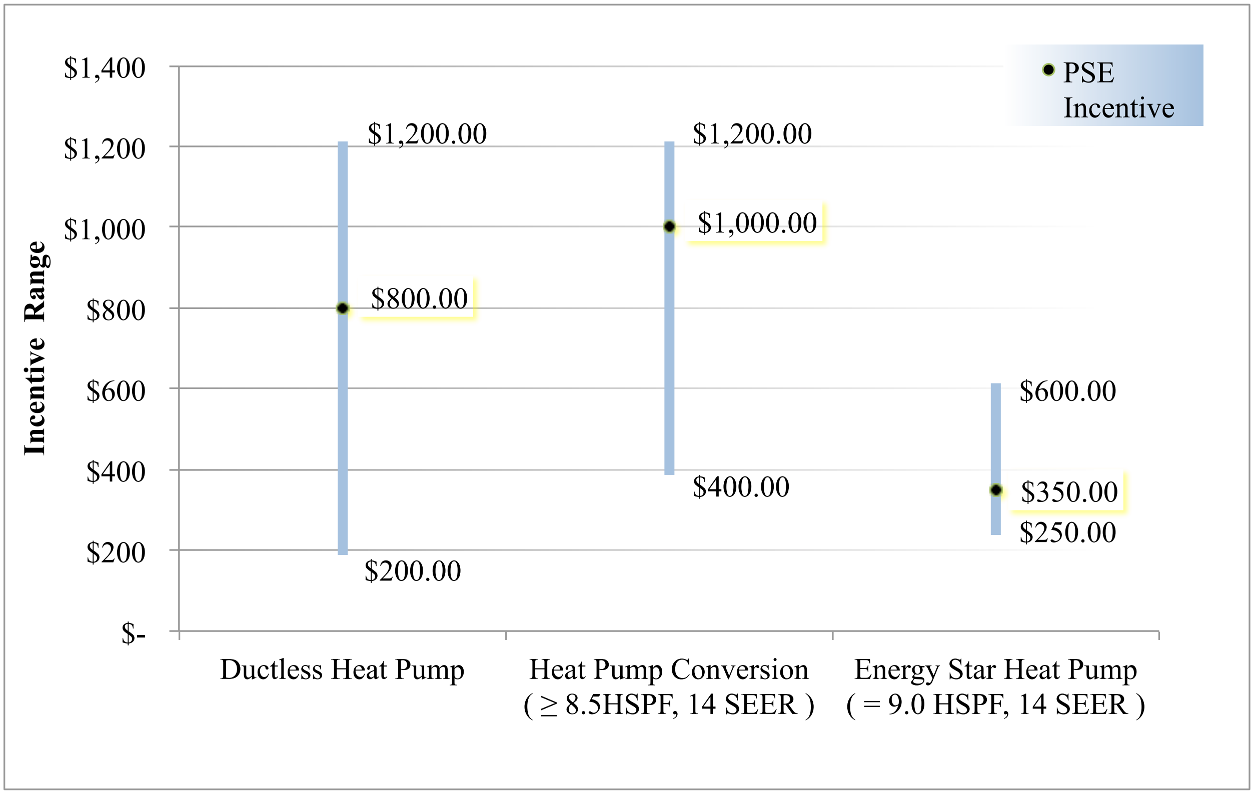


Figure 5-2 shows the range of financial incentives for high efficiency heat pumps. PSE pays in the midrange for all three of these offers, yet there are slight differences in how the measures are defined among the utilities. For example, PSE offers $350 for an Energy Star heat pump with a Seasonal Energy Efficiency Ratio (SEER) 14 and Heating Seasonal Performance Factor (HSPF) of 9. ConEd offers the highest incentive on ENERGY STAR heat pumps among all the utilities reviewed, but they only offer incentives for a higher efficiency unit than PSE (ConEd limits incentives to 16 SEER units). This is likely because PSE focuses on heat pumps for heating, where HSPF is priority. In contrast, ConED is more focused on cooling; thus SEER is likely a more important metric.

In addition, SnoPUD offers two different incentives ($500 or $1000) for Energy Star Heat Pumps, neither of which is exactly the same as the PSE measure; the $500 incentive offered by SnoPUD is for a unit with a slightly lower HSPF (8.5) than PSE offers, while the $1000 offer is for a slightly higher SEER (15). Slight differences in definition of the heat pump measures may account for the observable differences in incentive amounts.

Figure 5-2: Market Comparison: Residential Heat Pump (per unit)



5.2. Commercial & Industrial Measure Comparison

As mentioned above, 34 PSE measures account for 75% of the total electric savings in the C&I sectors combined. These measures fall into three discernible categories: retrofit measures, fixed incentive prescriptive measures, and new construction measures. This section will discuss our findings related to these measures.[22] In general, PSE pays comparable incentive amounts for all of these measures, but higher amounts for a few.

Retrofit measures

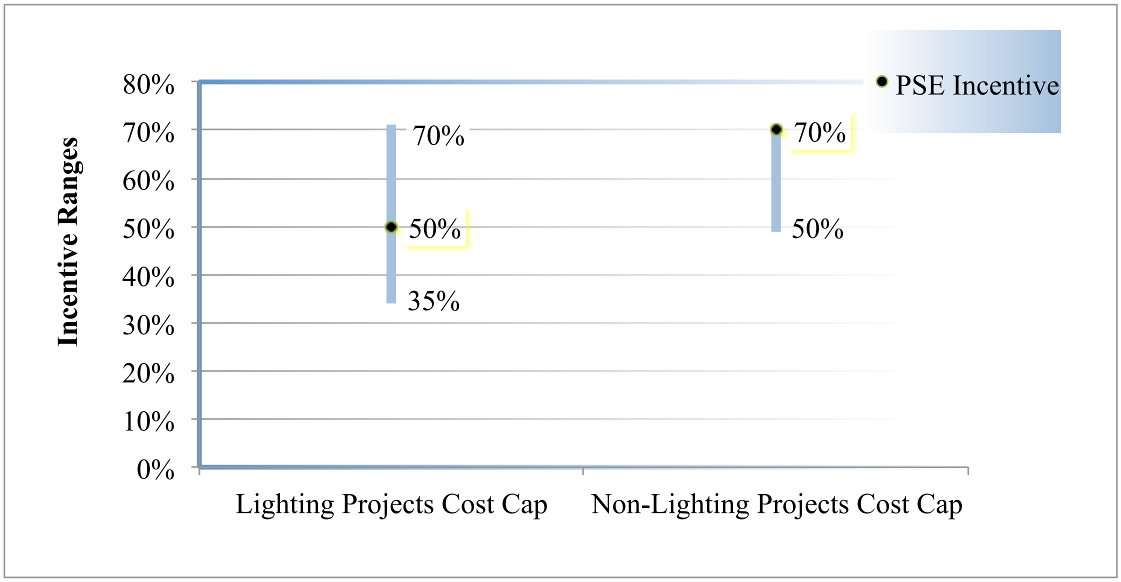
C&I retrofit measures span across many types of projects including grants for custom and standard lighting upgrades, process improvements, HVAC upgrades and systems, and commissioning. These measures account for 29.5% of the total electric savings for the BEM portfolio. 62% of these savings come from lighting with the remainder from non-lighting measures (e.g. process improvements, VFDs, commissioning, etc.) Calculated retrofit measures do not have fixed incentives, rather the incentive levels are determined by formulae with total incentives for any one project capped. The structure of PSE's incentives and related formulas for C&I retrofit projects are described in detail in Section 3 of this report.

[22] The RCM measures, which account for 11% of the C&I savings, were not comparable to measures offered by other utilities, as similar programs are extremely rare and those that do exist have been based on PSE's program – the first to build this type of program design.

Caps on Incentives

Figure 5-3 illustrates a comparison between the cap on the percent of total cost that PSE is willing to pay for C&I retrofit measures and the range of caps the peer utilities are willing to pay. The figure illustrates how the two PSE caps on C&I retrofit project costs compare to the caps set at the six peer utilities.

Figure 5-3: Market Comparison: Cap on Incentives (as % of Cost)



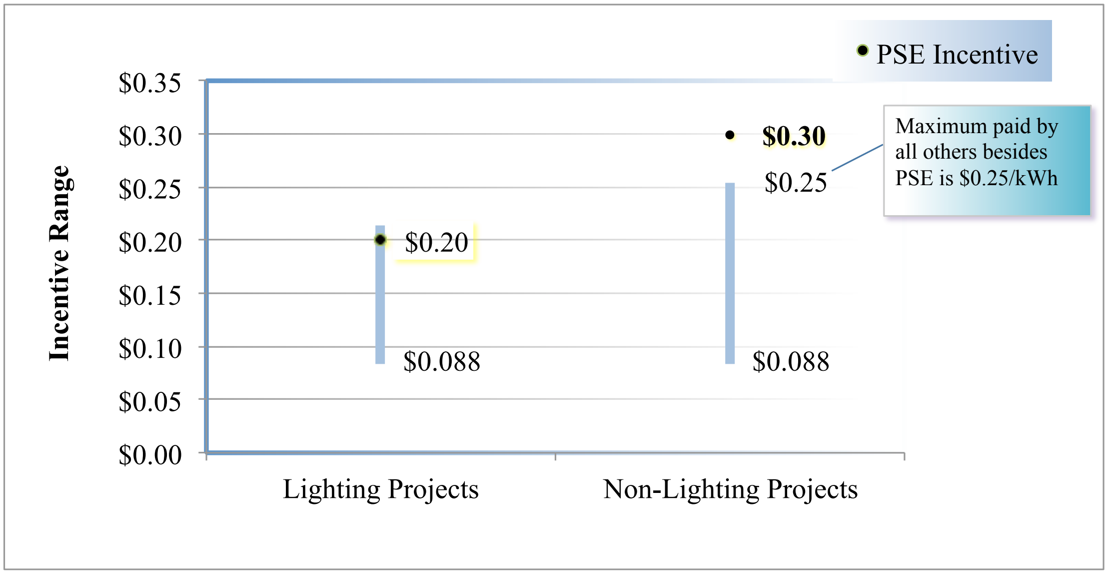
Our analysis reveals that compared to the selected peer utilities, PSE caps incentives in the midrange for C&I lighting retrofit projects and on the upper end of the range C&I non-lighting retrofit projects. PSE and ETO are the only organizations that apply different caps to lighting projects than to non-lighting projects, although the ETO cap for lighting varies based on whether the project involves custom (35% applies) or standard lighting measures (50% applies). Only two of the peer utilities cap their incentive at less than 70% (ETO and Avista).

Whereas most caps for custom, site-specific projects are based on a percentage of total project cost, the Avista cap is set at 50% of total *incremental* project costs, or the cost difference between the existing technologies and new technologies. This distinction is important to recognize, as there could easily be a difference between total project costs and incremental costs for certain measures.

Maximum Rate Paid

Figure 5-4 depicts a similar comparison for another component of the incentives for C&I retrofit measures. The maximum flat rate, expressed in dollars-per-kilowatt-hour (kWh) of annual electric savings, is the rate the utilities are willing to pay for C&I retrofit projects.

Figure 5-4: Market Comparison: Maximum Flat Rate Incentive (per kWh)



When comparing this flat rate metric across utilities, PSE incentives fall into the higher spectrum of the range among all the peer utilities for lighting and above the range for non-lighting projects. The range for this metric for the utilities in the Pacific Northwest (PNW), which comprises all six peers besides ConEd, is between $0.17 per kWh and $0.21 per kWh for lighting and between $0.17 and $0.25 for non-lighting projects. As depicted in the figure, PSE will pay up to $0.20 per kWh for lighting projects (close to the maximum among those reviewed) and $0.30 per kWh for non-lighting projects ($0.05 above the maximum paid by all the utilities reviewed). However, it should be noted that PSE has the same 70% cap on incentives as the peer utilities (as discussed above); thus, the PSE incentive does not necessarily exceed by $0.05 per kWh on every non-lighting project.

In contrast with the PNW utilities, ConEd pays three tiers based on savings for both lighting and non-lighting, but at a much lower flat rate than the PNW utilities. The PSE incentive for lighting projects is significantly higher than ConEd, which pays three tiers based on annual kWh savings ($0.088, $0.10, or $0.12 per kWh). The maximum that ConEd will pay (the highest tier), however, is only $0.13 per kWh of annual electric savings. We speculate that this lower rate is due to higher avoided costs in the New York region. Although ConEd customers are eligible for incentives from ConEd or NYSERDA, they may only receive payment from one administrator because all incentives come from the same Systems Benefit Charge source.[23]

Variable Frequency Drives

Although, there is an extensive list of measures – both lighting and non-lighting – that might be installed under the C&I Retrofit project, variable frequency drives (VFDs) are worth discussing in isolation. VFDs for HVAC fans are offered under the C&I retrofit program (if the standard $100 per horsepower rebate

[23] Per phone conversation with representative of ConEd's Green Team. Customers may apply to both ConEd and NYSERDA to compare the total incentive offers available to them, but they can only receive incentives from one source.

does not apply) and account for 1.5% of the total C&I electric conservation portfolio.[24] We comment on this measure because it falls within the top 75% of savings as part of both the C&I Retrofit Program and C&I New Construction Program and several utilities offer specific incentives for VFDs in C&I retrofit projects. The utilities do not solely base incentives for VFDs on established formulae, such as the caps or flat rates for incentives.

PSE, ETO, and Tacoma Power offer the same incentive of $100 per fan motor horsepower. Avista offers $80 per fan motor horsepower, and ConEd offers an incentive of $60 per fan motor horsepower; ConEd has an additional qualifying requirement that the VFD must run at least 1800 hours per year. No similar usage qualifications were identified for other peer utilities. When VFDs are part of a calculated retrofit incentive, the caps on total grant amounts per project discussed above may apply.

C&I Prescriptive Measures

The prescriptive measures for small business lighting, commercial refrigeration, and others we examined together account for 25% of the total C&I electric savings.

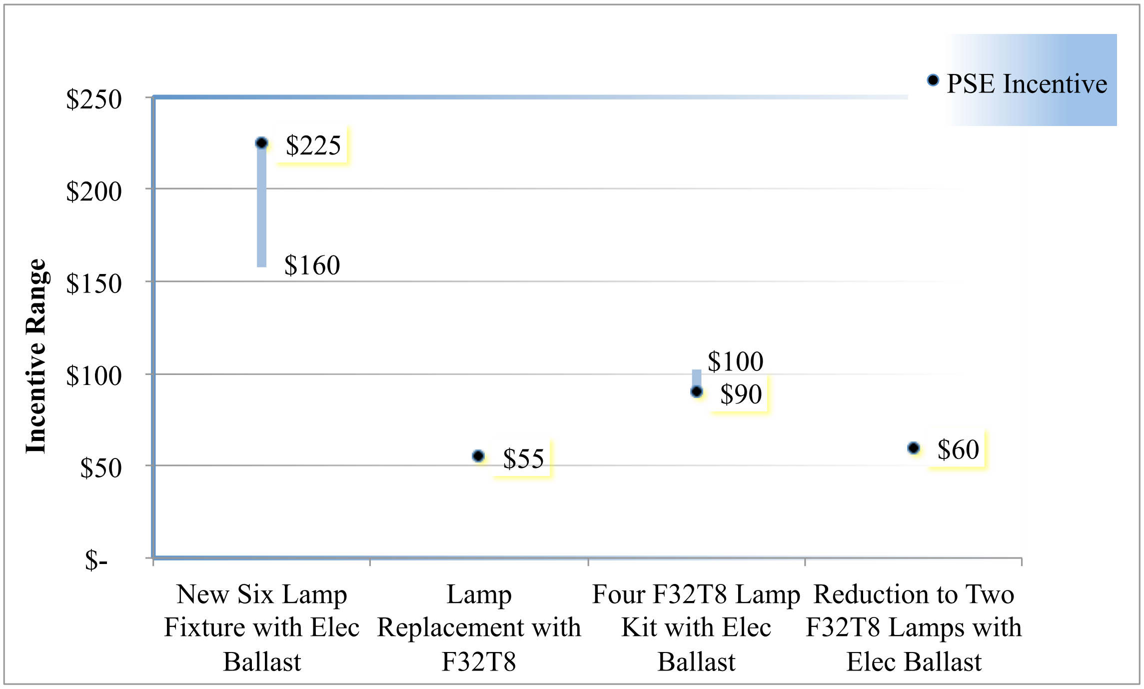
Small Business Lighting

Four prescriptive lighting measures offered to small businesses accounted for 5.8% of PSE's C&I electric savings in PY2010. As shown in Figure 5-5, of the peer utilities, only Tacoma Power also had incentives for these specific measures. PSE and Tacoma Power both offer identical incentives for F32T8 lamp replacement ($55) and reduction down to two lamps ($60).

PSE offers a significantly greater rebate for 6-lamp 32 Watt T8 fixtures at $225 per fixture installed, compared to $160 per fixture offered by Tacoma Power. Tacoma Power offers a higher incentive for the fourth measure, a kit of 4 F32T8 lamps, at $100 compared to the $90 offer from PSE.

[24] The standard $100 per horsepower rebate for VFDs will not apply if the VFD is installed in a non-HVAC system or in an HVAC system in conjunction with other substantial measures such as major control upgrades, ductwork modifications, etc.

Figure 5-5: Market Comparison: Small Business Lighting Incentives (per unit)

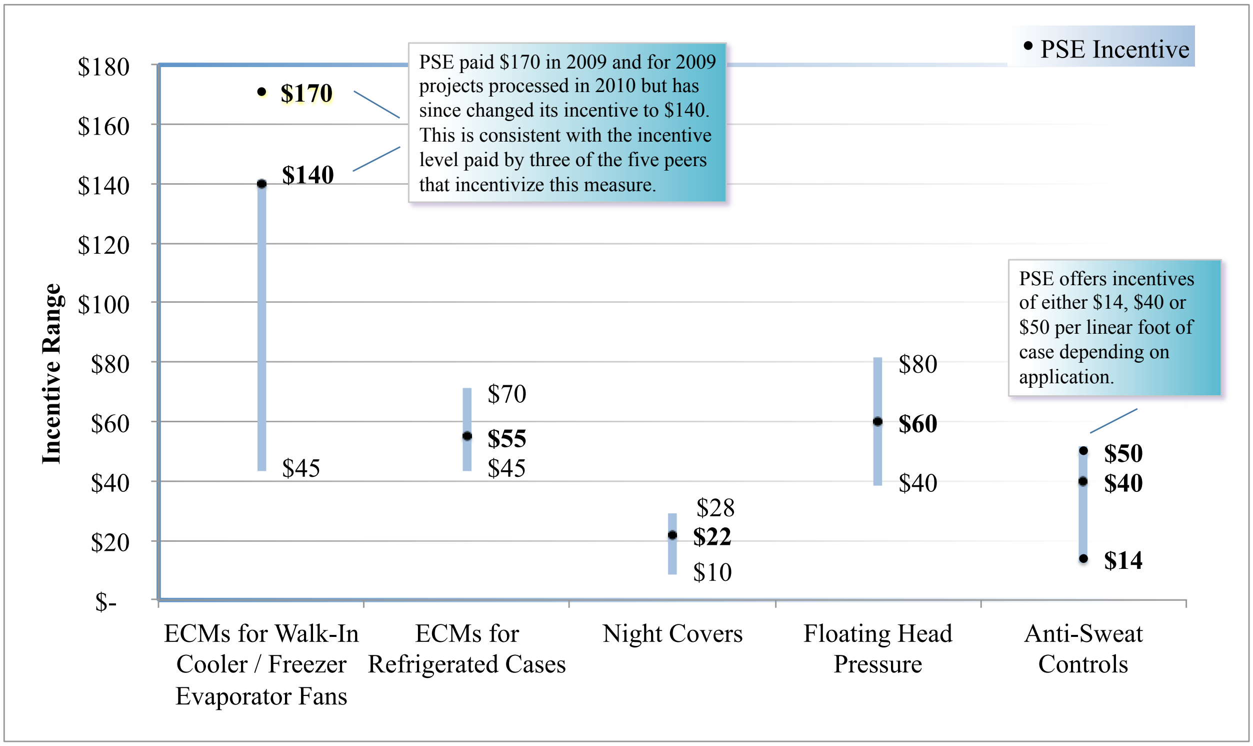


Although the remaining utilities do not have specific incentives identified for efficient lamps for small business, these may be covered under their C&I retrofit programs.

Commercial Refrigeration

Commercial refrigeration accounts for 14.3% of the total C&I electric savings at PSE. Figure 5-6 shows the range of incentives offered for five commercial refrigeration measures that were part of the Energy Smart Grocer program. Energy Smart Grocer is offered under a common marketing banner across the Pacific Northwest; however, each utility defines their program and incentives differently.

Figure 5-6: Market Comparison: Commercial Refrigeration (per unit)



For two of the measures, (floating head pressure and night covers), PSE offered an incentive that fell in the midrange of what the peer utilities offer. Similarly, PSE offers three different incentives for anti-sweat controls, all of which are consistent with those paid by the peer utilities.

The two EC motors (ECMs) measures account for the most electric savings of the refrigeration offerings (4.6% of the PSE PY2010 C&I electric savings). The PSE incentive for ECMs is divided into two groups: ECMs for walk-in cooler/freezer evaporator fans with an incentive of $140 per motor (down from $170 per motor in PY2009), and ECMs for refrigerated cases with an incentive of $55 per motor. When compared to peer utilities, the PY2009 PSE incentive of $170 per walk-in ECM was larger than the peers. However, the PY2010 offer of $140 per motor and is consistent with its peers for this measure: Avista, SCL and Tacoma Power all offer this same incentive amount. As for the incentive for cases, $55 per motor offered by PSE is comparable to others. The other utilities that offered an incentive for cases include Avista at $55, Tacoma Power at $70, and SnoPUD.[25]

Two commercial refrigeration measures are not shown on this chart: floating suction pressure and case lighting. PSE and the three peer utilities that offered an incentive for floating suction pressure all used a fixed incentive of $15 for this measure. For case lighting, PSE offered a range of $51.50 to $70 per linear foot for specific LED lighting options. ETO also specified LED lighting options (a different set that PSE), but ETO offers a fixed incentive of $10 per linear foot for case lighting. Three other utilities offered a range of incentives, with specific incentives based on lamp type or wattage: SnoPUD ($5 – 31 per linear foot), Avista ($3.50 – 31 per linear foot), and Tacoma Power ($5 – 32 per linear foot). PSE and other

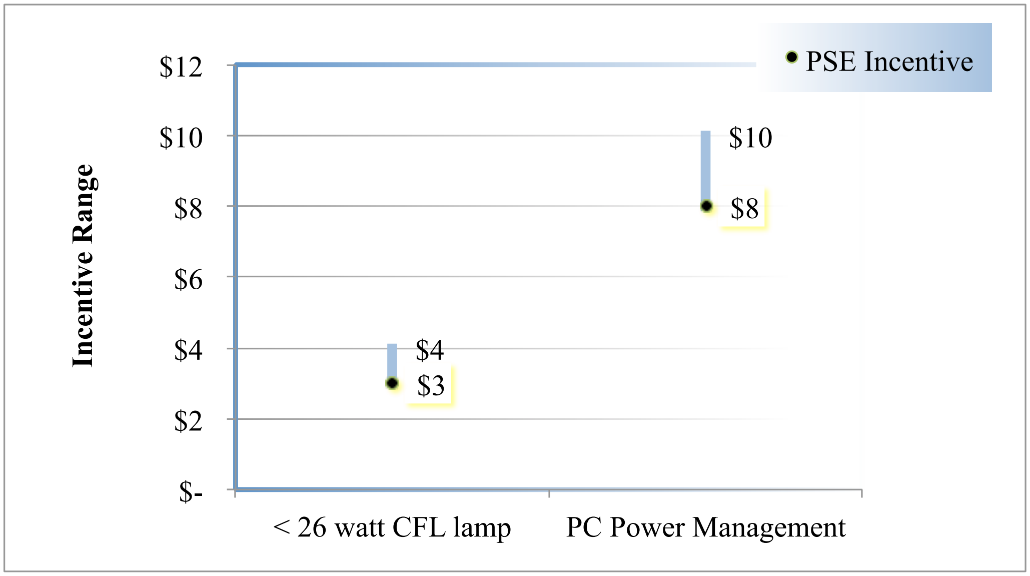
[25] The range calculation for SnoPUD was difficult to identify because program information indicates that incentives range from $25 – 100 depending on the application for EC motors but does not detail specifics.

utilities also offer incentives for T8 case lighting if upgrading from T12 but this measure was not assessed.

Other Measures

PSE offers commercial customers incentives to purchase more efficient CFLs and to implement PC Power saving features. Figure 5-7 depicts the findings for CFL lamps and PC Power Management, two low-cost measures.

Figure 5-7: Market Comparison: Other Measures (per unit)



The $3 rebate PSE offers for CFL lamps under 26 watts is the same incentive offered by the majority of the other utilities, but $1 less than what ConEd offers. There is some variation in the wattage of qualifying lamps among the utility programs, while the incentive is generally the same. The Tacoma Power rebate consisted of the largest range accepting all lamps under 40 watts; ConEd included all those under 32 watts; but PSE incentivizes only those under 26 watts. As such the measure costs are likely different; the quality could also be different; and the lower wattage indicates higher efficiency for the PSE bulb.

The second measure in Figure 5-7 is the PC Power Management incentive. SnoPUD and Tacoma Power offered the same rate of $8.00 per computer as PSE while Avista and the ETO both offered $10.00 per computer. ETO requires a minimum of 20 desktop licenses to quality for the rebate; a similar minimum computer requirement was not identified for other utilities.

Not shown on the chart is the CFL Markdown Program that consists of three distinct measures, accounting for 2.7% of the total C&I energy savings at PSE. Two of these measures have an incentive of $6 per bulb, which covers up to 100% of the price depending on whether the bulb is a 39W CFL or 39W reflector or specialty lamp. PSE offers more than most peer utilities for these bulbs; SnoPUD, who also offers $6 per bulb, is the sole exception. The remaining utilities only offer an incentive of $2 – $4 per bulb, meaning they are either incentivizing cheaper bulbs or cover less of the total cost.

C&I New Construction

The complexity of new construction incentives creates a challenge when comparing these incentives to a larger peer utility market. Measures that apply to C&I new construction projects account for 6.87% of PSE's C&I electric savings. New construction measures are part of the group of measures that account for 75% of C&I savings. Specific measures and criteria are detailed in Exhibit 4.

Through our market research, it became apparent that each peer utility had considerably different methodologies to incentivize new construction projects. Programs also have distinct customer eligibility requirements – for example, the whole building prescriptive approach at PSE is only applicable to office, schools, and retail < 100,000 square feet. Yet some similarities exist; for example, both prescriptive and custom incentives are often provided based on first year savings, and incentives are only provided to those new construction projects exceeding some standard of performance, such as a current building code.

PSE offers four paths for new construction incentives: A) Energy model whole building, B) prescriptive whole building, C) component approach, and D) rebate measures. Both of the whole building approaches provide incentives on a square foot basis. The component approach provides incentives based on first year energy savings. A flat rebate for specific installed equipment applies to the "rebate measures" for new construction. The rebates for these measures are consistent with other C&I prescriptive rebates. Among these three kinds of incentives, some comparison can be made with peer utilities.

Whole building

Whole building approaches vary by utility in terms of delivery. Whole building incentives are offered by three peer utilities. However, the incentive offered to ConEd customers is administered by NYSERDA. Whole building incentives are sometimes offered based on square footage for particular types of whole building installations (such as lighting or mechanical controls) and other times on first year savings. Whole building incentives require meeting modeled or measured improvement over current codes or best practice. SnoPUD requires savings of 10% over the WaNREC. Tacoma Power requires 10% savings over the current Tacoma Energy Code. NYSERDA offers incentives for achieving LEED status of $5000 for buildings less than 50,000 square feet and $10,000 for larger buildings.

PSE, Tacoma Power, and NYSERDA offer additional incentives or direct support for technical assistance or design work. For Tacoma Power, design incentives are provided for high efficiency (30% or better improvement over Tacoma Energy Code) design for those buildings greater than 30,000 square feet. NYSERDA will cover the first $5000 of technical assistance and provides a cost share of 50% up to $75,000 for energy efficiency measures and up to $100,000 for demand response measures.

When all the details are considered, it is clear there is no manner of direct comparison. EMI believes that each utility has structured these incentives based on their knowledge of their customer needs and internal accounting procedures. Despite the differences in program design, the goals of these programs are similar.

Component approach

Component incentives are offered by five of six peer utilities. There are differences in the component approach based on whether the project is a lighting project or not.

Lighting

Similar to custom grants, PSE offers incentives of $0.20 cents per kWh (first year savings) for lighting measures – capped at 50% of incremental measure costs. The range offered by peer utilities is $0.14 per kWh (SCL) to the max of $0.25 per kWh (SnoPUD).

Non-lighting
PSE offers incentives of $0.30 per kWh for non-lighting measures – capped at 70% of incremental measure costs. Non-lighting incentives at peer utilities vary by utility. SnoPUD offers an incentive of 20 cents per kWh – capped at 50% of material costs or 100% of incremental costs (including design).

SCL offers a range of incentives: for lighting and HVAC controls from $0.17 - 0.20 per kWh; for motors from $0.15 per kWh for process loads to $0.23 per kWh for non-process loads; and for HVAC equipment from $0.23 - 0.29 per kWh.

Rebate measures

Like PSE, ETO offers standard equipment rebates, similar to those offered for retrofits, for new construction. ETO has a worksheet for calculating total rebates based on types and numbers of installed equipment and the customer's utility (e.g. Pacific Power). SCL offers $30 for exit signs; $30 for wall mounted occupancy sensors; and $90 for ceiling mounted occupancy sensors.

6. SUMMARY

Utility-sponsored programs designed to procure energy efficiency resources have long relied upon the use of financial incentives (e.g., rebates, grants, etc.) as a way to influence customer purchase decisions related to energy-consuming equipment (e.g., lighting lamps and fixtures, air conditioning units, refrigerators, furnaces, etc.). The intention of these rebates is generally to address financial barriers (i.e., high equipment cost, high installation cost, etc.) that might otherwise preclude customers from buying equipment that is more energy efficient. The design of utility rebates have typically been calculated as a way to:

- Minimize first costs
- Reduce simple payback periods
- Offset incremental (increased) capital costs
- Offset incremental (increased) design or installation costs

Through a review of the literature on conservation program incentive setting, a review of NWPCC council methodology related to incentives, and a comparison of PSE's incentives with those of six peer utilities, EMI has determined that PSE puts considerable thought and attention into its incentive level design. Our research, including discussions with energy efficiency experts such as Ed Vine and Pierre Landry, outside the scope of this work, indicates that there is no consensus on best practices for how to set proper incentive levels, and that most utilities do not have rigorous methods or processes for defining incentive levels.

Through the documentation of PSE's current incentive setting process coupled with the data from the literature review task, the peer utility comparison task, and past research EMI has conducted in the area of incentive setting, EMI believes that PSE's incentive setting process is in alignment with the Agreed Conditions For Approval of Puget Sound Energy, Inc.'s 2010-2011 Biennial Electric Conservation Targets Under RCW 19.285, Docket No. UE-100177 and Agreed Modifications to Electric Settlement Terms for Conservation in Docket No. UE-011570, Section K. (7) (c). Specifically, EMI believes that overall incentives at PSE are:

- Periodically examined;
- Kept at as reasonable level (neither high nor too low); and
- Not unnecessarily limiting the acquisition of all available conservation that is cost-effective, reliable, and feasible.

Given that there is significant evidence, both in and outside the scope of this particular project, that there is no consensus on best practices for how to set proper incentive levels, EMI is unable to provide a list of specific best practices because they *just do not exist*. However, we did uncover a set of key points that represent the current thinking on incentive setting processes that are worth consideration. These are discussed by each related task in the project scope.

Literature Review

EMI found several key points related to incentives from our review of the literature including information on: (1) motivations for utilities to supply financial incentives, (2) impact of incentives on program results, and (3) additional non-financial program interventions.

Incentives are provided to encourage customer adoption of conservation measures, and they act on customers by reducing up front costs, signaling positive affect, and driving market transformation. Research has not found incentives to be consistently tied to program participation at any specific level. However, program evaluation has shown that levels of incentives should be program specific and sometimes technology specific. In addition, the market has been found to be most sensitive to changes in levels of incentives at extremes of incentives, such as moving from 100% of incremental costs to 80%. However, incentives do not act alone and work well with programs that fill a knowledge gap or frame conservation choices as social norms.

When incentive levels are discussed in the literature, the average incentive appears to be one-half of incremental costs. However, one of the most vexing questions within the energy efficiency industry is related to understanding the precise relationship between incentive levels and market adoption of energy efficient equipment. Although there is a long history of utilities providing incentives to drive efficiency, there is a noticeable dearth of literature on optimizing this relationship.

In our review of PSE's incentive setting methodology, we found that PSE considers each program individually and offers a mix of financial and non-financial customer interventions with its measures. PSE relies on market research to ensure the needs of the target market are addressed by incentives, and PSE already uses a ramping up and down with financial incentives depending on the customer's costs. As such, EMI can say that PSE appears to be already considering the key points found in the literature.

Alignment with Energy Independence Act and NWPCC Methodology

As mentioned above, EMI believes that PSE's current incentive setting process is in alignment with the Energy Independence Act and NWPCC Methodology. Our review of the Energy Independence Act and NWPCC methodology for specific guidance or methodology related to incentives found only indirect effects, specifically from determination of cost-effectiveness and market penetration. EMI was specifically advised by NWPCC that the NWPCC does not make any assumptions about program design, or incentives in particular, nor does it provide methodology for incentive setting practice. Based on our review of PSE regulatory filings and PSE's incentive setting process, we believe that PSE is in compliance with NWPCC methodology for the indirect drivers of cost-effectiveness and market penetration.

Comparison of PSE Incentives with Peer Utility Incentives

EMI compared PSE's financial incentives to those of six peer utilities for dozens of conservation programs that account for approximately 70% of energy savings in PSE's conservation portfolio. PSE provided financial incentives in the mid-range for almost all of these measures. This indicates that PSE incentive levels are within the norms of the industry.

APPENDIX A – ANNOTATED BIBLIOGRAPHY AND REFERENCE LIST

A.1 Annotated Bibliography

Aalbers, R., van der Heijden, E., Potters, J., van Soest, D., & Vollebergh, H. (2007). Technology Adoption Subsidies: An Experiment with Managers. *Discussion Papers* 07-082/3, Tinbergen Institute. http://www.tinbergen.nl/discussionpapers/07082.pdf.

Summary
The paper describes a framed field experiment to determine the effect technology adoption subsidies have on managers' decisions to adopt technologies.

Methods
This paper develops a model how business manager decide whether or not to invest in energy efficient technologies. The model includes how a subsidy affects the net-present-value of the technology, as well as how the presence of the subsidy effects how managers search for products. The authors then conduct an experiment to test the role of subsidies in shaping managers' energy efficient investments. The laboratory experiment works like this:

- Managers were divided into control and treatment groups, such that treatment groups would receive a subsidy on the technology and the control group would not.
- In the first period, the manager can choose between two activities. The manager can decide how much output to produce (after observing what demand is for their good) using an existing non-efficient technology or can purchase an energy efficiency technology. This trade-off is meant to represent the opportunity cost managers face when choosing which technologies to invest in—since it takes time to research options, choosing to search for an energy efficient technology means giving up time focusing on other business decisions.
- If the manager decides to search for technology, they are given an option to buy a technology with some energy savings and some rebate (for treatment group only, there were no subsidies offered to the control group). They can choose to accept this or keep searching, in which case they are given another randomly drawn savings/rebate combination. That game ends when they make a decision (there are six games total).
- Total profits the business makes over the period depend on if/when they buy the new technology since having the technology lowers costs.

Highlights
The following highlights came out of this research. First, managers that were offered subsidies went on to search for and adopt more expensive technologies. On the other hand, the presence of subsidies made some mangers more reluctant to adopt technologies (i.e. made them search longer). The first effect was stronger since the managers offered subsidies ended up choosing technologies with higher energy cost savings. Even though these technologies had higher per-period cost savings, they had lower net-present value once their price and subsidies were taken into account. Since managers who were acting, as rational consumers would choose the technology with the highest net-present value, the presence of subsidies led to significant changes in managers' decisions, with them not acting as rational consumers. As the authors conclude:

> "An additional factor may be that the presence of a subsidy invokes a positive connotation, in much the same way as a discount, a rebate or a sales price do. Such a positive connotation may carry enough weight in an agent's decision-making process to tip the balance in favor of the subsidized technologies." (p. 17)

> "The main impact of the subsidy is via reducing complexity. The subsidy adds an element of positive affective valence to an otherwise neutral but complex decision problem." (p. 21)

Relevance/Limitations
This paper gives an example of a methodology to determine the relationship between subsidies and purchases with a field experiment. It would be an interesting method to modify to test consumers willingness to buy energy efficient goods depending on subsidies. The set-up would have to be altered to mimic the trade-offs consumers make when deciding whether to invest in energy efficient technologies, and a new method would be needed to capture the opportunity cost of searching for the optimal technology.

Bayus, B. (1988). Accelerating the durable replacement cycle with marketing mix variables. *Journal of Product Innovation Management*, 5, 216-226.

Summary
This paper estimates how marketing variables—namely price, advertising expenditures, product features and product style—affect the time until a person replaces durable goods, in this case color televisions. It focuses on the decision to replace durable goods that are still working.

Methods
The paper develops a duration regression model that estimates the time until replacing a durable good—color televisions—as a function of price and adverting.

Highlights
The paper finds that decreasing the price of color televisions 10% decreases the time until a working televisions is replaced by 14 months (the average time until a working television is replaced is almost ten years). That increases to 18 months for a 20% increase in price. They find that the effect of decreasing the price is much larger than the effect of increasing advertising spending, which requires a 50% increase to decrease the time until a product is replaced by 11 months. Although not tested formally, looking at aggregate data on when televisions are replaced implies that product features and style have even less of an effect.

Relevance/Limitations
The paper sheds some light on the effects of price and advertising for replacement of working durable goods. It also provides an econometric model if we want to measure *when* a person replaces durable goods instead of solely *whether* they do or not.

The data used to run the analysis presented in this paper is based on color televisions, which might not be directly applicable to air conditioners. The study does not take any factors other than price and advertising into account. In addition, given the age of the study and the significant changes in the television market since 1988, the results must be considered with caution. The methodology used to run the analysis presented in this paper is more relevant than the actual findings reported.

Berry, L. (1993). A review of the market penetration of US residential and commercial demand-side management programs. *Energy Policy*.

Summary

This 1993 study by Linda Berry from the Oak Ridge National Laboratory reviews a number of other studies that had been conducted prior to 1993 on the market penetration of DSM programs. The author ties her review to integrated resource planning (IRP) stating that expected market penetration of DSM programs is one source of uncertainty in such planning activities. The intent of the article is to identify the various factors affecting participation rates in a manner that boosts assumptions used by planners in the development of integrated resource plans (IRPs).

Methods

This article relies upon other sources to build a collection of assumed penetration rates. Data is gathered from case studies of residential and commercial new construction and retrofit programs as well as participation data based on surveys. This data is reviewed to "characterize the typical patterns of variation" in the participation rates achieved by this wide range of program type including ranges, averages, and maximum levels (p. 54). This review helps Berry illustrate various types of factors affecting participation rates and draw conclusions.

Highlights

There are a few highlights in this report. First, a number of example participation rates are provided. Many of these come from a group of 1988 EPRI studies and a 1988 Lawrence Berkeley National Labs study. These are shown in the following table presented here as Figure 2-29. The data in this table found in the second column from left, labeled "Number", represent the number of programs reviewed.

Figure 8: Variation in annual market penetration rates from Berry study

Table 1. Variation in annual market penetration rates (% participation by eligible customers).

	Number	Average	Minimum	Maximum
Residential				
Audit[a]	85	3.2	0.03	31
Incentive[a]	71	5.5	0.02	59
Direct load control[a]	58	26.0	0.01	100
Time of use rates[a]	51	24.0	0.1	100
Home energy rating systems[b]	13	40.0	2.0	100
Commercial				
Audit[c]	21	3.6	0.01	50
Incentive[c]	11	2.4	0.13	32
Direct load control[c]	5	0.3	0.12	1
Time of use rates[c]	20	1.1	0.10	100

Although, information on incentive levels was not provided, details on residential participation rates from the EPRI study and discussed by Berry include:

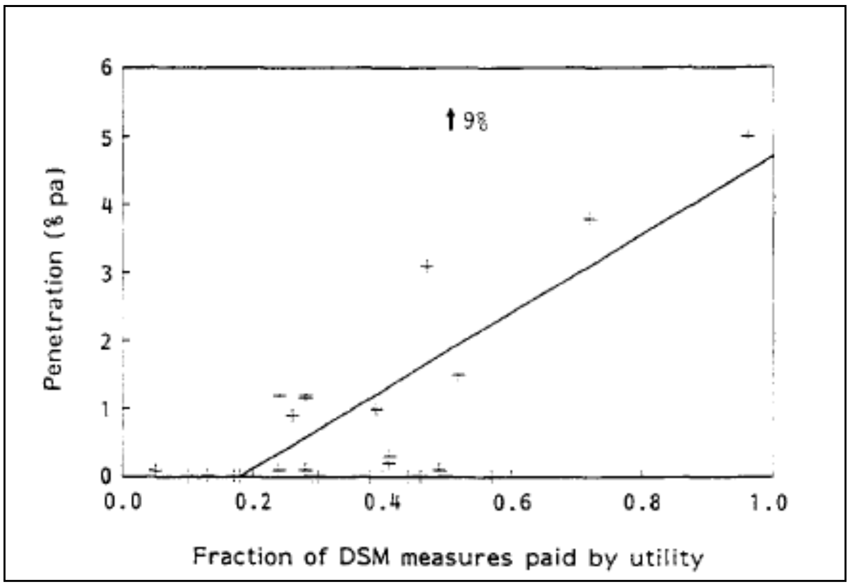
- Very low participation rates (less than 1%) for a *majority* of residential audit programs.
- A higher *average* participation rate for audits at 3.2%; highest rate 31%
- Average rate for residential incentive programs (including appliance rebates and weatherization) was ~6%; highest rate was 59%
- Almost half of the incentive programs had rates <1%

A number of other studies were discussed that had specific numbers for participation rates, some with more information on incentive levels:

- Many residential retrofit programs in California from mid-1970 to mid-1980s achieved cumulative penetration rates nearly reaching 50%.

- 40% of buyers of high-efficiency models in one (unspecified) program applied for a rebate
- Data from an EPRI survey showed 4% market penetration for rebates offers on heat pumps and high-efficiency air conditioners.
- A line is drawn for penetration rates by incentive fraction (incentive cost/purchase cost) in a study by Camera and other from 1989. This study found that “as the incentive fraction increased from zero to one, the annual market penetration rates rose from 0 to 4.9%” (p. 59). Figure 930 below shows this relationship.

Figure 9: Penetration Rate by Incentive Fraction as Shown in Berry 1993. Originally from Camera, et al. 1989.



Note: The Camera, et al study has not been located and could not be reviewed.

As part of her review, Berry has constructed a table of attributes of successful programs (measured by high participation rates). This is presented as Figure 2-31below. These attributes are subdivided into are categories: program context, program features, customer characteristics and community characteristics. It is interesting to note the similarity between these categories Stern’s three domains of decision-making: the personal, behavioral, and contextual (Stern 1999).[26]

[26] Also see Figure 38 in Section 4.

Figure 10: Characteristics of Programs with High Participation Rates

Table 4. Characteristics associated with high programme participation rates.

Programme context
High commitment of sponsor (including top management)
Not supply constrained (enough budget, manpower, and materials to meed demand)
Rising energy prices
Expected energy shortages
Favourable political and social climate
Programme features
Trusted, credible sponsor (eg local community groups, trade allies)
Simplicity and convenience (one step, direct installation)
Financial incentives (no cost to customer)
Marketing
- Most effective techniques used (direct personal contact, door to door canvassing, telemarketing)
- Market segmentation used
- Targeted groups involved in programme planning
- Features matched to customer needs by market segment
- Variety of barriers addressed

Duration (programme lasts five years or more)
Sales training and rewards for programme personnel
Communication factors
- Vivid, personalized information
- Peer testimonials
- Stress current loss instead of future gains

Risk reduction
- Quality control
- Warranties
- Guaranteed savings

Customer characteristics
Residential
- High income
- High education
- Middle-aged
- Home owner
- Attitudes and lifestyle match programme features

Commercial
- Large size
- Hotel/motel

Community characteristics
- Rural, often with public power
- Well integrated
- Conservation ethic

Relevance/Limitations
The two most relevant sections of the Berry study are the curve shown in Figure 9 and the table showing traits of successful programs presented as Figure 10. The curve depicts the exact relationship we are aiming to study. However, there are certain limitations with the study. Although the article does discuss the relationship between incentive level and penetration rates, the age of the study make the findings less meaningful and less relevant since DSM programs have greatly evolved since the 1980s and 1990s. Additionally, the Northeast Region Demand-Side Management Data Exchange (NORDAX) database, which was analyzed in the referenced study by Camera, is not discussed in great detail. The Camera study has not been found and information about the database is difficult to trace. The little we know comes from the report reviewed next by Hirst and Sabo. Unfortunately, without more information about the programs in the NORDAX database and without the Camera study, the relationship depicted in the Berry study is limited in its relevance.

Chandra A., Gulati, S., & Kandlikar, M. (2010). Green Drivers or Free Riders: An Analysis of Tax Rebates for Hybrid Vehicles. *Journal of Environmental Economics and Management*, 60 (2), 57-144.

Summary
This study estimates the impact of Canadian province-level rebates on the sales of Hybrid Electric Vehicles (HEVs) and non-hybrid vehicles that compete with HEVs. The authors use variation in the size and timing of rebates across provinces to estimate the relationship between rebate size and sales.

Methods
The researchers collected data including HEV rebate levels, as well as vehicle purchases and leases by model, year and province in Canada from 1989 to 2006. They also used data on vehicle characteristics so as to examine what vehicles are replaced by HEVs. They used this data to test a regression model in which sales of HEVs and non-HEVs in each province in each year is a function of:

- Rebate levels
- Province fixed (these are a set of variables with one constant variable for each province, such that these variables control for the unobserved differences between provinces)
- Time fixed effects (these are a set of variables with one variable for each year, such that these variables control for changes in HEV sales over time)
- Vehicle characteristics (to control for customers' tastes)

Highlights
The researchers found that a $1000 increase in the provincial sales tax rebate increases the market share of hybrid cars by 31-38%. However, they find that only 26% of the hybrid vehicles sold during the rebate programs can be attributed to the rebate, so the rebates ended up subsidizing some consumers who would have purchased hybrid vehicles or other fuel-efficient vehicles anyways.

Relevance/Limitations
These findings could also apply to energy efficiency programs, since the paper includes information on rebate levels and vehicle levels. However, there are often many more considerations that go into purchasing a vehicle than typical energy efficiency measures (performance, style, etc.), and purchasing a vehicle is often a much larger purchase, so the data needs to be considered with caution. The methodology could possibly be applied to a future study on the influence of incentive levels on energy efficiency purchases.

Datta, S., & Gulati, S. (2009). Utility Rebates for Energy Star Appliances: Are they Effective? *Mimeo, University of British Columbia*.

Summary
This paper estimates the impact of utility rebates for ENERGY STAR appliances on the market share of these appliances. They use variation in the size and timing of rebates across states to estimate the relationship between rebate size and market share.

Methods
The researchers collected data on average utility rebate levels, sales of ENERGY STAR appliances and sales of standard appliances, along with data on personal income, education levels and electricity prices. They have quarterly observations between 2001 and 2006 for all 50 states. They use this data to test a regression model where the market share of ENERGY STAR appliances in each state by quarter is a

function of rebate levels, the control variables mentioned above, and state and time fixed effects. The state fixed effects are a set of variables with one constant variable for each state, such that these variables control for the unobserved differences between states. Similarly, year fixed effects introduce one variable for each year, so these variables control for changes in energy efficient appliance sales over time.

Highlights
The authors found that the utility rebates do have a significant effect on the market share of ENERGY STAR clothes washers, although there is no significant effect for dishwashers or refrigerators. For clothes washers, a one-dollar increase in the rebate leads to a 0.3% increase in the share of ENERGY STAR-qualified clothes washers. They also find the clothes washer rebates to be cost effective for the utility.

Relevance/Limitations
This is potentially a good starting point for information related specifically to clothes washers, dishwashers and refrigerators. The approach of looking at variation in rebate levels across time and place could also be used for air conditioners. It is important that the authors did not find significant effects in their analysis of rebates for dishwashers and refrigerators. The authors attribute these null findings to the fact that there were fewer rebates for these two appliances, making it harder to prove statistically significant results. Also, utility rebates are averaged over an entire state, since the appliance sales data they used was measured at the state-level. They are not able to match up each utility's rebate with appliance sales in its service area, which means that the relationship they measured between rebates and appliance sales is not very precise.

Environmental Protection Agency. (2010). National Action Plan for Energy Efficiency. Customer Incentives for Energy Efficiency Through Program Offerings. *Environmental Protection Agency*. http://www.epa.gov/eeactionplan

Summary
This EPA brief is meant to provide guidance to organizations responsible for the development of incentives for energy efficiency by providing a review of various approaches utility energy efficiency program administrators take when designing incentives. It is designed as an addendum to the National Action Plan for Energy Efficiency, which also presents guidance on a number of other related (but not relevant) energy efficiency topics.

Methods
The methods used to draw the conclusions are not described in this study. However, it is clear that a number of studies, including the suite of best practice studies carried out by Quantum were reviewed.[27]

Highlights
The report provides a high-level review of the use of financial incentives in energy efficiency programs. It does not provide details on specific incentive levels, participation levels with given incentives or any other such data-driven findings. As such, it functions best by providing general guidance about how programs work under different designs. These generalizations are expressed in their findings.

[27] EMI did not include Quantum's "Best Practices Benchmarking for Energy Efficiency Programs" studies in this annotated bibliography because past reviews of these reports for other projects and additional scans of the Residential Heating and Cooling section of the online database did not identify specific findings that would benefit this research.

First, program administrators meeting aggressive energy savings targets are making use of the most appropriate design for their customers. Recent program designs focus on bundling financial incentives with technical assistance, as opposed to more traditional financial incentive designs offered on stand-alone bases. These approaches are designed to obtain deeper savings per customer and produce wider and longer-lasting market effects. Targeting which approach works with the given audience is a key component of an effective energy efficiency incentive program. As Figure 11 illustrates, different types of incentives have different effects.

Second, the authors report that "new research and program pilots are underway to better understand emerging, innovative incentive approaches, including whole-building performance-based incentives and incentives designed to change customer behavior and decision-making, beyond targeting product purchase transactions" (p. 2). Five examples of these more-comprehensive program models proven to "complement rather than supplant simpler and mass market approaches" are provided (p. 16). These highlighted programs include:

- Home Performance With ENERGY STAR: http://www.energystar.gov/homeperformance
- Xcel Energy Commercial Real Estate Efficiency program: http://www.xcelenergy.com/Minnesota/Business/Programs_Resources/ConservationRebates_Incentives_Business/Pages/Commercial_Real_Estate.aspx
- New Jersey Clean Energy Pay for Performance: http://www.njcleanenergy.com/commercial-industrial/programs/pay-performance
- Energy Trust of Oregon: http://energytrust.org/business/incentives/commercial-buildings/new-building/custom/custom-track-incentives
- Building Performance With ENERGY STAR (an NSTAR performance-based incentive pilot program): http://www.nstaronline.com/business/energy_efficiency/electric_programs/benchmark.asp

Perhaps the most useful sections of this report deal with barriers and incentive design. The study lists a number of barriers for various customer segments. This segment, as stated in this report, typically faces the following barriers: "higher initial cost, lack of information, competing priorities, inexperience or prior negative experience with technology, and emergency replacements" (p. 9).

In terms of incentive design, the most useful point the EPA authors make is that the "incentive design process should not be an abstract analytical effort" (p. 12). In other words, making use of feedback and data from customers and trade allies as well as continuous observation will greatly benefit incentive programs over the long-term. In fact, the study points out that trade allies and customers can provide a great deal of information on the market during the design phase that can be useful to incentive design such as information on market barriers, incentive levels and types, and other services. Moreover, the authors say that during the design phase, it is important to consider the comparative impacts of different types of incentives. The following table, shown here as Figure 11, provides this general guidance.

Figure 11: General Guidance on Impacts of Incentives from EPA brief

Key Impacts	Direct Financial Incentives	Upstream/ Midstream Incentives	Information Services	Technical Services	Bundled Incentives/ Services
Impact on Capital Investment	H	M	L	M	H
Impact on Behavior Change	L	L	H	M	M
Impact on Customer Decisions	H	M	M	M	H
Impact on Third Party Decisions	L	H	M	L	M
Impact on Participation	H	H	L	M	H
Impact on Energy Savings	M	L	L	M	H
Impact on Measurement and Verification Complexity/Cost	L	M	H	M	M
Impact on Regulatory Approval	L	M	L	M	M

H = highly likely to be effective for the incentive and its role;
M = moderately likely to be effective; L = low likelihood of being effective

Relevance/Limitations
This study is not extremely helpful to specific energy efficiency program decisions for existing programs or utilities with experience, as it is only general in its guidance. There are very few quantitative details presented, and those that are offered, are qualified with a statement indicating the "necessary subjectivity." As such, it is not relevant to determining precise incentive levels for a specific type of program. With all that said, the study does provide an indication of the types of incentives that impact participation as shown in the table above presented as Figure 11, namely direct financial incentives, upstream/midstream incentives, and bundled incentives/services. The latter, the EPA brief contends, also has a high impact on other attributes of energy efficiency programs, such as capital investment and energy savings.

Erickson, J. (2003). Addicted to Rebates? Or Are They Just What the Doctor Ordered? *Meeting Diverse Needs, Seattle, Washington: International Energy Program Evaluation Conference.* http://www.iepec.org/2003PapersTOC/papers/018.PDF

Summary
This article discusses the role of rebates in the energy efficiency market. It includes case studies of programs that have used rebates to help transform the energy efficiency market, but then discusses potential unintended negative consequences of using rebates on the market, such as "[diminishing] the chances that some more cost-effective energy efficiency actions are taken or [creating] expectations and attitudes that stand in the way of other energy efficiency actions." The author also discusses areas of research into the potential negative impacts of rebates and offers advice on how these negative effects might be mitigated or avoided.

Methods
The author of the paper searched the energy efficiency and general marketing literature to find evidence on the effects of rebates on market transformation as well as utilized a case study approach.

Highlights
The case studies profiled in this paper all demonstrate the benefits of using rebates to influence the adoption rate of energy efficient technology and thus transform the market.

- Residential Gas Furnaces in Wisconsin: Rebates were used in the 1980's to reach up to 90% penetration levels of efficient furnaces installation. By 1991, all utilities were told to stop offering rebates, but Wisconsin's furnace market continued to have higher installation rates of high efficiency units than neighboring states.
- Clothes Washers in the Pacific Northwest: Rebates were introduced in the spring of 1997 to increase sales of high efficiency clothes washers, the rebates were reduced, and then discontinued in the fall of 1998. Over the promotional period, sales of high efficiency washers increased significantly. Though sales declined immediately following the removal of rebates, they remained above preprogram levels and continued to rebound in the following years.

Hypothetical drawbacks discussed in this paper include:

- Distraction: Distraction may be caused by focusing consumer attention on the action (saving money) rather than the cause (energy efficiency, long term savings). This trend has been noticed by automakers where consumers focus on incentives rather than the specific features of a car. The other side of this argument is that rebates get consumers to focus on the product for long enough to get the energy efficient message across.
- Suspicion: Consumers might get suspicious of a product's quality because of the rebate. This suspicion stems from traditional marketing where undesirable items are put on sale, while "hot items" are kept at full price.
- Narrow Focus: Consumers may believe that by buying the rebated product they are doing the recommended action for energy-efficiency, rather than investigating more comprehensive options.
- Load Building: Consumers may buy additional products and think the action is okay because of the energy-efficient label.
- Entitlement: Consumers may start buying products only when a rebate is offered, believing that they are entitled to a lower price. Evidence of this problem has been seen in the automotive marketplace.

The author provides future research possibilities related to each of these five drawbacks. In addition, the author identifies three factors that are key to rebate programs achieving market transformation:

- Large market size
- Large rebate budget relative to market size
- Rebates available for a long enough period of time

Relevance/Limitations
This article describes considerations that should be made by program designers regarding rebate programs and offers areas for future research. The drawback of the article is that it offers no proof of the negative consequences of energy efficiency rebate programs - a limitation that the author clearly states. Due to the theoretical nature of this paper, the author is unable to quantify the three key factors to ensuring rebate programs transform the market. The reader is left asking questions like: "How big does the market need to be for rebate programs to be effective in transforming the market?" With that said, this document

provides a foundational discussion of the potential positive and negative impacts of rebate programs which should be considerations of program and incentive designers.

Fernandez, V. (2000). Decisions to replace consumer durable goods: An econometric application of Weiner and renewal process. *The Review of Economics and Statistics*, 82(3), 452–461.

Summary
This paper developed a model to analyze the decision to replace central air conditioners. The authors use data from the Residential Energy Consumption Survey (RECS) of the U.S. Department of Energy to measure the effect that demographic variables, operation and replacement costs, and equipment characteristics have on the decision to replace air conditioners and electric heaters.

Methods
This paper develops a duration regression model, which estimates how long it takes a consumer to replace a central air conditioner as a function of age of the head of household, monthly family income, electricity prices, cooling degree days, house size, house age, family size, living in urban area, the availability of natural gas, family credit ratings and product deterioration. She also has a similar model for the decision to replace electric space heaters.

Highlights
This paper presents a set of variables that do and do not affect the decisions to replace an air conditioner, which would be useful in informing which variables should be controlled for in future research. Variables that do significantly affect the decision to replace an air conditioner include:

- Age of the head of the household
- Operation costs (electricity prices)
- Equipment characteristics
- Climate

Variables that do not affect the decision to replace an air conditioner include:

- Income
- Living in an urban area
- A poor credit rating

Relevance/Limitations
This paper's findings informs program administrators about which variables should be considered when designing programs whose intent is to encourage the replacement of household appliances. These considerations also impact the incentive design for these types of programs.

That major limitation on this study is that there is no data on the effect of price level on the replacement decision, so there are no results directly applicable to the question of optimal incentive sizes.

Fernandez, V. (2001). Observable and unobservable determinants of replacement of home appliances. *Energy Economics*, 23: 305-323.

Summary
This paper developed a model to analyze the decision to replace central air conditioners. It uses data from the Residential Energy Consumption Survey (RECS) conducted on behalf of the U.S. Department of

Energy to measure the effect that demographic variables, operation and replacement costs, and equipment characteristics have on the decision to replace air conditioners and electric heaters. Fernandez introduces a new statistical methodology for estimating her model in this paper that improves on the Fernandez (2000) paper cited above that allows for product operating costs to be correlated with unobservable characteristics, which affect operating costs but cannot always be controlled for (such as product quality).

Methods
This paper develops a duration regression model, which estimates how long it takes a consumer to replace central air conditioners as a function of age of the head of household, monthly family income, house size, living in urban area, family credit ratings, product operating costs, product cooling capacity and product age. She also has a similar model for the decision to replace electric space heaters

Highlights
This paper presents a set of variables that do and do not affect the decisions to replace an air conditioner, which would be useful in informing which variables should be controlled for in future research. Variables that do significantly affect the decision to replace an air conditioner:

- Age of the head of the household
- Square footage of the house
- Cooling capacity of the unit
- Age of the unit

Variables that do not affect the decision to replace an air conditioner include:

- Income
- Living in an urban area
- A poor credit rating

The paper finds that the cost of operating air conditioners is correlated with unobservable characteristics of the units such as their quality, such that not accounting for these unobservable characteristics can overstate the effect of operating costs on replacement decisions. Once the paper accounts for the unobservable characteristics, results are mixed on whether operating costs are a significant determinant of product replacement decisions.

Relevance/Limitations
This paper's findings inform program administrators about which variables should be considered in the development of a study of the decision to replace air conditioners. It also provides an econometric model for duration studies that address *when* a person replaces their air conditioner instead of solely *whether* they do or not.

That major limitation on this study is that there is no data on the effect of price level on the replacement decision, so there are no results directly applicable to the question of optimal incentive sizes.

Four Winds Alliance & D&R International. (2000). Opportunities for New Appliance Market Transformation Programs in the Pacific Northwest. *For Northwest Energy Efficiency Alliance*.

Summary

This report studies two previous appliance market transformation programs and provides insights to the programs' effectiveness. The authors then make recommendation on program elements to include in a similar program implemented by the Northwest Energy Efficiency Alliance.

Methods
The authors of this report primarily used data and findings from reports and studies and other secondary data sources. They did also conduct primary research "through interviews with key market actors including manufacturers, national retailers, independent retailers, contractors, multi-family builders and property managers, public housing agencies, and regional and national Market Transformation (MT) stakeholders" (p.1).

Highlights
Between 1998 and 2000, Wisconsin Energy Conservation Corporation focused their appliance programs on education and retailer recruitment. The program initially provided a $100 incentive on washers and a $15 SPIFF (A SPIFF refers to a special payment incentive for the sale of an item paid to the retailer or directly to the sales person.) A year and a half into the program the clothes washer rebate was reduced to $50 and the SPIFF to $5. In the second year of the program, rebates remained the same and SPIFFs were eliminated (p.92). Sacramento Municipal Utility District focused their promotional program, run between 1998-2000, on outreach and incentives for refrigerators and clothes washers. In 2000, refrigerators had the following tiered rebate program: $25 for 20% better than standard; $75 for 25% better; $100 for 30% or better, with plans to eliminate rebates in 2001. For washers, in 2000, $75 was offered for the minimum ENERGY STAR level, and $125 at the next level, with plans to continue the program in 2001 (p.94).
In interviews with national retailers, the authors found that many do not allow SPIFF money to go to individual salespeople, and that many thought SPIFFs generated the wrong behavior in salespeople, wanting the salesperson to focus on consumer needs over individual monetary gains. Additionally, "Point-of-purchase (POP) materials are problematic for some of the large retailers. One said they will not use POP materials and the others said they need long lead times to coordinate and flexibility on how the materials are designed and used" (p.114). From the interviews the authors compiled lists of program elements that retailers found the most important. Below are the tables for national and independent retailers. Both types of retailers rate the following program elements in the top four in terms of importance: rebates, advertising campaigns, and sales person education.

Figure 12: Importance of Program Elements to National Retailers

Program Element	Score 1-10 (1 low, 10 high)
Rebates	8.8
Advertising Campaign	7.0
Sales Person Education	6.5
Tax Credits	6.5
Point-of-Purchase Materials	6.0
SPIFF's	4.3
Consumer Contests	4.0
Retailer Contests	1.0
Bulk Purchases	No Comment

Figure 13: Importance of Program Elements to Local Retailers

Program Element	Score 1-10 (1 low, 10 high)
Rebates	8.6
SPIFs	8.1
Sales Person Education	7.9
Advertising Campaign	6.5
Point-of-Purchase Materials	6.4
Tax Credits	6.2
Retailer Contests	5.4
Bulk Purchases	4.3
Consumer Contests	3.5

In their recommendations, the authors agree with short-term targeted incentives to encourage retailers to carry new superefficient appliances and increase consumer awareness. They caution against the long term use of rebates, stating "We do not believe that rebates should be a permanent fixture in this marketplace, but used instead as a strategic option to help focus consumer and retailer attention on new products, or to leverage increased participation and investment….by key actors in the distribution chain" (p.122).

Relevance/Limitations
This report provides insight from retailers on the relative importance of financial incentives in the marketing of energy efficient appliances. However, it does not recommend how to appropriately calculate incentive levels, only giving empirical data on what other programs have given. It also recommends caution in the use of financial incentives. Additionally, this report is eleven years old, which limits it relevance in today's market.

Friedrich, K., Amann, J., Vaidvanathan, S., & Elliot, R. N. (2010). Visible and Concrete Savings: Case Studies of Effective Behavioral Approaches to Improving Customer Energy Efficiency. *Research Report E108. American Council for an Energy-Efficient Economy.*

Summary
The report focuses on finding the best ways to tap into behavioral changes of consumers to increase energy efficiency savings. The report defines behavioral programs as programs that were designed to make long-term changes in individual or organizational behavior. The authors profile ten successful behavioral energy efficiency programs and summarize the results of those programs to make recommendation for further implementation of behavioral programs. They conclude that such programs can provide significant savings, but require tracking of data to prove the achievable results.

Methods
The authors of this report examined recent energy efficiency programs and chose, for further review, one that showed the following characteristics (making exceptions where they felt a particular program warranted special attention): "

- Provided evidence of both cost-effectiveness and (proportionally) significant energy savings
- Took place in the United States or Canada
- Showed potential for larger-scale adoption
- Provided evidence that savings persisted beyond 12 months
- Were evaluated by third parties
- Reported "cause and effect" results for specific measures
- Had energy efficiency objectives or reported energy savings" (p.2)

Highlights
The main highlights of this report were the connections made between behavior and energy use, identification of areas for further study, and suggestions for program design based on the behavioral findings. Among the behavioral measures recommended are: visibility, social context, corporate culture, and relevant benefits.
In the second case study, Residential Smart Energy Monitoring Pilot by Cape Light Compact in Massachusetts, was on energy savings caused by users being able to monitor usage through data and graphics on a website. Some of the key findings in the study are included below:

- "The most reliable predictor if savings was the frequency of customer visits to the program Website. The survey data – demographics, attitudes, and even reported behaviors – did not predict the energy savings that occurred. Because of this, PA Consulting recommended that programs gather energy savings data rather than relying on self-reported results alone (PAC 2010)."(p.15)
- At the end of the pilot 90 percent of the participants said they were interested in continuing to use the website. The average customer was willing to pay $7.57 per month to have access, with willingness to pay ranging from $0-$30 per month. The evaluators recommend a nominal fee be charge for website usage to encourage engagement (p.16).

The third case study, Flex Your Power in California, was on energy efficient engagement spurred by an educational campaign. At the end of the program evaluators found that Spanish speakers responded more positively to the message than English speakers. In fact 84% of Spanish-speaking respondents were interested in getting more information and/or making behavioral changes (p. 19).

The fourth case study, Home energy Reporting Program by OPOWER for Sacramento Municipal Utility District, gave important insights into the results of augmented energy reporting. The study found that consumers responded best to information that came in a normal sized envelope with mostly graphical data. Furthermore, the study found that consumers, who used less energy than their neighbors, could get demotivated by the reports and could be encouraged by the use of emoticons to track their usage from month to month (p.21).

The number one recommendation of the report is to increase visiblity of energy usage to help encourage adoption of enery efficient behaviors. The report lists: Websites, In-home displays, Pay-as-You-Go Programs, Advanced-Billing Programs, Corporate Energy Management Programs, and Labeling Programs, as potential options to increase visiblity (p.38). To determine the success of programs the authers recommend focusing on actions (as related to behavioral change) and using surveys as a supplement to energy use data to help understands actions that have been taken (p.39). People can be further encouraged to make changes through the use of goal setting, competition, and social status creation (p.42).

Relevance/Limitations

This report is highly relevant to the current research task because it discusses, in detail, the behavioral incentives that need to be set to encourage energy efficiency by both residential and commercial customers. The report shows that these programs have had success, even with traditionally hard to reach sectors. The authors performed a thorough analysis of what elements of behavioral programs work to encourage energy efficiency.

Gardner, J., & Skumatz, L. (2005). Decomposing price differentials due to ENERGY STAR® labels and energy efficiency features in appliances: proxy for market share tracking? *Proceedings from European Council for an Energy Efficient Economy Summer Study.*

Summary

This paper estimated the price differential between efficient Energy Star appliances and standard appliances, to determine the amount of incremental cost of energy efficiency in an appliance. The cost of energy efficiency in an appliance is not just equal to the difference in prices between Energy Star and standard appliances. The price differential is complicated be the fact that Energy Star appliances are generally bundled with other high-end features that also increase their price. The authors used statistical methods to control for appliance features and estimate the price premium on Energy Star appliances that is attributable solely to being more efficient, referred to as the hedonic price difference within the field of economics. The authors argue that this estimate of the price premiums for efficient Energy Star appliances can be used to understand the market share of Energy Star appliances. Specifically, if this price premium decreases over time, a supply-side perspective would imply that the quantity of efficient appliances—i.e. the market share—has increased.

Methods

The authors used a regression model to decompose the differences between prices of efficient Energy Star appliances and standard appliances into the differences caused by a) appliance features and b) energy efficiency. Separate models were applied to refrigerators, clothes washers, and dishwashers. To run this model, the authors gathered primary data on the prices and features of both Energy Star and Standard appliances. The authors collected this data from store visits and web searches.

The regression model estimates the price of an appliance as a function of an indicator variable for whether an appliance was an Energy Star appliance as well a set of indicator variables for the various product features customers consider when purchasing an appliance. The coefficient on the variable for whether an appliance was an Energy Star appliance represents the price premium or hedonic price difference for an energy efficient appliance, holding all other features constant.

Highlights
This paper found that the true price premium for an Energy Star appliance, after controlling for differences in product features between Energy Star and standard appliances, is much lower than the sticker price differences (the gross price difference) between Energy Star and standard appliances. The authors found that this is because Energy Star appliances are often bundled with other high-end features, such that the higher price of Energy Star appliances reflects these features along with their energy efficiency. The differences between the gross price differences and the true price premium, or hedonic price difference, are summarized in Table 2-25 below.

Figure 14: Refrigerator Price Decomposition

	Gross price difference	Gross price difference (%)	Hedonic price difference	Hedonic price difference (%)
Refrigerators	$650	109%	$251	42%
Clothes washers	$313	64%	$71	15%
Dishwashers	$96	27%	$0-12	0-3%

Because it is very hard to get data on the sales of Energy Star or other efficient appliances, it has been difficult for researchers to measure the market share of these products over time. The authors argue that using their approach to measure hedonic price differences over time could fill this void. Following the rules of supply—when quantity goes up, price goes down—their suggested approach is to use changes in hedonic price differences over time to understand how the quantity supplied in a market is changing. If the price premium on energy efficient appliances decreases, this would imply the quantity in the market has increased, and thus market share has increased. To this end, the authors have tracked the market of two appliances (they don't specify which two) for a client over the past two years and have found that the price premium for Energy Star has fallen over that time. They proposed this trend demonstrates the progress of the market and suggest that future results can be used to determine market maturity (p.922).

The authors go on to suggest that the gap between gross price differences and hedonic price differences are important for energy efficiency program managers to address. They state that program managers have increasingly worried about the price gap for Energy Star clothes washers without realizing that the majority of the gap exists because of manufacturers adding premium features on Energy Star models. The negligible hedonic price difference for dishwashers, in particular, shows that this market may be fully developed. The authors advise that "this indicator might be adopted as a trigger for invoking an "exit strategy" for program interventions" (p.922).

Relevance/Limitations
This study is relevant to the current research project because the majority of rebates on appliance are calculated to cover some percentage of the incremental cost of the energy efficient measure. According to this study, then, the majority of rebates are set higher than necessary since these rebates are based on

gross price differences, which overstate the cost of energy efficiency. Instead, the authors argue that the maximum a rebate should be is the hedonic price difference, i.e. the price premium of efficient products that is actually attributable to energy savings, not other product features. Because incentives based on the hedonic price differences would be smaller than ones based on gross price differences, the authors go on to argue that using hedonic price differences to identify appropriate incentives for Energy Star appliances will help reduce the costs of energy efficiency programs. (p.923).

The study is limited because the authors do not include the exact results of the regressions, as far as importance of different features. Additionally, it is unclear whether there has been any field trial using the incentive levels suggested in this paper. A trial of this theory is important to ensure that consumers really do make decisions in line with the regression model. The authors also do not attempt to address what percentage of the hedonic price difference would need to be covered to encourage buyers to purchase efficient appliances.

Finally, the authors' suggestion that tracking hedonic price differences over time will shed light on market transformation is based on the assumption that demand for efficient appliances (or appliances at all) will not change over time. This is a bold assumption, which would need to be justified further before such an approach was to be taken.

Gibbs, M. & Townsend, J. (2000). The Role of Rebates in Market Transformation: Friend or Foe? *Proceedings from American Council for an Energy Efficient Economy (ACEEE) Summer Study on Efficiency in Buildings.*

Summary
This paper discusses the pros and cons of rebates and their overall impact on market transformation goals. It also discusses a *theoretical* framework for setting rebate levels based on proper market information.

Methods
The framework that Gibbs and Townend discuss, which is based on work conducted by the US Treasury Department, aims to help program administrators determine the most effective rebate levels. The work is based on experience in the energy efficiency industry. In particular, the authors have designed (but not implemented) a "sealed-bid" auction process to determine the "market clearing" rebate level for energy efficiency measures. No specific measure or use of the model is discussed but details on how such a framework might be structured are shared. The framework includes the following steps:

1. Budget for the incentives paid is announced prior to the bidding.
2. Bidders submit a bid sheet including only one round of bids. The bid sheet shows the number of units that manufacturers would ship across different incentive levels ($/unit).
3. Auction organizer sums the quantities offered at each rebate level.
4. The subsidy level is set so that the subsidy multiplied by the total number of units offered equals the budget. A single subsidy level is set for all bidders, so as not to create a "discriminatory" auction.[28]

[28] The authors refer to a US Treasury study that ran a "discriminatory auction" (as opposed to a uniform-price auction like the authors used) where each bidder pays the price he or she bids. The authors "do not recommend using a discriminatory auction because: 1) theory suggests that bidding is more competitive under a uniform-price auction; 2) the outcome, with different bidders receiving different subsidy levels, might be perceived as unfair; and 3) the differing price rebates could be confusing to consumer" (p. 6.130).

5. All bidders who bid at or below the chosen rebate level are chosen as “winners” and are required to deliver the number of units they bid at the chosen rebate level.

Highlights

Clearly, the main highlight of this study is the auction process discussed above. On the surface it seems to be a very solid method for determining appropriate incentive levels. The authors detail the steps as illustrated in the methods above and provide a few useful tables that help the reader understand how such an auction might be carried out. One of these tables is titled the “Illustrative uniform-price sealed-bid auction bid sheet,” which shows exactly what a bid sheet could look like.

In addition, the paper explains the benefits and downsides of using rebates to influence the market. This description provides a layer of context that helps the reader understand how and why the auction framework may work. The positive functions that rebates serve, detailed by the ICF authors, are as follows:

- Reducing risk for market actors,
- Creating a marketing impact for consumers, and
- Acting as a temporary market support until economies of scale reduce product costs.

Similarly, the risks of rebates are listed as the following:

- Interfering with market signals,
- Causing a marketing effect that is detrimental to long-term sales, and
- Diverting energy efficiency program resources away from other intervention tactics that may have greater long-term impacts.

Each of these potential benefits and costs are explained in further detail in the study.

Lastly, the study focuses on the attributes of successful rebate design. The guidelines portray the need for four attributes:

1. **Planning for the long-term** – “short planning horizons of rebate programs limit manufacturers’ abilities to respond” to new programs or changes in the program design. Manufacturers need time to make modifications to their product lines in order to be able to offer qualifying equipment to their customers. As such, long-term planning horizons may have positive effects on stakeholders.
2. **Developing individual strategies for each technology** – recognizing the uniqueness of each technology, measured by its “own market characteristics and technological potential” helps maintain market accuracy.
3. **Use an integrated market transformation strategy** – as many other studies suggest, utilizing a “suite” of aligned strategies, such as education and information tactics, can provide a multiplier effect.
4. **Use market-based rebate levels –** the ICF authors detail one way these levels might be set in the framework they design. The rationale for setting rebate levels based on market information is described as follows: "...rebates should be set at the margin in a way that inhibits noncompetitive producers and inferior products from thriving in the marketplace...we expect that the higher the rebate levels as a percentage of sales price, the more likely that the rebate will interfere with market signals that drive a competitive product market."

Relevance/Limitations

This study is very relevant to the research at hand. The framework is one alternative for how to set rebate levels. Although the study is clearly limited by the fact that this paper solely offers a theoretical framework and does not include case studies of real-world implementations, the experience of ICF and the knowledge of rebate programs are evident throughout the study. A few limitations and unanswered questions remain:

- Could this framework apply to a customer-focused program as opposed to a manufacturer-based program?
- How many customers or manufacturers would need to bid to make it truly valuable?
- Do manufacturers and/or customers have the information they need prior to bidding? If not, what information would they need?

Guiltinan, J. (2010). Consumer durables replacement decision-making: An overview and research agenda. *Market Letters,* 21:163–174.

Summary
This research paper is a very recent review of the theory and empirical work conducted around consumer replacement of durable goods. The author integrates research in economics, behavioral science and marketing to augment the traditional rational consumer model with a behavioral science perspective. The research provides a starting point for understanding the academic research concerning consumers' decisions to replace durable goods and what factors should be considered when studying this decision.

Methods
This paper is written as a review of recent theoretical and empirical research concerning consumer durable replacement behavior. The authors organize this research together into a proposed conceptual framework of the replacement decision process, focusing on how the traditional rational consumer model can be extended by behavioral science.

Highlights
This paper synthesizes research on many different factors that affect consumers' decisions to replace durable goods. Some of these factors include the following:

- **Consumer discount rates[29] -** Consumers with higher discount rates value present consumption more than future consumption, and thus are likely to replace durable goods more often.[30]
- **Loss aversion.** – Loss aversion is especially high when replacement good seems similar to current good or when the replacement good does not fulfill the same consumption goals as the current good.
- **The perceived substitutability of the new good –** New goods that are perceived as substitutes can lesson loss aversion when giving up an old good, while the additional features associated with a new good can influence the consumers decision to replace the old good or not.
- **Whether or not an old good can be traded in when purchasing a new good –** This can help mitigate the loss aversion from giving up the old good.

[29] Consumer discount rates are defined as the measure of how much consumers value present consumption relative to future consumption.
[30] In the energy efficiency context, consumers with higher discount rates value present consumption of a good relatively more and thus will be less likely to invest in more expensive energy efficient products today if the value of energy savings is realized in the future.

- **The effectiveness of marketing and advertising**
- **The functional role of the product to a consumer**
- **The psychological costs of scrapping a functioning good**

Relevance/ Limitations
This review provides a solid starting point for thinking about how consumers make replacement decisions when designing a study for looking at the role of financial incentives in these decisions. However, this study does not include any useful primary research.

Hunt, A. (2009). Social Norms and Energy Conservation. *Working Papers 0914, Massachusetts Institute of Technology, Center for Energy and Environmental Policy Research.*

Summary
This paper evaluates the effectiveness of OPOWER's programs that send energy usage reports to residential customers comparing their usage to that of neighbors. The author uses the data provided for all current OPOWER programs to calculate the Average Treatment Effect of the programs. He uses this analysis to compare the cost-effectiveness of this behavioral program to that of traditional energy efficiency incentive programs.

Methods
The author used the data collected by OPOWER in each utility experiment. OPOWER takes care to determine the experimental populations based on historical energy usage and construct neighbor comparisons. OPOWER randomly determined control groups and treatment groups, where members of the treatment group received Home Energy Report. Depending on the utility program, reports were sent monthly, bimonthly, or quarterly. "In some of the more recent projects, letters are sent each month for the first several months of the program, with a lower frequency after that. In five experiments, the populations were divided into sub-populations with higher and lower baseline usage, with the Treatment groups in the high-usage subpopulation receiving more frequent Reports. As a result, there were 17 separate experimental populations randomized into treatment and control across the 12 utilities. In Connexus and in Experiment 11, the population was randomized into monthly vs. quarterly frequency, and in Experiment 3, population was randomized between bimonthly and quarterly frequencies"(p.7). Meter readings of treatment group customers taken at least 30 days after Home Energy Reports have been generate are considered to display "post-treatment" behavior.

Highlights
One pilot program included a self-reporting survey on what energy-efficiency were taken by households. A few households reported upgrading household efficiency, including weather-stripping and insulation measures. Far more households changed their day-to-day energy usage: turning on lights, unplugging electronics, adjusting thermostats, and closing window blinds. "Interestingly, these are behaviors that most consumers likely already knew could save them energy. This suggests that at least some of the letters effects act through drawing attention or increasing the "moral cost" of energy use, instead of solely by providing new information or inducing changes in capital stock"(p.11). The author calculates the average energy savings in households at .57 kilowatt-hours per day. These savings translates a day, or 9.5 hours of a incandescent light bulb. He calculates short term price changes that would lead to similar savings (based on Reiss and White 2008) as a increase of 17 to 29 percent. (p.11) The author notes that the cost-effectiveness of this program is really good compared with traditionally incentive programs. Among the reasons for this efficiency, is an option for consumers to opt-out of the program, allowing the

utilities to avoid the cost of sending reports to those who do not want then. The author suggests that further cost-effectiveness in OPOWER programs can be achieved through profiling of the customer base. Households that have relatively high usage to their neighbors provide much more opportunity for improvement due to Home Energy reports and thus meet a high cost-effectiveness threshold. (p.17)

Relevance/Limitations
This report provides relevant calculations on the efficiency of the Home Energy Report statements as behavioral energy efficiency programs. The author provides clear evidence that the programs are affecting change and creating voluntary energy-efficiency among residential consumers. The paper is limited by its scope of only examining OPOWER programs. It would be relevant to the current research to compare the achieved cost-effectiveness with that of financial incentive programs or examination of what adding financial incentives could deliver in terms of enhanced savings.

Johnson Controls, Inc. (2008). Energy Efficiency Indicator Report 2008.

Summary
Johnson Controls is a global diversified technology and industrial leader, serving customers in more than 150 countries. The company prepared this report to gauge what the North American business community is doing in response to rising energy costs, what expected paybacks periods are on energy efficient investments, and whether concerns are environmental or just economic. A survey was conducted and the results were summarized, to help give insight into the commercial sector's motivations.

Methods
The results presented in this report are compiled from an online survey that was completed in March 2008 by 1,150 energy management decision makers. For respondents to qualify for the survey, they had to have official job responsibilities reviewing or monitoring the company's energy use and have budget responsibilities for the company's facilities.

Highlights
The respondents of this survey were characterized by the following demographics: 56% of the respondents to this survey managed facilities of less than 100,000 square feet; an additional 19% managed less than 500,000 square feet. Also 56% of respondents work for companies with less than 100 employees. Respondents believe energy costs are 10% of total expenses on average, and 80% expected that energy prices would rise in the next year.
The most interesting responses are included below:

- "Companies of all sizes are paying greater attention to energy efficiency than they were one year ago but those with larger facilities have increased the attention by a greater margin. 42% of those with the largest facilities say they are paying a lot more attention versus year ago, compared to only 26% of those with the smallest facilities." (p.9)
- "The relative influence of cost savings versus environmental responsibility in energy management decisions does not change with facility size – the emphasis is always on cost savings, with environmental responsibility playing a secondary role." (p.9)
- "Incentives are also considered somewhat more influential by those with larger facilities." (p.9)
- "Monthly continues to be the most common frequency for companies to review energy consumption, and on average companies review consumption slightly more than once a month. Average frequency of reviewing consumption data has declined slightly since one year ago."

Figure 15: Frequency of Reviewing Consumption Data

Frequency of Reviewing Consumption Data		2008 (1145) %	2007 (1249) %
Daily	(265)	2	3
Weekly	(52)	5	6
Monthly	(12)	47	40
Quarterly	(4)	17	19
Twice a year	(2)	9	7
Annually	(1)	11	14
Less than once a year	(0.5)	6	8
Don't know		3	3
Avg. times per year		*15.0*	*17.1*

- "Cost savings are a considerably greater motivation for achieving energy efficiency than is environmental responsibility, however the environment is usually at least partly the reason: 41% of respondents believe energy efficiency is mostly or somewhat more for cost savings but few believe it is entirely for cost savings. About one-third believe environmental responsibility and cost savings are equally behind decisions to improve energy efficiency." (p.20)
- "Education of staff and other facility users is a very commonly implemented tool for increasing energy efficiency – around 70% of companies appear to do this." (p.23)
- "The larger the area of facility space, the greater the importance of energy management to a company. For one-third of those with 500,000 square feet or more, energy management is *extremely* important, and for three-fourths it is *extremely* or *very* important. However, even for those with smaller facilities, half or more consider it at least *very* important." (p.31)
- "Regardless of the total area of their facilities, the majority of companies have a tolerance for a payback on energy efficiency investments of between one and 6 years. Those with the largest facilities will tolerate slightly longer payback periods."

Figure 16: Tolerance for ROI on EE Investments

Tolerance for ROI on Energy Eff. Investment		Total (1144) %	<100,000 sq. ft (640) %	100,000 – 499,999 sq. ft (218) %	500,000+ sq. ft (267) %
Less than a year	(0.75)	5	6	3	2
1 but less than 2 years	(1.5)	16	16	15	14
2 but less than 3 years	(2.5)	22	22	22	24
3 but less than 4 years	(3.5)	16	14	22	16
4 but less than 6 years	(5.0)	18	15	20	24
6 but less than 10 years	(8.0)	6	4	8	10
10 years or more	(10.0)	3	2	1	6
Would not require ROI		4	6	2	1
Average Maximum ROI period		*3.6 years*	*3.3 years*	*3.7 years*	*4.1 years*

- "Government and utilities incentives are more influential in the west than in other regions."

Figure 17: Influence of Incentives on Decisions

Influence of Utilities/Gov. Incentives on Energy Efficiency Decisions		Total (1143) %	Northeast (250) %	Midwest (303) %	West (329) %	South (383) %
Extremely/very influential		38	37	32	47	37
Extremely influential	(5)	13	14	11	16	11
Very influential	(4)	25	23	21	32	25
Somewhat influential	(3)	37	40	41	36	37
Not very influential	(2)	14	15	15	10	15
Not at all influential	(1)	8	7	8	6	8
Mean		*3.22*	*3.22*	*3.13*	*3.41*	*3.17*

Relevance/Limitations

This survey gives insights into possible commercial sector responses to energy efficiency programs. These insights can be used to help design incentives to best engage this sector in energy efficiency programs. It is interesting that in comparison to the Oxera study on residential households, where future energy savings were not considered an important factor in undertaking energy efficiency measures, such savings are the primary concern for commercial consumers. The study does not ask respondents the amount of incentive necessary to motivate energy efficiency measures, which limits its relevance to the current project.

Lutzenhiser, L. (2009). Behavioral Assumptions Underlying California Residential Sector Energy Efficiency Programs. *Prepared for CIEE Behavior and Energy Program.*

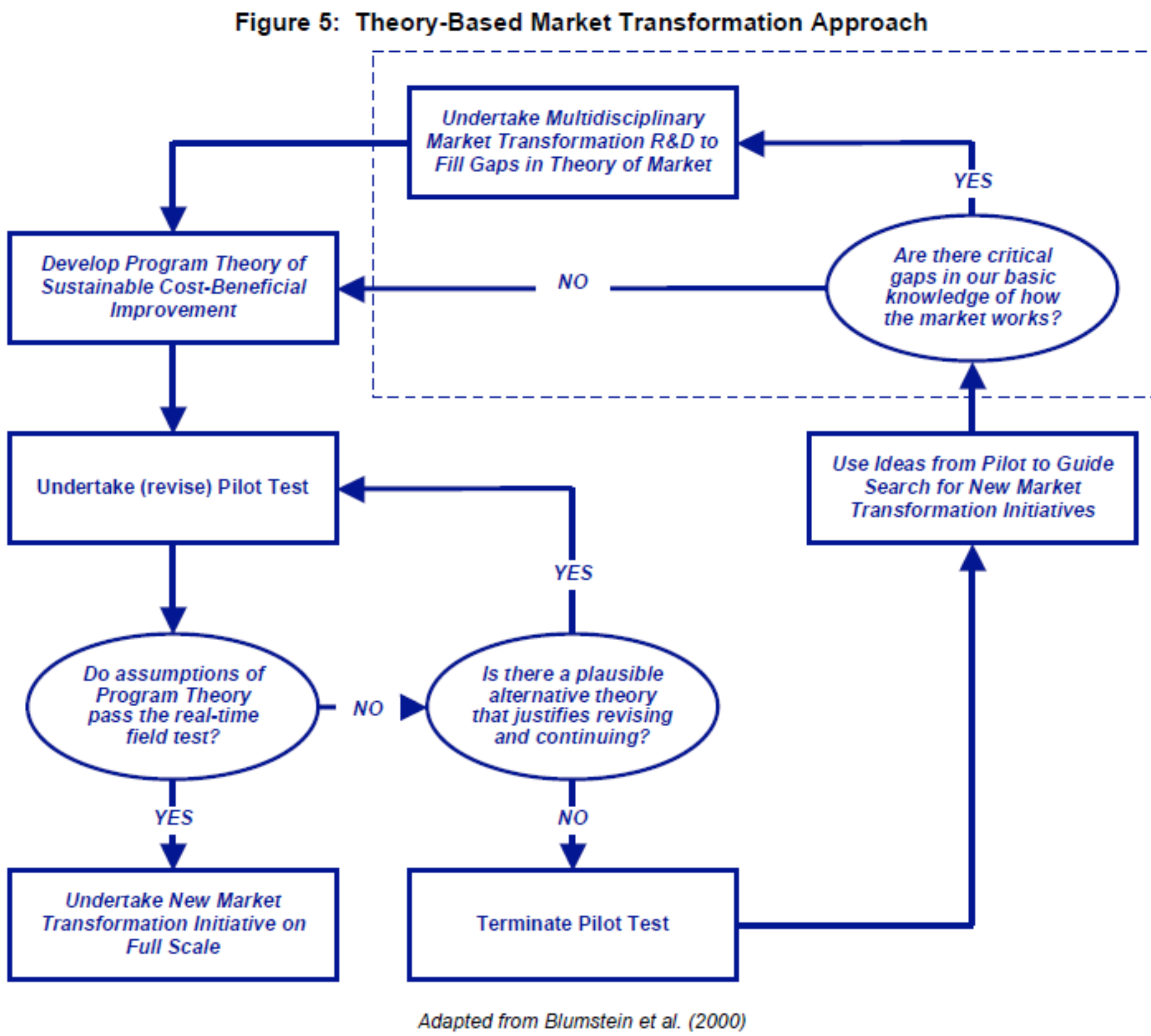
Summary
This white paper discusses the current framework for residential energy efficiency programs in California. The framework is analyzed for its successes and failures in encouraging reductions to energy usages. The authors than delve into a discussion on different behavioral approaches to exerting change and suggest how energy efficiency policies can be adjusted to become as productive as possible.

Methods
The authors of this paper obtained data from California residential energy efficiency programs documents filed by investor-owned utilities (IOUs) with the California Public Utilities Commission (CPUC) and CPUC official policy documents. They also interviewed program managers, from both IOUs and public utilities. The interviews focused on program design, assumptions, implementation, and evaluation. To expand their research further, researchers also read social science documents, gray papers, and energy efficiency program descriptions from the United Kingdom and European Union. (p.4)

Highlights
The white paper thoroughly dissects the current physical-technical economic model (PTEM) used for the design and evaluation of energy efficiency programs. This framework is routed in classical economics and thus "has characterized consumer behavior and choice as instrumental, purposeful, rational, and secondary to the devices, machines, and appliances that are seen as the actual users of energy." (p.II)

The main highlights of this paper are in the discussion of new frameworks that can be used for program design implementing research on behavioral economics, sociology, and psychology. The first of these is experimental design, which the authors note will be appealing for utilities and program implementers because it can build upon existing programs, and systematic make adjustments to various components. The scientific measures of this approach would make it easy to report on and have quantifiable results data. There are, however, drawbacks to this approach. The first drawback is the need to base any changes in program on credible theories, and not just experiment for the sake of experimenting.
The authors' final conclusions on experimental design are: "The bottom line, in our view, is that while program experiments can be imagined and might be quite valuable, they are much easier to imagine than they are to plan, design, execute, analyze, and have confidence in the findings – and have findings that are useful, powerful, and/or generalizable. But these are not insurmountable challenges, and they may be worth the cost and time for us to arrive at improved programs and policy mechanisms" (p.83). The other approach suggested by the authors is theory-based market transformation, which is best described by the figure below.

Figure 18: Theory-Based Market Transformation Approach



The authors stress that knowledge gaps exist before programs go into the market and they need to be addressed while the measures are in the field. They also note that programs may turn out to be failures, but failures are important to learning what not to do. (p.86)

Relevance/Limitations
Though this paper is highly respected in the field of energy efficiency it has limited relevance to the current research project, as it focuses on a complete shift in program design rather than optimal incentive level setting. We felt that it was important to include this paper because of its efforts to shift the tradition paradigms used in energy efficiency, its possible applications to future program design, and that many of the other papers in this annotated bibliography list this report as a source.

Mauldin, T., Li, A., Hoefgen, L., Ledyard, T., Tolkin, B., & Feldman, S. Are Retailers Gaming the System? Availability and Pricing of ENERGY STAR Room Air Conditioners. ***Energy Program Evaluation Conference, New York.***

Summary
This study looks at the market for Room Air Conditioners (RACs) in Massachusetts as well as nationwide during the period 2001-2004 with a focus on the availability and pricing of ENERGY STAR models sold by retailers. After observing seasonal fluctuations (e.g. between quarters), the authors conducted a study to understand the effects of seasonal availability on price differentiations. The study concludes that the difference in price between efficient RACs and non-ENERGY STAR RACs does not differ, and as such retailers do not appear to be "gaming" the system. The study also briefly mentions that incentive levels (covering 2/3 of the incremental costs) appear to be reasonable, but very little explanation for this conclusion is provided.

Methods
A regression analysis was conducted to understand how much the ENERGY STAR label increases the price, and how price fluctuates overtime for both ENERGY STAR and non-ENERGY STAR RACs. The analysis also determined whether incentive levels were reasonable by estimating the incremental cost of the ENERGY STAR models. In particular, the authors aimed to determine whether the incremental price of ENERGY STAR models were higher when the program was running as compared to when no incentives were available. More details on the methods include:

- Data on price and features of various models sold at retail stores in Massachusetts were gathered in May and August 2004.
- Fifteen independent retailers and six regional or national chain stores were selected randomly
- RAC model data collected includes manufacturer, model number, price, ENERGY STAR status, presence of ENERGY STAR label, size, BTU per hour, EER, and availability of specific features

Highlights
A few relevant pieces of information can be gathered after a close review of this study and should be highlighted:

- Program incentive levels for RACs in Massachusetts in 2004 were $25, representing about two-thirds of the incremental cost and offered only during the second quarter.
- Market penetration in the second quarter of 2004 was 58%, which is 10% higher than it was during the third quarter. This reversed a trend from 2001-2003 that showed market share of RACs to be higher each year during the third quarter.

Relevance/ Limitations
This study is relevant to the objective of this research because it discusses the impact of financial incentive levels. However, it is less relevant than it might be if it had focused on a more expensive measure and discussed participation levels in more detail. It is more a discussion of what is currently available than what impact incentive programs are having on the market. As such, it is of limited value beyond providing one data point with a few caveats.

Mid American Energy. (2005). MidAmerican Energy Company: Residential Process Evaluation Report.

Summary
This document is a process evaluation of MidAmerican Energy's five Residential Energy Efficiency Programs. The evaluation provides key insights into consumer's responses to energy efficiency incentive programs in Iowa.

Methods

The authors reviewed program documentation and tracking data. They continued their research by conducting in-depth interviews of 14 program staff and 47 trade allies, and telephone interviews of 700 customer participants and 200 customer nonparticipants. The authors analyzed the results of the data collection to develop key findings and opportunities of improvement.

Highlights

MidAmerican's Residential New Construction program uses lump-sum financial incentives, which equate to 60 to 70% of the incremental capital costs of energy efficient measures, to encourage green building. The receipt of incentives is dependent on successful completion of construction and verification by MidAmerican (p.5-4). Consumers surveyed stated that the most important reasons for participating in the program were "getting higher quality construction, comfort, and saving. ENERGY STAR features and the rebate ranked relatively low" (p.5-9). However, rebates typically went to builders, not homeowners. Builders' insights into incentive structure, as reported by the authors, were as follows: "Eight of the nine builders thought the rebate levels were adequate. When asked for recommendations on the incentive structure, three builders offered suggestions including adding a window rebate, making the rebates the same as the rural electric companies' rebates, offering a structure to bring in smaller houses, and creating tiers for incentives with increased incentives for builders who do more of their homes through the program" (p.5-19).

The Residential Load Management program aims to provide an incentive, in the form of a bill-credit at the end of the program season, that is high enough to encourage ongoing participation, but low enough to prevent spending more than is necessary to attain results. MidAmerican has calculated this incentive to be $40 for first year participants, and $30 for returning customers. Prorated incentive checks are given to participants who drop out before the end of the season (p.6-3). The survey found that only .7% of all program participants (including dropouts) had concerns over the amount of the rebate (p.6-13). The table below shows the participants' stated interest in the program. It is interesting to note that incentives were only the third most likely reason for participating, behind both energy savings and a reduced energy bill.

Figure 19: Interest in Residential Load Management Program

Table 6-4. What Most Interested Participants in Program

	Percent of Responses
Energy Savings	35.3%
Reduced Energy Bill	30.6%
Incentive	23.2%
Avoiding Power Shortages	2.7%
Don't Know/None	2.6%
Other Reason Interested	2.0%
Protecting The Environment	1.5%
Someone Else's Experiences/Previous Experience	0.7%
Reduced Need For New Power Plants	0.7%
Civic Responsibility	0.7%
Reducing Emissions	0.1%

Source: Participant survey P2. N=207

(p.6-7)

The Residential Audit also provides some cost subsidies and rebates for energy efficiency measures. Additionally, the program offers financing to consumers on windows and insulation measures, as an alternative to rebates. Comparing responses on participation to those for the load management program, we see that incentives are relatively more important to audit participants.

Figure 20: Interest in Residential Audit Program

Table 7-4. What Most Interested Participants in Program

	Percent of Responses
Energy Savings	28.9%
Incentive	27.7%
Reduced Energy Bill	14.6%
Improved Home Comfort	6.2%
Assurance of High Quality	5.8%
Curious About Home's Efficiency	4.8%
Needed New Equipment	4.4%
Someone Else's Experiences/Previous Experience	3.0%
Other Reason Interested	1.7%
Recommendation from Contractor	1.2%
Increased Home Value	1.1%
Reducing Emissions	0.4%
Recommendation from MidAmerican	0.2%

Source: Participant survey P2. N=205

(p.7-7)

Relevance/Limitations

This study gives relevant information on consumer interest levels in energy efficiency programs and participant satisfaction levels with rebates. The survey responses, however, are limited because they focus much more on participants than nonparticipants. As a result of this focus there is little insight into how to increase program participation and whether higher incentives or a different incentive type might encourage program enrollment.

Mills, Evan. (no date). Using Financial Incentives to Promote Compact Fluorescent Lamps In Europe: Cost Effectiveness and Consumer Response in 10 Countries. *Department of Environmental and Energy Systems Studies, University of Lund, Sweden.*

Summary

The author wrote this study as a comparison of 51different compact fluorescent lamp promotion programs in 10 European countries between 1987 and 1991. The author uses statistics collected on the participation and costs of each program to determine the best practices to encourage participation and increase cost-effectiveness.

Methods

The author does not clearly address the methods he used for this paper. It is apparent from the text that the author closely examines the program evaluations of the 51 CFL programs in Europe and drew insight from trying to find common successes and failures.

Highlights

The greatest highlights of this paper are brought out in the two figures below. The first graph, figure 2-7, shows statistics from the NESA program, which took place in Denmark in 1990. From this graph we learn that 77% of lamps purchased were from the program over three billing cycles, 9% of lamps were paid for in one bill, and 14% of lamps were paid for in cash. Also the more lamps a household bought the higher the likelihood of them choosing the 3-payment option.

Figure 21: Participation Rate vs Incentive Type

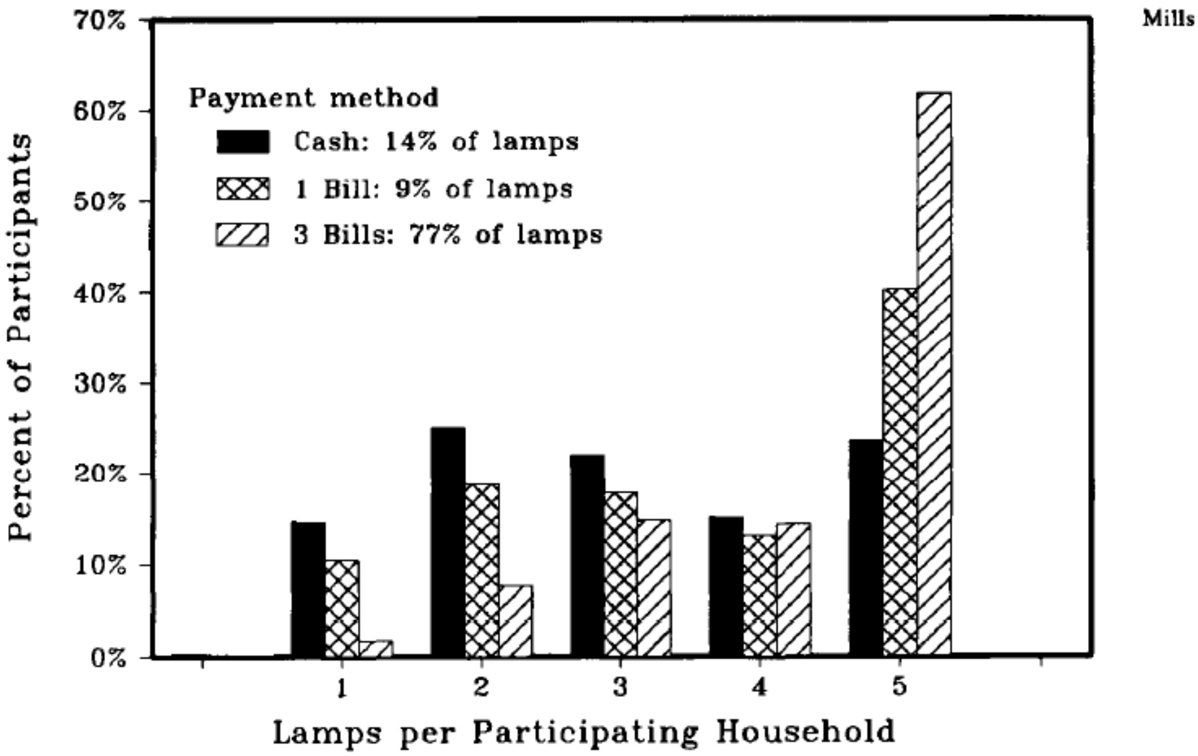


Figure 6. Participation rates versus incentive type for the NESA programme (single-family homes) [Denmark]. Participants preferred to pay for CFLs via the bill and bought more lamps than participants choosing to pay cash.

Figure 2-8 displays data from three different programs on the same graph. The graph shows participants, and nonparticipants, and the willingness to buy another CFL lamp outside of a program at different price points.

Figure 22: Consumer Willingness to Pay for CFLs

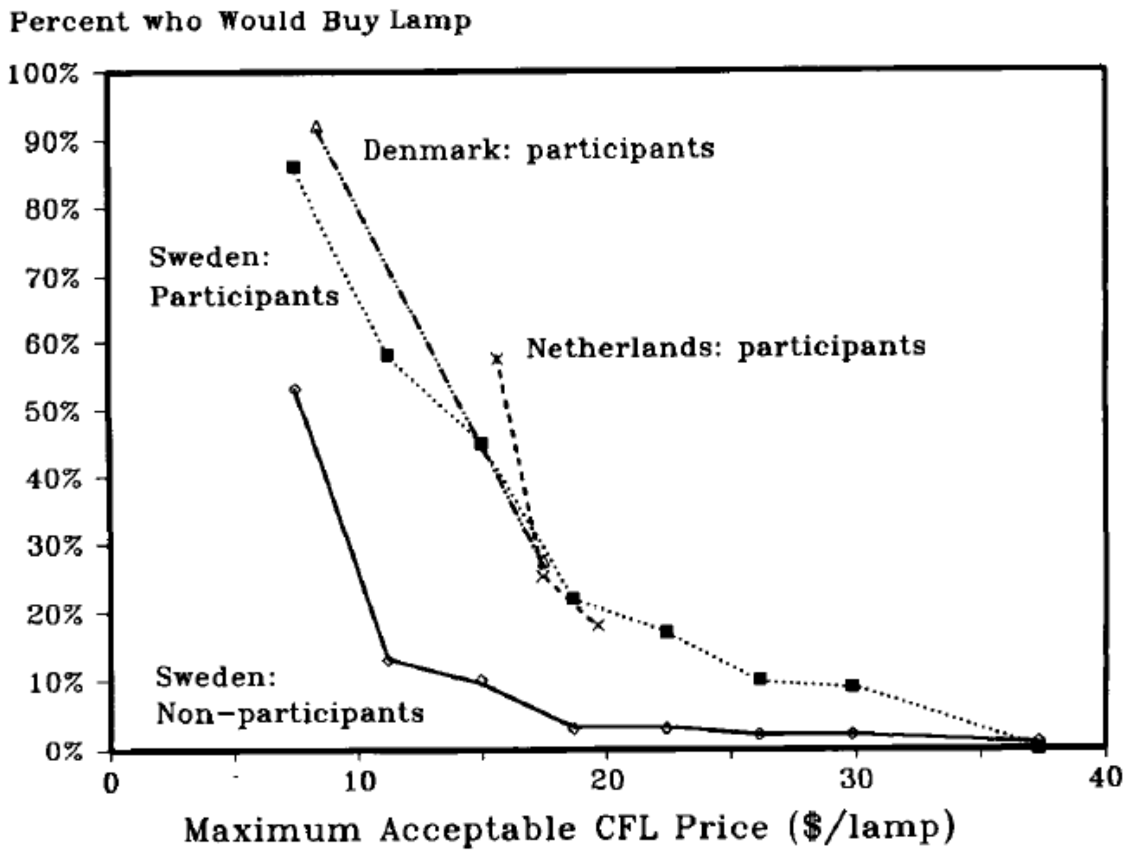


Figure 7. Consumer cost-response curves show the price that consumers report a willingness to pay for CFLs. The Danish example is the ELSAM programme, the Dutch example is the Friesland programme, and the Swedish example is the STEV programme. Exchange rates are the same as those shown in the notes to Table 1.

Relevance/Limitations

The only relevant points in the study are highlighted above: encouraging the usage of on bill financing for energy efficient measures, and showing price sensitivity to new technology can be similar in different countries. The second highlight is important because it shows the relevance of other country's research in the current task. Though there is no date on the study, based on the timeframe of programs evaluated we can assume it was written in 1991 or 1992, making it 20 years old. Given the development of CFL technology in that time most of what was written was deemed irrelevant.

Monsethnal, P. H., & Wickenden, M. (1999). The Link Between Program Participation and Financial Incentives in the Small Commercial Retrofit Market. ***Evaluation in Transition: Working In a Competitive Energy Industry Environment, Denver, Colorado: International Energy Program Evaluation Conference.*** **http://www.iepec.org/1999PapersTOC/papers/040.pdf**

Summary

These authors closely studied the relationship between program participation and financial incentive amounts for the small commercial retrofit market. The authors state the purpose of the study as follows: "Unlike other studies, [this study] relies on a rich database of program activity for a single program in which virtually all other program design and implementation procedures were held constant. It confirms many previous research results, yet provides some indication that other non-cash rebate strategies may be more effective in this market than previously thought" (p. 1). Specifically, the authors state that previous research (Berry 1990; Nadel 1996; Warner 1994)[31] indicated that participation drops as incentive levels drop. Some of the "non-cash" strategies referred to include simple qualifying mechanisms and simple repayment mechanisms.

Methods
The analysis approach taken by the authors of this study looked at the relationship between incentive levels and three key variables signifying participation levels: the mean customer adoption rate, the overall measure adoption rate, and the proportion of "audit" customers (those who had undergone an audit) installing any measures. Mosenthal, et al. relied on data for one specific program, referred to as a small commercial and industrial retrofit program. The program operated from 1993-1995. The program addressed a number of measures including lighting motors, refrigeration, water heating and fuel switching. The program relies upon on-bill financing services, simple credit application processes, and easy to use repayment mechanisms.

It was understood by the authors that no single variable outweighs the others in energy-user decision making. As such, other variables were held constant. However, since the program studied was a program that involved an audit and the option to install multiple measures, there was also a need to identify "partial versus complete measure adoption."

The authors analyzed the relationships among three different program parameters to overall incentive levels by examining T-Statistics and confidence levels. These three variables include:

1. Mean customer measure adoption rate (customer installation $/customer recommended $)
2. Overall adoption rate (total installation $/total recommended $)
3. Proportion of audit customer installing any measures

First, the authors provide a table illustrating participation and installation rates by incentive levels (grouped into 5 strata). This data is found in Figure 2-1 below.

[31] All studies referenced throughout this document *within* the sources selected and reviewed were examined if available as time has allowed. Those that were located and provided enough relevant content were reviewed and are included as a selection in this annotated bibliography. Many of the sources could not be found within the time frame of the study or were deemed irrelevant.

Figure 23: Participation and Installation Rates from Mosenthal, et al.

Table 1. Participation and Installation Rates, by Discounted Incentive Level Strata

Strata	Strata range (recommended incentive)	Sample Size (n)	Mean Customer Installation Rate (installed$/ recommended$)	Overall installation rate by strata (total installed$/total recommended$)	Percent of participants who installed anything
1	90-100%	56	84%	91%	84%
2	70-89%	60	74%	66%	75%
3	50-69%	64	61%	54%	63%
4	20-49%	44	77%	65%	80%
5	0%	53	6%	4%	8%
1&2	70-100%	116	79%	72%	79%
3&4	20-69%	108	68%	59%	69%

Then, the authors' then presented a table that shows confidence levels for the differences in strata mean proportions (shown here in Figure 2-2).

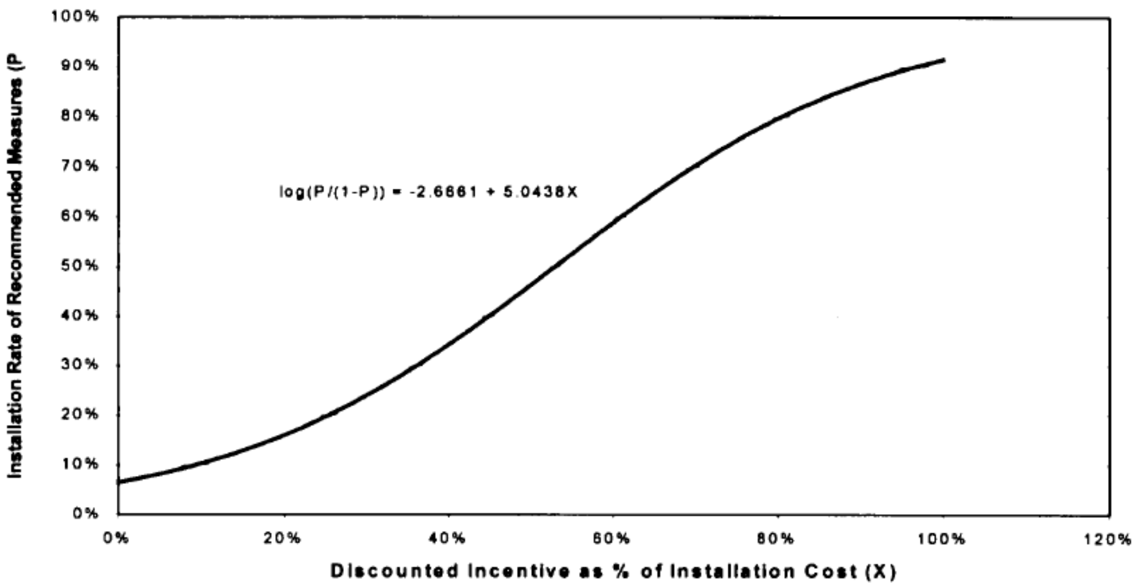
Figure 24: Confidence Levels from Mosenthal, et al.

Table 2. Confidence Levels that Strata Mean Proportions are Different

	Mean Customer Installation Rate (installed$/ recommended$)		Overall installation rate by strata (total installed$ /total recommended$)		Percent of participants who installed anything	
Strata Comparisons	t-Statistic	Confidence Level	t-Statistic	Confidence Level	t-Statistic	Confidence Level
1 to 2	1.37	82.6%	3.50	99.9%	1.20	76.7%
2 to 3	1.46	85.4%	1.41	84.0%	1.52	86.8%
3 to 4	1.71	91.0%	1.17	75.6%	1.99	95.0%
4 to 5	9.83	100.0%	7.92	100.0%	10.17	100.0%
1 to 3	2.87	99.5%	5.14	100.0%	2.75	99.3%
1 to 4	0.91	63.8 %	3.24	99.8%	0.56	42.4%
1+2 to 3+4	1.86	93.6 %	2.05	95.8%	1.70	90.9%

The authors also conducted a logit analysis, explaining that although some other studies (such as Camera, Stormont and Sabo 1989) have used regression analyses, there is limited applicability of such analyses because "participation is bounded" at 0% on the low end and 100% at the high end. They argue that a simple regression may oversimplify the relationship and fail to capture the variations in slope over the full range of incentive levels" (p. 5). The resulting curve is shown in Figure 25.

Figure 25: Logistic Curve from Mosenthal, et al.



Highlights
The highlights of the paper are found in three of its conclusions:

1. There are reductions in participation levels as financial incentives decrease.
2. Participation is less sensitive across mid range incentives levels than higher levels.
3. The streamlined program design is influencing participation levels.

The authors state the first two of these findings, which are visually depicted in the logistic curve found in Figure 25, as follows:

> "(Our research) shows statistically significant reductions in participation parameters and measure adoption rates as financial incentives go down. In addition, it seems to confirm other hypotheses that participation levels are more sensitive to incentive changes at high levels of incentives [80-100% of project cost], than across mid-range of incentives [30-70% project cost]" (p. 9).

For this program, a relatively high level of participation is maintained over mid range incentives even with lower rebate levels (e.g. 10-40% of project cost). Moreover, the authors also contend that the incentive level may have less influence on participation than other factors: the provision of what the authors call "immediate positive cash flow" given the design of the program analyzed. In other words, the mere facts that direct payments on customer bills and simple financing were part of the offer may be more influential than the actual rebate amount.

Relevance/Limitations
A limitation of this study is that it focuses on the small commercial sector and thus may not generalize to other market sectors. In addition the document is twelve years old, as such the findings should be taken with caution as DSM programs have developed significantly since the time of this paper's publication.

Morghan, T., & Felder, F. A. (2010). Comparison of energy efficiency incentive programs: Rebates and white certificates. *Utilities Policy* 18(2): 103–11.

Summary

This article compares the use of rebates and white certificates[32] as effective incentive programs for energy efficiency. The comparison uses New Jersey specific energy data to model costs, value, and overall effectiveness of the two incentive types.

Methods

The authors used quantitative and theoretical approaches to build the comparison model. The model was developed from the perspective of a program administrator for electric and natural gas, covering all ratepayer sectors (residential, commercial, and industrial). Important model assumptions were:

- Done for a 10-year time frame.
- The same targets and data were used for white certificates and rebates.
- The levels of rebates and white certificate assignment were done for quantity (amount of energy saved), not price (how much measure cost).
- Assumed rebate level of 75% (of incremental cost), 75% minimal acceptable level for selling white certificates.
- The costs of research studies, such as the ones necessary to correctly price rebates, were ignored.

Further details of the model methodology were included in the article, but are not important for the current research.

Highlights

There are several highlights in this article. The author does a thorough analysis of the pros and cons of using each incentive type. Rebates are easy to implement and require very little additional staffing or resources to run. However, "whether due to financial, political, or feasibility constraints, rebate approaches seldom support the incentive variations required to identify optimal payment levels and adjust program parameters through time" (p.3). Also because rebates are typically structured as one payment at time of purchase, consumers may cheat the system by doing multiple installations. Additionally, owners may not maintain their systems properly because they have received their full rebate, and the potential savings of installed systems may never be met. These problems can be addressed by structuring rebates programs in multiple payments over time, but this loses the convenience typically associated with rebates and increases administration costs. Rebate programs can also lead to leakage; when consumers from other states, or service areas, buy equipment with the rebate and then install it out of area.

White certificates automatically adjust to market rate, so administrators do not have to worry about setting value too high or too low. The system rewards consumers for installing inexpensive measures that produce extra white certificates and requires owners to maintain systems to achieve maximum efficiency. Therefore, this system produces a profit maximizing, cost minimizing dynamic while promoting energy-efficiency. However, white certificate values are very sensitive to program target levels. This sensitivity introduces risk and uncertainty to the investment and may worry consumers. Furthermore, white certificates markets require the development of new processes making them impractical when incentives

[32] **White certificates** are documents certifying that a certain reduction of energy consumption has been attained. In most applications, the white certificates are tradable and combined with an obligation to achieve a certain target of energy savings.

need to be introduced quickly. Figure 2-22 summarizes the advantages and disadvantages of the incentive programs.

Figure 26: General Qualitative Program Comparison

Table 4
General qualitative program comparison.

	Rebates	White certificates
Range of measures supported		×
Program flexibility and feedback		×
Administrative cost burdens	×	
Program penetration		×
Need for new processes	×	
Public information availability	×	
Financing		×

Both incentive models met energy efficiency program standards and energy savings goals, but program costs and rate impacts varied greatly. The model shows that despite significantly larger initial capital necessary to run a white certificate market; the societal burden achieved by both methods is the same, assuming that program administration costs are similar. This result changes if the administration costs are not equal, which is an issue that requires further study.

The study concludes that program costs and bill savings depend heavily on the program targets and energy efficiency potential studies, especially with white certificates. Therefore, program administrators must have a reliable knowledge of energy efficiency potential to help choose the correct incentive program. Program administrators must also be careful to not overestimate the availability and costs of energy efficiency measures. If programs require a lifetime purchase agreement at the time of measure installation, then white certificate program costs come closer to rebate programs without sacrificing market efficiency or financial benefits.

Relevance/Limitations
This article is very relevant to the current research project. The side-by-side comparison of white certificates and rebates is very helpful in the analysis of what type of incentive program is best for a given utility program. The study is also very recent and uses real state energy efficiency data for the model, which make the findings accurate and relevant given the current economy and state of energy efficiency technologies. As with the two New Jersey Assessments, this study is based on incentives in the renewable energy market, so further research is warranted to decide if white certificate theories can be applied to energy efficiency certificate development. The author also admits limitations in the lack of detail in program administration costs and participation rates. If program administration costs vary greatly, that will affect the author's finding that rebates and white certificates are equally good. Additionally, rebate funds place burden on non-participants, so participation rates must be studied to ensure that certain segments of society are not bearing the weight for others efficiency upgrades.

Nadel, S., & Geller, H. (1996). DSM: What have we learned? Where are we going? *Energy Policy*, Vol. 24, No. 4, pp. 289-302.

Summary
In this study, Nadel and Geller from ACEEE wrote a brief history of demand side management (DSM), outlining experiences and lessons learned from the mid-1970s to the mid-1990s. The paper discusses many topics related to DSM including various program approaches, resource acquisition and planning, and attributes of successful programs. The authors then build upon this understanding of the history of DSM to make some predictions about the future of the industry. This report is included in this bibliography because some of the findings relate to the use of incentives and participation in DSM programs.

Methods
This study offers brief but thorough descriptions of the three major "eras" of DSM (information and loans, resource acquisition, and preparation for a more competitive industry) and provides many examples of programs, outlining their strengths and weaknesses drawing on many topics such as the use of financial incentives.

Highlights
During the brief historical overview at the beginning and in the discussion about program types and results, the authors make several points related to the impact of incentives on participation rates. Many of these points are worth reiterating here:

- During the 1980s, many rebates programs existed, but on their own they were "not very effective at promoting the integrated packages of measures that represented a large portion of the savings potential" (p. 290).
- C&I programs that offer "one-on-one marketing and provide financial incentives have achieved participation rates up to 90%" (p. 292).
- The average payment per participant for load control (demand response) programs in the 1980s was approximately $25-30 per year and these programs have achieved participation rates of 25% or more, up to 50% (p. 294). The factors linked to high participation in these programs "include:
    - High incentives,
    - Duration of the program, and
    - An intensive marketing effort including print and broadcast media" (p. 294).
- Rebate levels in custom C&I programs have a wide range of 20-100% of the measure cost (p. 295).
- The majority of C&I rebate programs had achieved low participation rates (cumulatively less than 4%), though some have reached up to 25% (p. 295).
- Referencing two other studies (Nadel 1990; Weedal and Gordon 1990) the authors imply that programs for measures that have low market shares and long payback periods tend to have a low number of free-riders (p. 296).

Although this last finding may not directly relate to incentive structures (the primary topic of this paper) it may be an important consideration for PSE program managers.

In addition to the above statements, the authors also provide an example that is perhaps the most relevant point to the study at hand. In a discussion about direct install programs, the authors provide an example, citing another study (Massachusetts Electric Company 1995) of the relationship between incentive levels and participations: "…NEES found that the percentage of customers who installed measures recommend by the audit decreased from 91% to 71% after the utility share of measure costs decreased from 100% to 80%" (p. 297).

Lastly, the authors discuss a number of features that successful DSM programs often have in common:

- Personal one-on-one marketing and community-based marketing
- Financial incentives (holding all other factors equal)
- Top management support and a capable staff
- Regulator support
- Enough lead time for manufacturers and distributors to produce and stock effectively
- Program evaluation

Relevance/Limitations
Given the above highlights that relate to participation, the study holds much relevance to the research at hand. However, like a number of the other studies reviewed, it must be kept in mind that the study may be outdated, as it is 15 years old. Also, the study is limited because it does not dive very deep into the examples it provides. EMI recognizes, however, that this was not the purpose of this study.

Oak Ridge National Laboratory. (1991). Electric-Utility DSM Programs: Terminology and Reporting Formats. Chapter 3: Program Participation. *Prepared for the Office of Conservation and Renewable Energy. US Department of Energy and Customer Systems Division. EPRI.*

Summary
This study carried out by the Oak Ridge National Laboratory in 1991 focuses on several aspects of DSM programs aimed at building understanding about reporting and terminology. It includes distinctions between different types of programs; definitions of program participation, energy and load effects, program costs and the role of program data. The review of this document was limited to the chapter on program participation, with one exception. In an earlier chapter there is a sidebar (Exhibit 1) that is relevant to the study at hand, which explains how a meaningful relationship between incentives and participation is not easy to yield through analysis.

The chapter on participation (Chapter 3) discusses how using proper definitions of participating units, other market information, and participation rates and outlining the time period of the incentives all help provide information useful for reporting.

Methods
This article does not have methods to highlight, as it is a theoretical review of terminology and reporting as opposed to a research study. The purpose of the study is to provide definitions of key terms in DSM and offer methods for determining specific variables. In the next section, we highlight a few of these methods relevant to incentives and participation. However, the NORDAX database, referred to previously (see Berry 1993 above), is discussed in this report. The authors give the following descriptions of the NORDAX database: "(The database) included data on 46 full-scale programs that had been in operation for more than one year (of about 150 programs in the database)...Complete information on participation rates, program costs, and energy or load reductions was available for only 18 of these programs" (p. 6). There is more information in the report about how specific cost calculations were conducted in NORDAX, but this is not relevant to the study at hand.

Highlights

A few highlights from Chapter 3 are worth mentioning. First, the authors define the term *participation rate*:

> "A program participation rate is the ratio of the number of participants to the number of customers eligible for the program. These rates are calculated as a percentage of *base market* (the largest market against which participation is measured), usually the *eligible market*. Eligible market is defined by the eligibility criteria for the program" (p. 15).

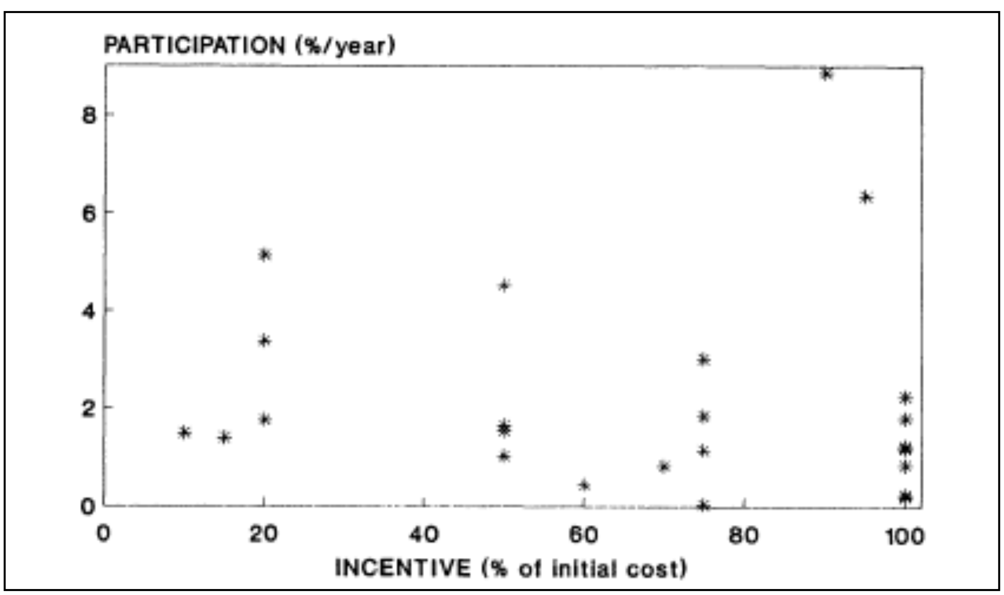
This definition is important to highlight because it is the only one this specific found in the literature. Also, this study recognizes that it is important for utilities to have a solid definition of participation, so they do not have to rely on other utilities experience. As the authors state, "[other utilities'] data are often difficult to interpret because of differences in the ways utilities calculate and report program market and participation data" (p. 15). The authors also say that the variables used to define eligible market and participating units should be the same. In other words, household can be used to define the eligible market, and participating units should also be defined in this manner to truly understand participation.

Two other definitions are worth mentioning, as these two words are used often in the industry:

- Saturation rate is defined as "the number of a specific type of equipment in place as a fraction of the total stock of equipment of buildings" (p. 20).
- Penetration is defined as referring to "flow and shows the fraction of sales, installations, or new construction of a certain type" (p. 20).

Finally, as mentioned above, in a separate section of the overall paper there is one relevant and useful "exhibit" or sidebar. This exhibit discusses participation and the difficult in comparing participation rates across programs to understand the relationship to predicts participation. Figure 27 from a separate study but included here (Schick et al. 1990) makes clear that the relationship is uncertain.

Figure 27: Illustration of the Lack of a Discernable Relationship Between Incentive Levels and Participation, taken from Schick et al. 1990.



Relevance/Limitations

The most relevant aspects of this paper are the highlights mentioned above. Clearly, the literature in the field and academic setting are often missing operational definitions of the terms explored in the articles, especially at the time this paper was written. In addition, the figure above (Schick et al 1990) is somewhat relevant to the current research project, but the original study cannot be found and the author reasons that applying its findings is limited by the fact that it is old and does not account for other external forces.[33] However, other than these highlights, there is little relevance of this paper for the work at hand. For one, the paper is nearly 20 years old. Secondly, for the most part, the paper works more as a guidance document than an example research study.

Oxera Consulting, Ltd. (2006). Policies for energy efficiency in the UK household sector. *Department of Environment, Food, and Rural Affairs.*

Summary

This report used a consumer survey and existing household data to study consumer response to energy-efficiency programs. The results give interesting insight to consumer behavior and the study framework displays possibilities for research of this type in the United States.

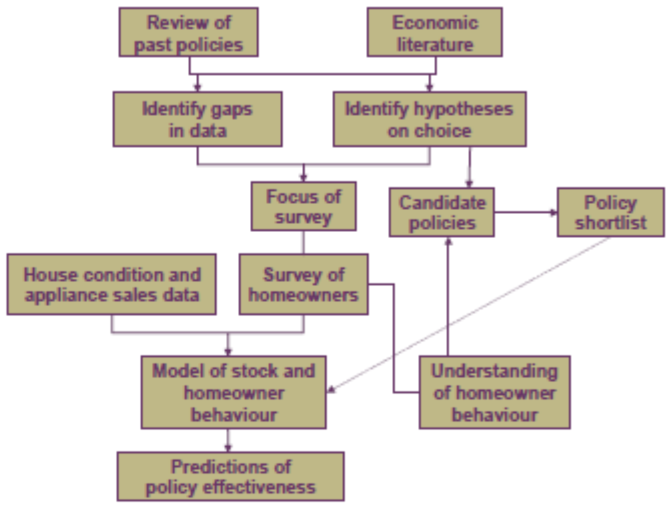
Methods

This report evaluated the current policies for energy efficiency in the UK and collected survey data from consumers. The company used statistics on home energy usage to create a survey focused on areas of greatest possible improvement to use in the collection of primary data. In-depth interviews, lasting 30 minutes each, were conducted with 1,000 homeowners. The data collected in these interviews was then analyzed to draw conclusions about drivers of choice and magnitude of influence.

[33] Schick responded to our requests for a copy by saying that the study is no longer available. He also questioned the usefulness of his report since “there is so much else going on that would need to be account for, and back in 1990 there was not a great track record” (Schick 2010).

Figure 28: Flow Chart of Study Methodology

Figure 1 Elements of the study



Source: Oxera.

The models were developed by combining the statistical results from the survey with data from the English House Condition Survey 2001, the Labour Force Survey and BRE, and information from the Energy Saving Trust. The models were designed to test the effect of different potential policies. The policies tested by the insulation model are: the perceived cost of the measure, the perceived amount of disruption its installation would cause, the presence and awareness of any accreditation regime, and whether the measure had been recommended to the household. Additionally, the model also allows measures to be adjusted to just specific subsets of the population.

Highlights

The study had many highlights related to consumer response to current energy-efficiency measures and incentives designed to encourage their participation. One of the most intriguing facts was “that households are already almost completely indifferent to the financial savings available from energy efficiency, regardless of income group” (p.5). This implies that focusing energy-efficiency programs on the message of future savings is not an effective strategy. The consumer knowledge gap about energy-efficiency measures was found to be an important factor to whether the consumer was willing to undertake the installation of a measure. The knowledge gap on household insulation was extremely high (for both cost and installation time), but was low for light bulbs and refrigerators. Both light bulbs and refrigerators have been marketed as energy-efficiency measures for a longer period of time, which is thought to be responsible for the low knowledge gap. Further highlights from the survey were that consumers put a premium on the accredited of builders/installers and that implicit value is given to energy-efficiency labels (on appliances), regardless of the energy savings. (Note that the labeling of fridges is A, B, C – similar to tiers of energy star in the United States.)

Below is a summary of results obtained from the models developed based on the known data:

- Figure 2-6, shows the effective difference between the Energy Efficiency Commitment, EEC, program, which provides both education and financial incentives to promote energy-efficiency measures and offering consumers a simple financial incentive.

Figure 29: Comparison of Efficiency of EEC and Simple Discount

Table 6.2 Comparison between EEC and a simple discount

	Carbon savings (MtC per annum)			Subsidy (£m)	
	2010	2015	2019	Per annum	Over whole period
EEC	0.73	1.23	1.55	78	1,107
Simple 50% discount	0.26	0.48	0.69	22	257
Simple 75% discount	0.28	0.54	0.76	35	427

Source: Oxera.

- Builder and installer accreditation were compared with offering simple discounts, and the effect of accreditation was shown to be equivalent to a discount of over 75%.
- "The elasticity of demand for light bulbs (with respect to price) has been calculated as -0.11. In other words, for every 1% increase in the price of energy-efficient light bulbs, there would be an 0.11% reduction in demand. This relationship also holds in the opposite direction – i.e., for every 1% reduction in price, demand increases by 0.11%. This result indicates that changes in the relative price of energy-efficient light bulbs have only a small effect on the probability of respondents' owning light bulbs." (p.26)
- "The survey tested the influence on consumers of a simple energy efficiency performance label, which grade performance alphabetically, and one that also states the value of energy savings per annum. The additional information on the value of energy savings was found to have no effect on consumers. This finding is consistent with several hypotheses, including that energy labeling is effective for some reason other than that it allows consumers to identify products that offer energy savings; that consumers correctly infer savings from the alphabetical label alone; and that consumes do not care about the value of energy savings."(p.27)

Relevance/Limitations
As highlighted above, this study has good information on consumer responses to energy efficiency programs. The study used both survey responses and population data to build models to predict the effectiveness of different program policies. The study's generalizability to the United States is potentially limited as the data is all from the UK. The authors focused on installing cavity wall and loft (attic) insulation as one of the best energy efficiency programs. Given the difference in English and American houses and building codes, insulation installation and the perceptions around it may not be applicable in the United States.

Quantum Consulting. (2001). Statewide Non-Residential Customer Hard-To-Reach Study" ***For Chris Ann Dickerson, Pacific Gas and Electric.***
http://www.calmac.org/publications/Nonres%20HTR%20Report.pdf

Summary
This consulting report provides survey analysis data that provides evidence that "hard-to-reach" (HTR) small businesses are truly underserved and evaluates the effectiveness of California's energy efficiency

programs in reaching small businesses. The report uses this analysis to make recommendations for how PG&E should structure future energy efficiency programs to better reach under-served populations.

Methods
The authors used two approaches to gather data on the hard-to-reach segments. First they conducted a telephone survey of 767 customers across California, to determine the self-reported participation and awareness rates of energy-efficiency programs. Next they analyzed program participation tracking data to find the actual participation trends among the HTR. After analyzing the data from these techniques the authors held 8 focus groups to determine the best practices for engaging HTR customers in energy-efficiency programs.

Highlights
The study found that among the groups of HTR customers in the study, the segment with the lowest participation rate was renters, due to split-incentives between renter and owner. The authors found, however, that renting customers were willing to work to overcome the split-incentive problem. Seventy-nine percent of renters were willing to contribute to energy-efficient measure with a payback period of one-year or less, and sixty-two percent were willing to help purchase measures with a payback period less than the remaining time on their lease. Additionally, almost two-thirds of renters had at least 5-year leases, which "indicate that there is a significant opportunity for utilities to work with both building owners and renters to cooperate and share in the costs and benefits of energy efficiency investments" (p.14).

Other findings, to suggest where to invest in energy efficiency programs, are summarized in the two figures below. Figure 2-9 displays the market barriers of HTR customers to energy-efficient investments. Figure 2-10 shows the importance HTR customers attach to potential elements of energy-efficient programs.

Figure 30: Market Barriers to Energy-Efficient Investment

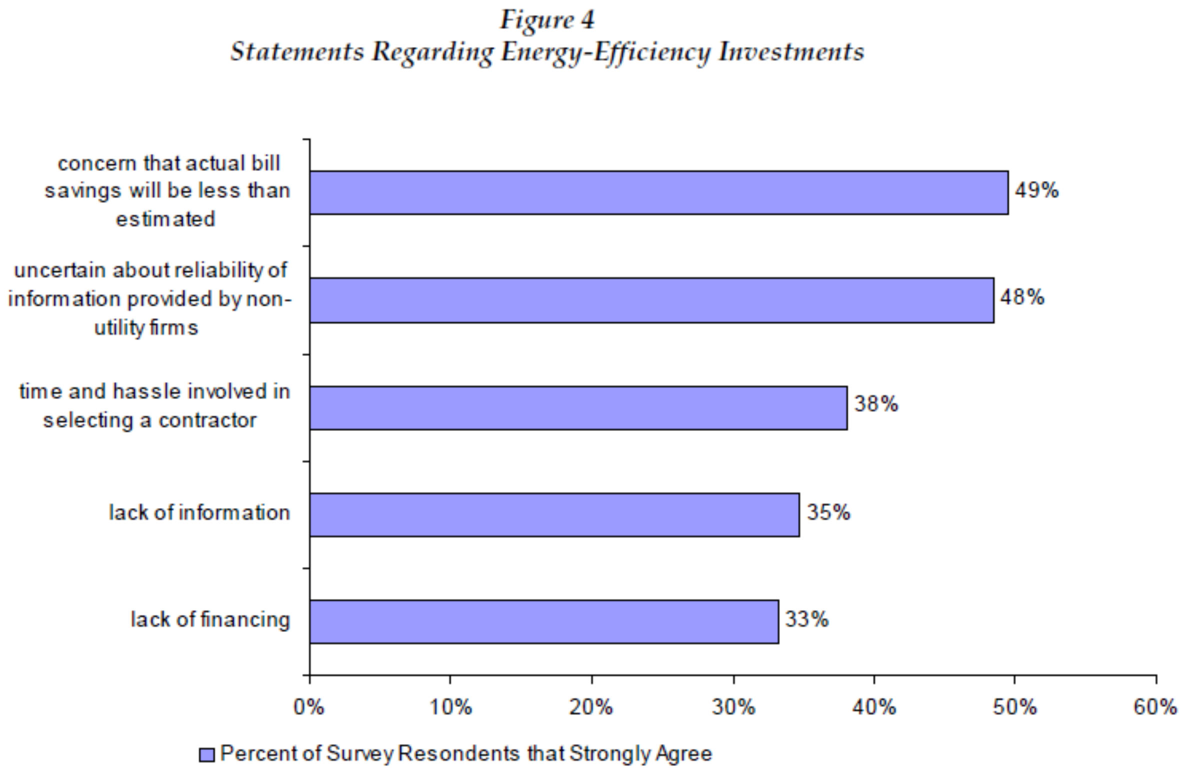


Figure 31: Program Helpfulness Ratings

Figure 5
Focus Group Customers Rated Program Elements on Helpfulness

Accurate estimates of savings from efficiency measures	8.3
Free energy audits	8.1
Rebates for high-efficiency, energy saving equipment	8.0
Direct installation of efficiency measures	7.6
Independent verification of energy savings promised by contractor	7.2
"How-to" guidebooks on choosing HE equipment and conservation actions	7.0
Low interest financing for high-efficiency energy saving equipment	6.9
Access to experts on energy needs of my business	6.8
Lists of suppliers or outlets for efficient equipment	6.6
Information on solar, wind, and other alternative power sources	6.4
Seminars and workshops	6.2
Lists of pre-qualified contractors	6.1
Sale or lease of backup generators	5.3
N = 80	
Note that ratings are based on a scale from 1=not at all helpful to 10=very helpful	

The authors recommend vendor bonuses, customized literature, energy audits, and community-based organizations and/or industry/trade organizations as the most important elements to consider for future program design.

Relevance/Limitations
This report addresses the market-barriers to participation for small businesses, which is relevant to determining incentive types and levels for these customers. However, the report has limited its scope to market-barriers and did not suggest specific incentives that could be used to help overcome the barriers. Furthermore the report was done based on data from 1999-2001 in California, which was during the California energy crisis. Findings of customer reactions and willingness to participate in energy-efficiency programs, therefore, need to be applied cautiously, given the significant changes in market conditions since that time.

Sandahl, L. J., Gilbride, T. L., Ledbetter, M. R., Steward, H. E., & Calwell, C. (2006). Compact Fluorescent Lighting In America: Lessons Learned on the Way to Market. *Prepared for The US Department of Energy*.

Summary
This report evaluates the efforts of utilities and government to increase the market penetration of CFLs. It groups the lessons learned into three categories: technology, marketing, and program design.

Methods
The report studied market history of CFLs in the United States and in Europe and reviewed the program design of CFL programs in the United States.

Highlights
The study found that the major initial reluctance to CFL adoption was price, awareness and knowledge of CFLs, attitudes and fears about CFLs, skepticism of product claims, and buying habits. Because these initial barriers relate to perception, the authors conclude that marketing campaigns for new technologies are essential. The study also found that due to give away programs and rebates, there were large price variations. Give away programs also included some low-quality, poor performing products, which reinforced negative perceptions of CFLs.

In regards to customer incentives the research showed point-of-purchase coupons approached almost a 100% redemption rate, mail-in rebates had redemption rates of only 20% to 80%, as did coupons mailed to customers at home. Manufacturers' response to buy down programs and coupons was negative; in fact "most manufacturers felt that public service announcements, in-store demonstrations, and consumer education are better approaches for utilities and energy-efficiency groups" (p.6.4). Along these lines, Southern California Edison found giving incentives to manufacturers to be more cost-effective:

> "In 1992, Southern California Edison switched its $5 per lamp rebate from the customer to the manufacturer and found much better results at lower program costs. For example if the wholesale cost of a given CFL was $10, and the typical retail markup was 67% ($6.70), the lamp would retail for $16.70. A $5 customer rebate would lower the retail price to $11.70 but a $5 manufacturer rebate would cut the wholesale price to $5. With a 67% markup ($3.35), the retail price would only go up to $8.35. SCE gave manufacturers additional incentives for higher power factor, good color rendering, and high lumen output and also for offering additional discounts and cooperative advertising money for their retailers. SCE gained from lower administrative costs – they went from 70% of program funds for the consumer rebate program going to incentives to 10% of program funds for the manufacturer program going to incentives" (p3.4).

The necessary evolution of market transformation programs, as described by the authors, is depicted in figure 2-14.

Figure 32: Evolution of Utility Market Transformation Program

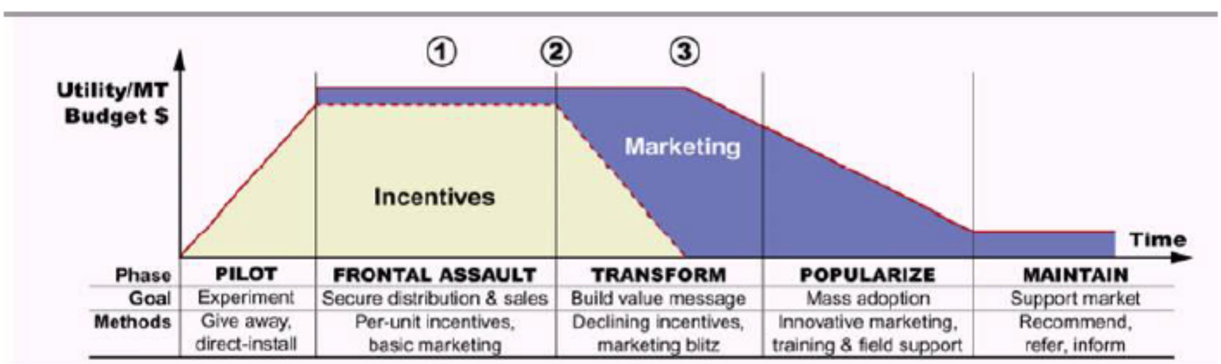


Figure 3.1. Evolution of a Utility Market Transformation Program {23}

The table below, shown here as figure 2-15, depicts the actually marketing strategies used over the course of the transformation of the early CFL market.

Figure 33: Marketing Trends in CFLs

Table 4.1. Marketing Trends

Trend	1980s-1990s	2000s
Key Messages	Talk about technology	Talk about benefits to consumers: longer life, cool and safe, less bulb changes, $ savings
	Like an incandescent	Better than an incandescent
Source for Bulbs	Utilities (giveaways, direct installs, bill stuffers)	Retailers (point of purchase displays, retailer training)
Utility Incentives	Given directly to consumer	Given to manufacturer to pass on higher savings to consumer
Shelf Display – Strategy	All CFLs lumped in a CFL section of shelf	CFLs integrated with other types of lamps, grouped by application and marked "good", "better", "best" for energy efficiency
Shelf Display – Quantity and Location	Low levels at low levels	Increasing amounts; increasingly at eye level
Packaging	Plain white boxes	Informative packaging that explains benefits
Advertising	Local and regional by individual utilities and retailers	Joining national marketing efforts like ENERGY STAR and Change a Light Change the World campaign
Manufacturer Advertising	Almost none	Manufacturers participating in regional and national efforts
Retail Availability	Few available at retail. Direct from utilities.	Rising influence of big box DIY stores, e.g., Home Depot and Lowes and eventually in some grocery stores
Media	Little attention, not quite ready	Helping to spread the message, riding the wave

Relevance/Limitations

This study's most relevant points are made above. To reiterate the points, setting financial incentives as the main tool for market adoption can be dangerous because it changes consumer perception of how much they should have to pay, might make them revert to older technologies once the incentives no longer exist. With the use of any financial incentive it is important to include a marketing campaign to increase awareness for the program/product. The study is limited due to its focus on CFL market transformation, though the authors extend lessons learned to the possible adoption of LEDs. In both cases, there are limited energy efficient technologies that are commodities to the extent that light bulbs are. Also in the past 5 year the CFL market has made huge steps forward so any suggestions on incentive levels on CFLs are likely out of date.

Stern, P. C. (1999). Information, Incentives and Proenvironmental Consumer Behavior. *Journal of Consumer Policy*, 22: 461–478.

Summary
This article by Paul Stern argues that policy makers need to keep in mind the interactive effects of *information* and *incentives* on consumer behavior. The article frames the discussion around "three systems or domains of phenomena:" the personal, behavioral, and contextual. Information and incentives intended to change consumer behavior fall into the personal and contextual domains. The author organizes the discussion in the following manner:

- Theories of "environmentally significant" behavior
- The effects of incentives and information on behavior
- The implications for policy development

The key argument made in the paper is that interventions intending to change behavior are most effective when they combine "information, incentives of various kinds, social influences, and institutional supports" (p. 475). However, the author recognizes that combinations of this sort are not practical for every type of intervention, program, and policy.

Methods
As mentioned above, three interrelated domains that influence behavior were discussed in the Stern article. The article bases the arguments about effects of incentives and information on behavior as well as the implications for policy on these three domains.

In the *personal* domain there is the "Value-Belief-Norm" (VBN) theory, which argues that environmental behavior is influenced by individual values, beliefs about "moral obligations" and other personal factors. The VBN theory is an extension of a similar theory of "altruistic behavior" from social psychologist S.H. Schwartz.

Stern says that behavior is influenced by a number of situational factors; this is the *behavior* domain. This theory has been labeled attitude-behavior-context (A-B-C) theory and is discussed in a few other articles Stern cites (all are also written by him). In Stern's words, the primary implication for policy "is that the extent to which behavior can be changed by interventions in the personal domain, such as education or information, depends on the strength of contextual forces: There are times and places when personal-domain interventions are likely to be effective and others when they will predictably fail" (p. 464).

The third domain discussed is the *contextual* domain, which says environmentally significant behavior is influenced by several structural or contextual attributes (e.g. cultural background, educations, rural or urban residence, energy taxes, etc). In this manner, both contextual constraints and capabilities will influence actions in the personal domain.

Highlights
A useful set of principles for interventions are found in a table in the section discussing implications for policy. The table is titled, "Principles for Intervening to Change Environmentally Destructive Behavior," adapted from Gardner & Stern (1996). These principles include the following:

1. Use multiple intervention types to address the factors limiting behavior change
    - Limiting factors are numerous (e.g., technology, attitudes, knowledge, money, convenience, trust)
    - Limiting factors vary with actor and situation, and over time

- Limiting factors affect each other (interactive principle)

2. Understand the situation from the actor's perspective
    - Conduct surveys or experiments
    - Participatory approach to program design
3. When limiting factors are psychological, apply understanding of human choice processes
    - Get the actors' attention; make limited cognitive demands
    - Apply principles of community management (credibility, commitment, face-to-face communication, etc.)
4. Address conditions beyond the individual that constrain pro-environmental choice
5. Set realistic expectations about outcomes
6. Continually monitor responses and adjust programs accordingly
7. Stay within the bounds of the actors' tolerance for intervention
8. Use participatory methods of decision-making

Limitations/Relevance
The article is limited by the fact that there are very few specific examples given. Rather, it is largely theoretical in nature. The above principles might be useful to consider when designing interventions such as an incentive-based retrofit program.

Summit Blue Consulting, Inc. (2008). Assessment of the New Jersey Renewable Energy Market: Volume 1. *For the New Jersey Board of Public Utilities Office of Clean Energy.*

Summary
This report is a comprehensive market assessment of the renewable energy market in New Jersey. The study evaluates the costs of and barriers to the development of renewable energy technologies. The authors of the report also recommend steps to be taken for the future direction of the programs (i.e., modifying rebate and/or program funding levels, adjusting the form of incentive distribution, etc.)(p.16). The team's recommendations are made based on financial models requiring an IRR of 12%.

Methods
The authors of this study began by doing a thorough review of background information on the New Jersey renewable energy market and incentive programs: including regulatory documents, program marketing material, and RPS compliance data. They used this background of market and performance indicators for developing survey and interview guides. During the course of the assessment, 177 market surveys and in-depth interviews were conducted, including a survey of 70 CORE program participants and 50 developer / installer interviews. In addition, the research team developed a number of spreadsheets to analyze potential costs under a variety of program mechanisms and market scenarios. (p.2) The analysis of incentives was conducted to find the minimum incentive level that would provide an IRR of 12% for each project undertaken with that technology. All incentives where calculated on a capacity basis ($ per kW of capacity), but the authors also calculated an estimate of the equivalent incentives on a performance basis ($ per MWh of generation). The assumptions used in the analysis, as written by the authors, are included below:

- "A starting price of $11/MWh was used for Class I RECs. This was the current price of RECs as of Spring 2007. It was assumed that the REC price would stay the same for the analysis period.

- A target IRR of 12% was used for all technology-market sectors. This value is based on input from the solar industry and the financial community, and it is consistent with the investment target used for evaluating ratepayer impacts of solar market transition scenarios as part of an earlier assignment for BPU.
- For technologies that qualify for a production tax credit, this was added as an income to the pro forma. For biomass, there is a 0.9¢/kWh production tax credit for ―open loop biomass, which is all of the biomass technologies included in the analysis. For wind, there is a $1.9 ¢/kWh production tax credit, and this is assumed to increase at a rate of 2% per year.
- For behind-the-meter applications, a starting price and escalation rate was used to estimate electricity rates over the period of the analysis, and these values were used to calculate avoided electricity costs. For grid supply applications, a wholesale electricity price was used to calculate income from electricity sales, with an associated rate of increase. The values used, shown in figure 2-18, are based on recent pricing in New Jersey" (p.92).

Figure 34: Electricity Costs

Table 5-14. Starting Price and Growth Rate for Electricity Costs and Income

Sector	Starting Price ($2008/kWh)	Rate of Increase
Residential	$0.13	2.99%
Commercial	$0.12	3.34%
Wholesale	$0.05	3.00%

Highlights

In the analysis of solar projects, the authors used data from the ongoing CORE project in New Jersey to determine the relationship between system size and cost. They found that "in general, system costs decrease as system size increases, but for systems less than 10 kW the decrease in cost is very small. For systems larger than 10 kW, project costs decline rather steadily, dipping below $6,000/kW for 100 kW projects. For projects smaller than 10 kW, costs decline only slightly with an increase in project capacity, and the average is just over $8,000/kW" (p.93). Important highlights from that model are that federal tax credits are fairly equal for all size residential systems, all small projects were assumed to be residential, and public sector projects would require a higher incentive because tax refunds do not apply.

For the calculation of wind incentives the authors used a pro-forma model. It is important to note that only the calculations for small wind, defined as <100 kW, are relevant to the commercial and residential sectors. The authors assumed that all systems in the small wind class would be part of the CORE program. Other important model inputs are outlined below:

- "The timeline for the model was from 2008 to 2027.
- The incentive level was adjusted until the model produced the target IRR of 12% for each size of wind technology.
- This adjustment was done twice, to find the incentives required for both public and private systems, as public systems are not eligible for the accelerated depreciation (MACRS) federal tax incentive.
- For the pro-forma analyses, a single system size was chosen as a sample system for each category of wind" (p.95).

Figure 35: Input Assumptions for Wind Incentives

Table 5-16. Input Assumptions for Wind Incentive Analysis

System	Rated Capacity	Net-Metered?	Power Revenues $/kWh	System Costs ($/kW)	O&M Cost as % of Capital Cost	Capacity Factor
Small Wind	10 kW	Yes	$0.13	$5,000	1%	15%
Large Onshore Wind	10 MW	No	$0.05	$2,229	3%	29%
Offshore Wind	100 MW	No	$0.05	$2,972	6%	34%

The recommended incentive levels are displayed in the tables below, but the authors include a few additional incentive recommendations. These recommendations were made for both solar and small wind.

- An energy efficiency adder, which would offer of an additional $0.25/W when systems are installed on buildings with a certain level of verified energy efficiency such as Home Performance with Energy Star, or the LEED rating.
- A low-interest loan option that would provide an interest rate buy down of 2%. (p.94)(p.95)

Figure 36: Recommendations for Solar Incentives

Table 5-15. Recommended Incentives for Solar PV

System	program	Class	Capacity Incentive ($/kW)	Performance-Based Equivalent ($/MWh)
< 10 kW Solar	CORE: Residential	Residential	$3,500.0	$166.5
10 kW <> 40 kW Solar	CORE: C&I	Comm or Public	$1,500.0	$71.4
40 kW Solar <> 100 kW		Public	$1,500.0	$71.4
> 40 kW Solar		Comm Private	None	None

Figure 37: Recommendations for Wind Incentives

Table 5-17. Recommended Incentives for Wind

System	Program	Class	Capacity Incentive ($/kW)	Performance-Based Equivalent ($/MWh)
Small Wind (< 100 Kw)	CORE	Resid./Comm.	$3,100.00	$129.56
Large Onshore Wind (> 100 kW)	REPGF/CORE	Public	$1,320.00	$29.00
		Private	$930.00	$20.00
Offshore Wind	REPGF	Public	$2,745.00	$50.25
		Private	$2,650.00	$48.51

Relevance/Limitations
This report goes into depth about how appropriate incentive levels were recommended for uptake in New Jersey's renewable energy portfolio. The obvious limitation is that installation of renewables, though related to energy efficiency programs, is not in itself an energy efficiency program.

Summit Blue Consulting, Inc. (2008). Assessment of the New Jersey Renewable Energy Market: Volume 2. ***For the New Jersey Board of Public Utilities Office of Clean Energy.***

Summary
This volume of the report includes detailed assessment reports for New Jersey's renewable energy market, and for each of the BPU's renewable energy programs, as well as a review of renewable energy market development strategies in place in other jurisdictions. Volume II also includes summaries of two reports the research team completed in support of the BPU's solar market transition efforts. This volume is intended for an audience interested in reviewing detailed data and discussion related to market and program performance, and policy and incentive strategies in place in other jurisdictions.

Methods
The methodology of this study is the same as discussed in the entry for Volume 1 of this report.

Highlights
The authors recommend possible program modifications to renewable energy incentives to encourage the implementation of energy efficiency measures. The recommended methods are listed below.

- "An enhanced rebate for Energy Star certified buildings (CORE current policy);
- An enhanced rebate for installing specific energy efficiency measures at the customer site, for non-Energy Star certified buildings (through one of the BPU's energy efficiency programs);
- A requirement to perform a non-binding energy audit to participate in the CORE program;
- A requirement that participants go through a home performance program before being accepted into the CORE program, with a full renewable energy rebate being given only to those who install all of the cost-effective efficiency upgrades recommended by the home performance program;
- A minimum energy efficiency requirement for participants in the CORE program" (p.42).

Renewable energy incentives are done mostly on a capacity basis because of the simplicity to implement rebate programs and the most documented barrier to solar installation is the high upfront cost, which rebates help defray. Furthermore, program administrators think that the appeal of rebates will help move the market to solar adoption faster. The paper included survey results from 70 CORE participants, "74% percent of survey respondents said they preferred the rebate structure to alternative incentive structures, and 56% of respondents reported that they would not have participated in the program if the rebate amount had been 25% less than the amount they received" (p.148). Upfront rebates, however, do not guarantee the performance of installed systems. To ensure optimal system performance market actors recommend performance based incentive (PBI) programs. PBI programs help encourage the maximum performance of systems over time, require less ratepayer funds due to the time value of money, and have been successfully implemented with European feed-in tariffs. The cost of program administration is much higher, because payments must be made over time.

Relevance/Limitations
The relevance of this study is limited to the highlights noted above. The rest of the study does not go into incentive programs. The findings of the CORE survey are interesting when compared to the

recommended incentive levels from Volume 1 of the study series, showing consumer response to specific rebate levels in the recent market.

Train, K., & Atherton, T. (1995). Rebates, Loans and Customers' Choice of Appliance Efficiency Level: Combining Stated- and Revealed-Preference Data. *The Energy Journal*, 16(1): 55-69. (1995).

Summary

This article estimates the impact of rebates and loans on the choice of efficiency of refrigerators by residential customers of Southern California Edison (SCE) using stated preference data (but not necessarily early retirement) combined with data on actual consumer purchases.

Methods

The researchers use survey data in which consumers were given a set of choices between buying a high efficiency air conditioner (and fridge) and a standard one, given various incentives to purchase the high efficiency one. They estimate a nested logit model where consumers choose which appliance to consume for each incentive package. They then calibrate this data using actual data on consumer appliance purchases when incentives were offered.

Highlights

The authors find that having a rebate increased consumers' willingness to buy energy efficient appliance. Given that there is a rebate, however, there was no difference between increasing the rebate $1 and decreasing the price $1. They also find that 68.3% of the population bought high-efficiency units when there were rebates, and this would have increased to 71.9% if the rebates were doubled. This includes consumers who would have purchased the air conditioners without the rebate. When considering consumers who would only purchase the air conditioners if there were rebates, they find that doubling the rebate level from its current level would increase the percentage of consumers who bought efficient air conditioners from 26.5% to 34.7%. They calculate that "consumers are willing to pay $1.72 for an extra dollar of savings from a high efficiency air conditioner, which translates into a 36 percent discount rate on the margin assuming a 10-year life and no growth in energy prices." (p. 59)

The research on offering financing also found that financing increased willingness to buy. However, it takes $3 extra dollars in financing to be considered equivalent to $1 extra of a rebate. This phenomenon is because rebates do not have to be repaid and loans do. Furthermore, if monthly payments rise due to extra financing it will take more than $3 to be equivalent to $1 in rebates.

Relevance/Limitations

The most relevant finding in the study to the current project is consumers obvious preference of rebates to financing. However, no information on the amount of the rebate under scrutiny is provided, which makes it hard to adjust their findings to our study. In addition, the findings might be a bit dated at this point and less relevant in the current economy.

Wilson, C., & Dowlatabadi, H. (2007). Models of Decision Making and Residential Energy Use. *Annual Review of Environmental and Resources*, 32:169–203. http://environ.annualreviews.org.

Summary

Four perspectives and their respective models for decision-making are explored in this article in an overview fashion. Although, particular lessons for program design can be drawn from each model, a more integrated approach is recommended. The four fields include:

1. Conventional and behavioral economics
2. Technology adoption theory and attitude-based decision-making
3. Social and environmental psychology
4. Sociology

The goals of this article, according to the authors, are to explain drivers of behavior for “interventions to target” and “provide a framework for empirical research on the impact of these interventions” (p. 170). Taken as a whole, this article appears to be well researched, objective, and achieves these goals. The article provides a thorough overview of various models of decision-making. It postulates “lessons for interventions” throughout the article, which can be gathered as insights into what may be most important for the reader to learn.

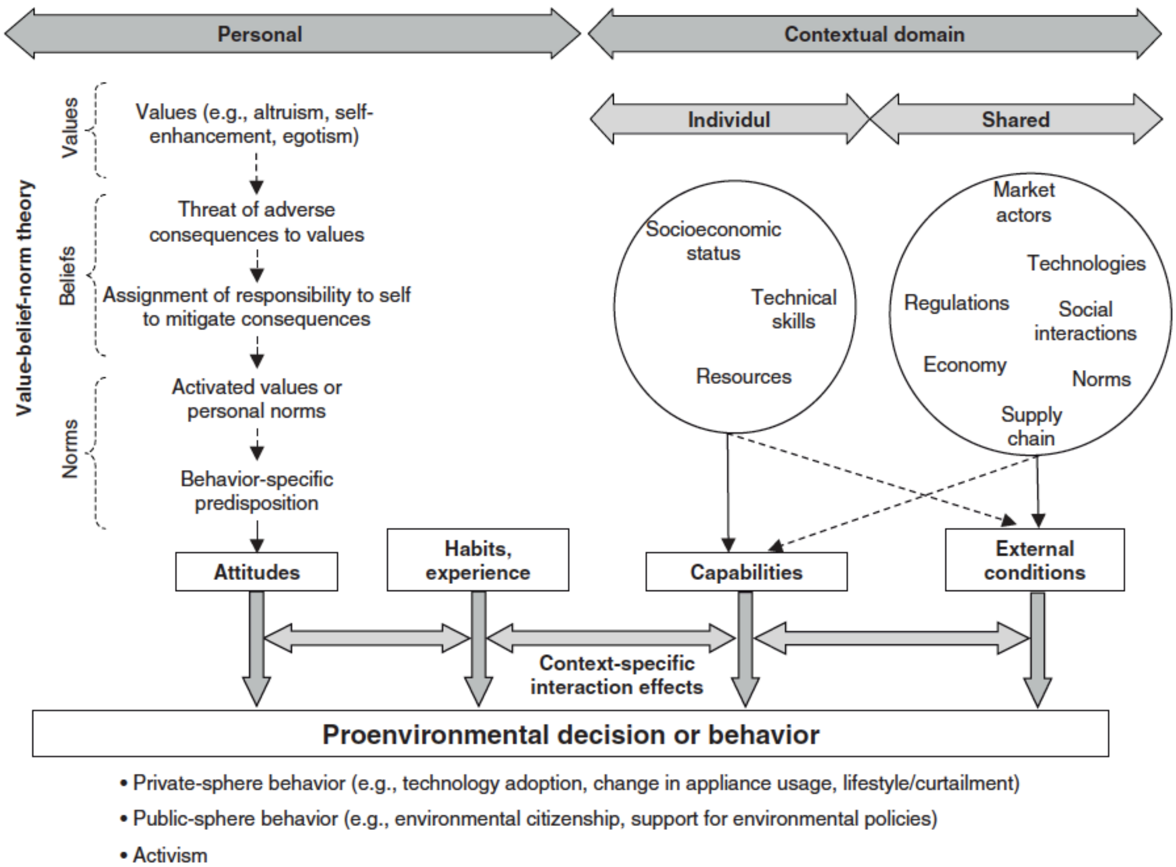
Method
These authors chose a number of empirical studies to review. To compare “decision making models,” the authors consider the different types of decisions made, and discuss the relevance of interventions in particular contexts (p. 171). The studies are then discussed in terms of the different types of models the authors have identified including:

- Utility-based decision models and behavioral economics
- Technology adoption and attitude-based decision models
- Social and environmental psychology decision models
- Social construction of decision making

Highlights
Of particular relevance to the overall goal of this annotated bibliography, is that the authors detail what they view as the limitations of reliance on financial incentives. For instance, when discussing social psychology effects, the author says “although monetary incentives certainly have a calculable effect on monetary cost-benefit ratios, their impact on decisions are more contingent” (p. 181). The author goes on to say that the impact of incentives is “contingent” on several attributes including administrative effort, eligibility criteria, cash-flow timing, the relevance of immediacy, and the requirement to take on debt. As such, social and environmental psychological factors may come into play.

The V-B-N theory, mentioned in Stern’s paper above is also discussed in the Wilson paper in the section on social and environmental psychology. The image below, Figure 38, originates in a Stern study from 2000. It is one of several papers by Stern included in the Wilson and Dowlatbadi review. The figure displays the V-B-N theory as set in the *personal* domain, as well as individual and shared factors in the *contextual* domain. These domains were discussed above in the review on Stern’s 1999 paper above. The figure depicts how various forces are in play within these two domains and interact to influence decision-making or the *behavior* domain.

Figure 38: An integrated model of proenvironmental behavior. Adapted from Wilson and Dowlatbadi 2007. Originally from Stern 2000.



Descriptive tables comparing and contrasting other models provide a useful graphical representation of the options for the integration of diverse models discussed in the Wilson and Dowlatbadi paper. The most useful and relevant one of these models, which addresses residential energy use is depicted below as Figure 39.

Figure 39: Table 2 Depicting Decision Making in the Residential Sector, from Wilson and Dowlatbadi 2007

Table 2 Comparison of disciplinary approaches to decision making in the context of residential energy use

Main features	Conventional economics	Behavioral economics	Technology diffusion	Social psychology	Sociology
	Section 3		Section 4	Section 5	Section 6
Decision model	Utility-maximization based on fixed and consistent preferences	Widely varying decision heuristics and context-dependent preferences	Attitude-based evaluation of technologies and the consequences of adoption	Interacting psychological and contextual variables	Sociotechnical construction of demand
Decision scale	Individual	Individual	Individual/social	Individual/social	Social
Main research methods	Quantitative (observed behavior)	Quantitative (controlled experiments)	Quantitative and qualitative (surveys, interviews, observed behavior)	Quantitative and qualitative (surveys, observed behavior)	Qualitative (interviews, observation)
Main dependent variables	Preferences between decision outcomes	Preferences between decision outcomes	Rate of diffusion	Self-reports of behavior and/or energy use	Observed or self-reported behavior
Main independent variables	Costs and benefits of outcomes and their respective weightings	Aspects of the decision frame, context, and elicitation method, as well as outcomes	Adopter role in social networks, communication channels, technology attributes, and leadership of adopter	Values, attitudes, norms, sociodemographics, economic incentives, skills, capabilities, and resources	Social, cultural and technical determinants of energy demand embedded in routine behavior
Empirical basis in energy use	Extensive	Very little	Some	Extensive	Some
Implications for interventions to reduce residential energy use	Provide information about benefits and incentives to improve cost-benefit ratio and improve cognitive capacity to assess net benefits/utility	Pay attention to framing and reference points for decisions, influence heuristic selection by emphasizing associations or emotive attributes, control choice sets and default options	Segment target population, exploit communication channels through social networks and use change agents, identify stage of decision process in target groups and use appropriate change mechanisms, ensure desired technology or behavior has key attributes	Influence attitudes only if external conditions are weak, use multiple interventions with due attention to interaction effects, identify and target barriers, design salient and personally relevant information, values provide a disposition for long-term change	Work toward long-term sociotechnical regime change, exploit opportunities of transition, recognize the social role of routine or habitual behavior, manage expectations
Timescales for interventions	Short term	Short term	Short to medium term	Short to medium term	Long term

The article also has an extensive list of references (196 citations in total) to draw upon. We have researched a number of these but could not locate and review them all in the given timeframe.

Relevance/Limitations
This article is inherently limited because it does not dive deeply into any particular model; rather it is designed more as a theoretical discussion than an investigational study. Thus, general concepts of the individual models are shared but specific empirical data is not provided. Additionally, without more details, some of the models are a bit ambiguous. The study highlights claims made by many other studies but does not provide direct evidence in most cases, rather it relies on other research instead. Finally, the article does not provide specific examples of utility programs, so it is not of direct relevance to the PSE project but can inform possible future studies regarding participation as a function of incentives.

Wokje, A., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, 25: 273–291.

Summary
This paper, written by a group of academics from the University of Groningen in the Netherlands, reviews 38 residential energy conservation studies. All of the studies reviewed included an intervention component. The paper reviews these studies to better understand resulting behavior change, determinants of behavior, attribution, and persistency, although the terms attribution and persistency are not specifically used. The purpose of the paper, as laid out by the authors, is twofold:

- To come to consistent findings with respect to the effectiveness of these interventions, and
- To improve understanding and knowledge of effective intervention planning.

Methods
The studies chosen were all carried out in the social and environmental psychology fields and qualified for this review only if based on real measurement of effects of an intervention compared to a baseline or control group. The authors group the intervention methods into two categories: antecedent strategies (those that aim to influence "determinants prior to the performance of behavior") and consequence strategies (those that use feedback and rewards).

Highlights
The highlight of this study is the table in the appendix listing all the "intervention studies" reviewed by the authors. The studies are organized by type of intervention (e.g. feedback, goal setting, reward, etc), design, statistical population (N), target behavior, behavioral determinants (if measured), duration of study, effect during intervention, effect size, and long-term effect. An excerpt from this table is shown below as Figure 40.

Figure 40: Excerpt from Table 1 (Entire Table Spans Several Pages) from Abrahamse, et al. 2005.

Table A1
Overview of intervention studies on household energy conservation (including author(s), type of intervention, design and number of groups, total sample size, target behavior, behavioral determinants, duration, effects during the intervention, effect sizes and long-term effect)

Author(s)	Intervention(s)	Design	*N*	Target behavior[a]	Behavioral determinants[b]	Duration	Effect during intervention	Effect size	Long-term effect
Becker (1978)	(1) Feedback (2) Goal setting (3) Information	(1) 20% goal, feedback 3 × per week (2) 2% goal, feedback 3 × per week (3) 20% goal (4) 2% goal (5) Control	100	Electricity use (C)	Not measured	1 month	(1) 20%-feedback: 15.1% (2) 2%-feedback: 5.7% (3) 20%-no-feedback: 4.5% (4) 2%-no-feedback: −0.6%	(1) $d = 0.97$ (2) $d = 0.36$ (3) $d = 0.09$ (4) $d = -0.07$	Not measured
Bittle et al. (1979)	(1) Feedback	(1) Daily feedback (costs) (2) Control	30	Electricity use	Not measured	42 days	Feedback group reduced electricity use by 4%, compared to baseline, and conserved more than the control group.		*24-day reversal* Experimental group no longer received feedback; still used less electricity than control group, now receiving feedback.
Bittle et al. (1979–1980)	(1) Feedback	(1) Cumulative feedback (kWh) (2) Cumulative feedback (costs) (3) Daily use feedback (kWh) (4) Daily use feedback (costs)	353	Electricity use	Not measured	35 days	For high consumers of electricity, all four types of feedback resulted in a lower rate of increase, but for medium and low consumers of electricity it resulted in an increase in consumption.		Not measured

Relevance/Limitations

The relevance of this study is limited because of its broad scope and lack of specific information on incentives and participation. Unfortunately, the study does not contain any recommendations for program design that are new to EMI. Moreover, the authors do not include the impacts (e.g. participation rates or energy savings) of the programs reviewed in the studies they are reviewing. In the absence of such data, the study is limited in its applicability to the study at hand.

A.2 References

Aalbers, R., van der Heijden, E., Potters, J., van Soest, D., & Vollebergh, H. (2007). Technology Adoption Subsidies: An Experiment with Managers. *Discussion Papers* 07-082/3, Tinbergen Institute. http://www.tinbergen.nl/discussionpapers/07082.pdf.

Bayus, B. (1988). Accelerating the durable replacement cycle with marketing mix variables. *Journal of Product Innovation Management*, 5, 216-226.

Berry, L. (1993). A review of the market penetration of US residential and commercial demand-side management programs. *Energy Policy*.

Chandra A., Gulati, S., & Kandlikar, M. (2010). Green Drivers or Free Riders: An Analysis of Tax Rebates for Hybrid Vehicles. *Journal of Environmental Economics and Management*, 60 (2), 57-144.

Datta, S., & Gulati, S. (2009). Utility Rebates for Energy Star Appliances: Are they Effective? *Mimeo, University of British Columbia*.

Environmental Protection Agency. (2010). National Action Plan for Energy Efficiency. Customer Incentives for Energy Efficiency Through Program Offerings. *Environmental Protection Agency*. http://www.epa.gov/eeactionplan

Erickson, J. (2003). Addicted to Rebates? Or Are They Just What the Doctor Ordered? *Meeting Diverse Needs, Seattle, Washington: International Energy Program Evaluation Conference*. http://www.iepec.org/2003PapersTOC/papers/018.PDF

Fernandez, V. (2000). Decisions to replace consumer durable goods: An econometric application of Weiner and renewal process. *The Review of Economics and Statistics*, 82(3), 452–461.

Fernandez, V. (2001). Observable and unobservable determinants of replacement of home appliances. *Energy Economics*, 23: 305-323.

Four Winds Alliance & D&R International. (2000). Opportunities for New Appliance Market Transformation Programs in the Pacific Northwest. *For Northwest Energy Efficiency Alliance.*

Friedrich, K., Amann, J., Vaidvanathan, S., & Elliot, R. N. (2010). Visible and Concrete Savings: Case Studies of Effective Behavioral Approaches to Improving Customer Energy Efficiency. *Research Report E108. American Council for an Energy-Efficient Economy.*

Gardner, J., & Skumatz, L. (2005). Decomposing price differentials due to ENERGY STAR® labels and energy efficiency features in appliances: proxy for market share tracking? *Proceedings from European Council for an Energy Efficient Economy Summer Study.*

Gibbs, M. & Townsend, J. (2000). The Role of Rebates in Market Transformation: Friend or Foe? *Proceedings from American Council for an Energy Efficient Economy (ACEEE) Summer Study on Efficiency in Buildings.*

Guiltinan, J. (2010). Consumer durables replacement decision-making: An overview and research agenda. *Market Letters,* 21:163–174.

Hunt, A. (2009). Social Norms and Energy Conservation. *Working Papers 0914, Massachusetts Institute of Technology, Center for Energy and Environmental Policy Research.*

Johnson Controls, Inc. (2008). Energy Efficiency Indicator Report 2008.

Lutzenhiser, L. (2009). Behavioral Assumptions Underlying California Residential Sector Energy Efficiency Programs. *Prepared for CIEE Behavior and Energy Program.*

Mauldin, T., Li, A., Hoefgen, L., Ledyard, T., Tolkin, B., & Feldman, S. Are Retailers Gaming the System? Availability and Pricing of ENERGY STAR Room Air Conditioners. *Energy Program Evaluation Conference, New York.*

Mid American Energy. (2005). MidAmerican Energy Company: Residential Process Evaluation Report.

Mills, Evan. (no date). Using Financial Incentives to Promote Compact Fluorescent Lamps In Europe: Cost Effectiveness and Consumer Response in 10 Countries. *Department of Environmental and Energy Systems Studies, University of Lund, Sweden.*

Monsethnal, P. H., & Wickenden, M. (1999). The Link Between Program Participation and Financial Incentives in the Small Commercial Retrofit Market. *Evaluation in Transition: Working In a Competitive Energy Industry Environment, Denver, Colorado: International Energy Program Evaluation Conference*. http://www.iepec.org/1999PapersTOC/papers/040.pdf

Morghan, T., & Felder, F. A. (2010). Comparison of energy efficiency incentive programs: Rebates and white certificates. *Utilities Policy* 18(2): 103–11.

Nadel, S., & Geller, H. (1996). DSM: What have we learned? Where are we going? *Energy Policy*, Vol. 24, No. 4, pp. 289-302.

Oak Ridge National Laboratory. (1991). Electric-Utility DSM Programs: Terminology and Reporting Formats. Chapter 3: Program Participation. *Prepared for the Office of Conservation and Renewable Energy. US Department of Energy and Customer Systems Division. EPRI*.

Oxera Consulting, Ltd. (2006). Policies for energy efficiency in the UK household sector. *Department of Environment, Food, and Rural Affairs.*

Quantum Consulting. (2001). Statewide Non-Residential Customer Hard-To-Reach Study. *For Chris Ann Dickerson, Pacific Gas and Electric.* http://www.calmac.org/publications/Nonres%20HTR%20Report.pdf

Sandahl, L. J., Gilbride, T. L., Ledbetter, M. R., Steward, H. E., & Calwell, C. (2006). Compact Fluorescent Lighting In America: Lessons Learned on the Way to Market. *Prepared for The US Department of Energy.*

Stern, P. C. (1999). Information, Incentives and Proenvironmental Consumer Behavior. *Journal of Consumer Policy*, 22: 461–478.

Summit Blue Consulting, Inc. (2008). Assessment of the New Jersey Renewable Energy Market: Volume 1. *For the New Jersey Board of Public Utilities Office of Clean Energy.*

Summit Blue Consulting, Inc. (2008). Assessment of the New Jersey Renewable Energy Market: Volume 2. *For the New Jersey Board of Public Utilities Office of Clean Energy.*

Train, K., & Atherton, T. (1995). Rebates, Loans and Customers' Choice of Appliance Efficiency Level: Combining Stated- and Revealed-Preference Data. *The Energy Journal*, 16(1): 55-69. (1995).

Wilson, C., & Dowlatabadi, H. (2007). Models of Decision Making and Residential Energy Use. *Annual Review of Environmental and Resources*, 32:169–203. http://environ.annualreviews.org.

Wokje, A., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, 25: 273–291.

APPENDIX B – MEASURES ASSESSED AS PART OF PEER INCENTIVES REVIEW

A.3 Residential Measures Assessed (Representing 75% of Total Residential Electric Savings)

Measure Name	Program Name	% of Total Residential Savings	Cumulative Percent of Total Res Savings
2010 Energy Star CFL bulbs & Recycling (retail)	Energy Efficient Lighting Services	50.6%	50.6%
2010 Refrigerator decommissioning	Refrigerator Decommissioning	5.4%	56.0%
Energy Star CFL In-unit (direct install)	Multi-Family Retrofit Elect	3.4%	59.4%
2009 Windows - U.30	SF Existing Wx - Electric	2.8%	62.2%
2010 Energy Star CFL fixture - Indoor	Energy Efficient Lighting Services	2.6%	64.9%
LIW Wx Tracking Measure E	Low Income Weatherization TE	2.5%	67.4%
2010 Forced-air-furnace to Heat Pump Conversion (greater than or equal to 8.5 HSPF, 14 SEER)	SF Existing Space Heat - Electric	2.2%	69.5%
Windows - U.30	SF Existing Wx - Electric	1.7%	71.3%
Ductless Heat Pump	SF Existing Space Heat - Electric	1.3%	72.6%
Windows (single to double paned) U= 1.2 to 0.30	Multi-Family Retrofit Elect	1.2%	73.7%
Energy Star CFL fixture - Indoor	Single Family New Construction - Electric	1.1%	74.9%
2010 Energy Star Heat Pump - Tier 2 = 9.0 HSPF, 14 SEER	SF Existing Space Heat - Electric	1.1%	76.0%

A.4 C&I Measures Assessed (Representing 75% of Total C&I Electric Savings)

C&I Measure Category	Measure Name	Program Name	% of Total C&I Electric Savings	Cumulative % of Total C&I Elec Savings
Lighting - Commercial	Lighting	E250 & G205 - Comml Ind Retro	9.43%	9.43%
Lighting - Commercial	Lighting fixtures plus controls	E250 & G205 - Comml Ind Retro	7.34%	16.77%
Refrigeration - Commercial	Phase 2 - ECM Motors	E250 Energy Smart Grocer	4.57%	21.33%
Process, Commercial	Compressors	E250 & G205 - Comml Ind Retro	2.81%	24.14%
HVAC - Commercial and Industrial	Electric units - Premium HVAC	E_G 262 Premium HVAC Service	2.68%	26.82%
Refrigeration - Commercial	Phase 2 - Floating Head Pressure	E250 Energy Smart Grocer	2.65%	29.46%
Process, Commercial	Other process	E251 G205 - Comml Ind New Constr	2.29%	31.75%
Lighting, Prescriptive	$225 new 6 lamp F32T8 fixture EB	E255 Small Bus Calculated Rebates	2.19%	33.94%
Refrigeration - Commercial	Phase 2 - Night Covers	E250 Energy Smart Grocer	2.17%	36.11%
Refrigeration - Commercial	Phase 2 Case Lighting	E250 Energy Smart Grocer	2.16%	38.26%
Whole Building	Whole Bldg - electric	E251 G205 - Comml Ind New Constr	2.13%	40.39%
Refrigeration - Commercial	Phase 2 - Anti Sweat Controls	E250 Energy Smart Grocer	1.86%	42.26%
Process, Commercial	Other process	E250 & G205 - Comml Ind Retro	1.77%	44.03%
HVAC - Commercial and Industrial	Fans, variable frequency drive	E251 G205 - Comml Ind New Constr	1.66%	45.68%
Lighting - Commercial	Fluorescent luminaires	E250 & G205 - Comml Ind Retro	1.65%	47.33%
Software	PC Power Management Software	E262 PC Power Mgmt Rebate	1.55%	48.88%
HVAC - Commercial and Industrial	Fans, variable frequency drive	E250 & G205 - Comml Ind Retro	1.50%	50.38%
O and M	RCM Salary Guarantee*	E253 or G208 - RCM	3.11%	53.49%

O and M	Year 3 Perform Incentive Electric*	E253 or G208 - RCM	2.42%	55.91%
O and M	RCM Performance Incentive, electric*	E253 or G208 - RCM	2.04%	57.95%
O and M	RCM Start-up incentive*	E253 or G208 - RCM	1.94%	59.89%
O and M	Year 2 Perform Incentive Electric*	E253 or G208 - RCM	1.56%	61.45%
Lighting, Prescriptive	$55 lamp for lamp F32T8 LBF	E255 Small Bus Calculated Rebates	1.48%	62.94%
HVAC - Commercial and Industrial	HVAC controls only	E250 & G205 - Comml Ind Retro	1.42%	64.35%
Process, Commercial	Process Modification	E250 & G205 - Comml Ind Retro	1.41%	65.76%
Lighting, Prescriptive	$90 kit four F32T8 lamps EB	E255 Small Bus Calculated Rebates	1.29%	67.05%
HVAC - Commercial and Industrial	Chiller	E250 & G205 - Comml Ind Retro	1.20%	68.26%
Lighting, Prescriptive	$6 Comml	E262 Comml CFL Mark Down Program	0.98%	69.24%
O and M	Commissioning, electric - Final 50%	E250 & G205 - Comml Ind Retro	0.95%	70.19%
Lighting, Prescriptive	$6 Comml 26 to 39W	E262 Comml CFL Mark Down	0.95%	71.14%
Refrigeration - Commercial	Phase 2 - Floating Suction Pressure	E250 Energy Smart Grocer	0.93%	72.07%
Lighting, Prescriptive	$3 < 26 watt lamp	E262 Commercial Lighting Rebate	0.93%	73.00%
Lighting, Prescriptive	$60 reduce lamps to 2 F32T8 lamps EB	E255 Small Bus Calculated Rebates	0.87%	73.87%
HVAC - Commercial and Industrial	Chiller	E251 G205 - Comml Ind New Constr	0.79%	74.67%
Lighting, Prescriptive	$3 Comml	E262 Comml CFL Mark Down	0.75%	75.41%

Note: Measures with Asterisks (*) are unique to PSE and were not applicable to the peer incentives review. Measures were often further grouped by measure category or program (e.g. C&I Retrofit) in order for comparisons to occur.

APPENDIX C – PEER INCENTIVES REVIEW COMPARISON DATA

A.6 Residential Incentives Comparisons

	Energy Efficient Lighting Services 2010 Energy Star CFL bulbs & Recycling (retail)	**Refrigerator Decommissioning** 2010 Refrigerator decommissioning	**Multi-Family Retrofit Elect** Energy Star CFL In-unit (direct install)	**Energy Efficient Lighting Services** 2010 Energy Star CFL fixture - Indoor
Utility	**Incentive**	**Incentive**	**Incentive**	**Incentive**
Puget Sound Energy (PSE)	$3.50 per bulb	$30 per unit	FREE	$12.50 per fixture
Seattle City Light (SCL)	$3 – 4 per bulb (varies by type)	$30 per unit	FREE	$10 per fixture
Snohomish PUD	$1 - 4 per bulb (varies by type)	$30 per unit	NONE	$20 per fixture
Energy Trust of Oregon (ETO)	$2 - 4 per bulb (varies by type)	$50 per unit	$2 per bulb	NONE
Avista	$1.25 - 2.25 per bulb (varies by type)	$30 per unit	DISCONTINUED	NONE
Tacoma Power	$1.50 - 2.35 per bulb (varies by type)	$30 per unit	FREE	$20 per fixture
ConEd(NY)	$2 - 4 per bulb (varies by type)	$30 per unit	FREE	$40 per fixture

	Single-Family Existing Wx - Electric	Multi-Family Retrofit Electric	Single Family New Construction - Electric
	Windows - U = 0.30	Windows (single to double paned) U= 1.2 to 0.30	Energy Star CFL fixture - Indoor
Utility	**Incentive**	**Incentive**	**Incentive**
Puget Sound Energy (PSE)	$6 per sq ft	$4 per sq ft	$20 per fixture
Seattle City Light (SCL)	NONE	$3-5 per sq ft	$10 per fixture
Snohomish PUD	A. $3 per sq ft (max. $1000) B. $25 per sq ft loan option (2.9%, max term 120 months, min value $1000)	$4 per sq ft	$20 per fixture
Energy Trust of Oregon (ETO)	$2.25 per sq ft. (U ≤0.22 = $3 per sq ft)	Calculated for Commercial Program	NONE
Avista	DISCONTINUED	$3 per sq ft	NONE
Tacoma Power	$4 per sq ft for replacing single pane $2 per sq ft for replacing double pane (older technology)	$4 per sq ft	$20 per unit
ConEd(NY)	NONE	NONE	NONE

	Single-Family Existing Space Heat - Electric	Single-Family Existing Space Heat - Electric	Single-Family Existing Space Heat - Electric
	2010 Energy Star Heat Pump - Tier 2 = 9.0 HSPF, 14 SEER	2010 Forced-air-furnace to Heat Pump Conversion (greater than or equal to 8.5 HSPF, 14 SEER)	Ductless Heat Pump
Utility	**Incentive**	**Incentive**	**Incentive**
Puget Sound Energy (PSE)	$350 per unit	$1,000 per home	$800 per unit
Seattle City Light (SCL)	$250 per unit	NONE	$1,200 per unit
Snohomish PUD	Up to $500 per ≥8.5 HSPF, 14 SEER air source heat pumper ≥9.0 HSPF Up to $1000 per 15 SEER air source heat pump	$1,200 per home	$800 per unit
Energy Trust of Oregon (ETO)	$250 per unit	$400 - $450 per system	$600 per unit
Avista	$400 per unit	$750 per system replacement	$200 per unit
Tacoma Power	$400 per unit	$400 per system (not required to be replacement, must be greater than 9 HSPF, 14 SEER)	$850 Total: $400 per unit + $450 install
ConEd(NY)	$600 per unit (9.0 HSPF, 16 SEER)	$1,000 per home ($400 per unit)	$1,000 per unit

A.7 Commercial and Industrial Incentives Comparison

C&I Retrofit – Grant Calculations	SCL	ETO	ConEd	SnoPud	Tacoma	Avista
Lighting **PSE** • Up to 50% of total project cost • Up to $0.25 per kWh of annual savings	• Up to 70% of the cost • No payback for the customer to any less than ½ years • Up to $0.20 per estimated first year kWh savings • Range of $0.17-$0.21 per kWh saved	• Up to 35 percent of the total approved installed cost (Standard lighting projects) • Up to 50 percent of the total approved installed cost Custom lighting projects) • Not to exceed $0.17/annual kWh saved. • All custom equipment must individually pass a cost-effectiveness test.	Tier 1: For 10% or less savings = $0.088/kWh Tier 2: For 11-20% savings = $0.11/kWh Tier 3: Greater than 20% = $0.132/kWh (Amounts stated include a 10% increase for 5% or greater peak hour savings reduction.)	• $0.20 /first year annual kWh saved. • Maximum funding of 70% of the total project costs • Cost-effective criterion determined when a measure payback (calculated at $0.069 per kWh per year) is within its projected lifetime	• $0.17 /kWh for the first year project savings • Up to 70 percent of the total project cost.	• Up to $0.20 per kWh first year savings • Capped at 50% of incremental project cost.
Non-Lighting (Process, HVAC, and O&M) **PSE** • Up to 70% of total project cost • Up to $0.30 per kWh of annual savings	• Up to 70% of the cost • No payback for the customer to any less than ½ years • Up to $0.20 per estimated first year kWh savings	• Up to 35% of the total approved cost • Not to exceed $0.25/annual kWh saved and $1/therm saved.				

Refrigeration Measures	SCL	ETO	SnoPUD	Avista (WA)	Tacoma Power	ConEd (NY)
ECM Motors **PSE** ECMs for Walk-In Cooler / Freezer Evaporator Fans - $170 per motor ECMs for refrigerated cases - $55 per motor.	$62 ECMs for Compressor Head Fans $70 for Shaded Pole to ECM in Display Cases $140 for Shaded Pole to ECM in Walk-In	$45 per motor change out, shaded pole or PSC to ECM	$25 – 100 per motor based on application (Not specified online)	$80 per motor for compressor fan $140 per motor for shaded pole to ECM (walk in) $55 per motor for shaded pole to ECM (display case)	$62 per motor for Compressor Head Fans $70 per motor for Shaded Pole to ECM in Display Cases $140 for Shaded Pole to ECM in Walk-In	No direct incentive identified.
Floating Head Pressure **PSE** $60 per controls hp	$60 for Air or Eval Cooled $80 for Air or Evap Cooled w/ VFD	$40 per compressor hp	$80 per hp with VFD or $60 per hp without VFD	Nothing now. Used to offer $60 per hp	$60 per hp for Air or Eval Cooled $80 per hp for Air or Evap Cooled w/ VFD	
Phase 2 - Night Covers (38.85%) **PSE** $22 per ln ft	$27.50 for Vertical $20 for Horizontal	$10 per linear ft	$20 per ln ft for horizontal or $27.50 per ln ft for vertical	$10 per ln ft for horizontal or $22 per ln ft for vertical	$27.50 per ln ft for Vertical $20 per ln ft for Horizontal	
Case Lighting **PSE** $51.50 - $70 (LED only)	Undisclosed	$10 per linear ft of LED	Various from $5 - $31 per ln ft based on lamp types and whether case is reach-in type or open.	Various from $3.50 - $31 per ln ft of LED based on lamp types, reach-in vs. open, and new vs. retrofit	From $5- 32 per ln ft of LED based on lamp types, case type, and new vs. retrofit.	
Anti Sweat Controls (42.87%) **PSE** $40 per ln ft	$40 per ln ft	$40 per linear ft in medium temp cases or $50 per linear ft in low temp cases	$14 per ln ft with EMS $40 per ln ft without EMS (med temp) $50 per ln ft without EMS (low temp)	$14 per ln ft with EMS $40 per ln ft without EMS (med temp) $50 per ln ft without EMS (low temp)	$40 per ln ft	
Floating Suction Pressure **PSE -** $15 per hp	$15 per hp	No direct incentive identified	$15 per hp	$15 per hp	$15 per hp	

Small Business Prescriptive Lighting Measures	Tacoma	Other Peer Utilities
PSE $225 per new 6 lamp F32T8 fixture EB	$160 per fixture	No exact measure matches
PSE $55 per lamp for lamp F32T8 LBF	$55 per lamp	
PSE $90 per kit four F32T8 lamps EB	$100 per kit	
PSE $60 to reduce lamps to 2 F32T8 lamps EB	$60 to reduce lamps	

Other Low-Cost Measures	SCL	ETO	SnoPUD	Avista (WA)	Tacoma Power	ConEd (NY)
PSE $3 per < 26 watt lamp	No specific incentive identified	No specific incentive identified	$3 per lamp	$3 per lamp	$3 per < 40W lamp	$4 per ≤32W bulb
PSE PC Power Management Software	No direct incentive identified	• $10 per license (20 desktop minimum)	$8 per computer	$10 per PC	$8 per computer	No direct incentive identified

PSE Comments on EE Program Incentives Study

Study Target Program: All EES Programs with Customer Incentives

Program Managers: Jeff Tripp (Mgr REM); David Landers (Mgr BEM)

Study Report Name: Energy Efficiency Program Incentives: A Review of Policies and Approaches

Evaluation Analyst: Eric Brateng

Comments:

The EE Program Incentives report by EMI was thoroughly reviewed be EES management and key program staff. These comments were developed with input from Bob Stolarski, Syd France, Jeff Tripp and David Landers.

EES Customer Energy Management staff overall are pleased with the EMI findings. We agree with the study Summary which includes:

Overall incentives at PSE are:

- Periodically examined;
- Kept at a reasonable level (neither high nor too low); and
- Not unnecessarily limiting the acquisition of all available conservation that is cost-effective, reliable, and feasible.
- Similarly, EMI found that:
- PSE's incentive setting process is in alignment with the Agreed Conditions For Approval, section K. (7) (c); and
- There is no consensus on best practices for how to set proper incentive levels.

Regarding the description of portfolio-level cost-effectiveness determination (pg 18), and several statements there relating to upper management involvement in the process, we want to be clear that all program and measure incentives, and changes to incentives, require Director level review and approval. While the TRC test is not impacted by incentive levels up to 100% of measure cost, Utility and Ratepayer costs are, and PSE program and management stakeholders are most sensitive to considering and optimizing the incentive/measure cost split between Utility and participating Customers.