A Tale of Two DSM Low-Income Residential Performance Bidding Projects in Oregon

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In 1992, both Portland General Electric Company (PGE) and Pacific Power & Light Company (PP&L) independently sought to obtain DSM for low-income residential customers by means of competitive bidding for 3-year ''pay for performance'' contracts expected to pay about $5 million each. Through competitive bidding, PGE selected SESCO, Inc.; PP&L chose ECONS, Inc.

The results of the projects are dramatically different.

1. The PGE-SESCO project is saving about 3.7 times as many *ex post* measured first post-retrofit year kWh per home treated as the PP&L-ECONS project (2822 kWh v 760 kWh).

2. The PGE-SESCO project is achieving *ex post* measured savings at a cost of about 2.4 cents per life-cycle kWh saved (1994 dollars), while the cost of the PP&L-ECONS project, comparably expressed, is 5.5 cents.

3. The PGE-SESCO project installed a greater variety of measures and substantially more weatherstripping, caulking, and other building shell infiltration reduction measures, along with more duct measures and compact fluorescent bulbs.

These differences stem from the design of each utility's ''pay for performance'' competitive bidding approach.

1. The PGE approach rewarded SESCO for:

   A. Comprehensive treatments by means of a ''tiered pricing'' system that offered a higher price for annual savings in excess of 1200 kWh per house treated;

   B. Long-lived actual kWh savings by truing up all initial payments to the *ex post* measured results, primarily to those achieved in the second and third post-retrofit years.

2. The PP&L approach failed to reward ECONS for:

   A. Comprehensive treatments by paying a flat amount per kWh saved, regardless of the level of savings per home treated;

   B. Long-lived actual kWh savings by not truing up any of the initial payment (50% of the *ex ante* estimated savings) to the *ex post* measured savings achieved.

Both programs provided energy savings at costs well below the utilities' other low-income weatherization programs operated under a ''pay per measure'' system.

INTRODUCTION

In 1991, the two largest Oregon investor-owned electric utilities considered new approaches to home weatherization programs for low-income customers (''low-income weatherization'' or LIW). Portland General Electric Company (PGE) and Pacific Power & Light Company (PP&L), acting independently, each initiated a competitive bidding approach, with each utility committing approximately $5 million for expected treatment of about 4000–5000 homes over a 3-year implementation period. This represented about a 5-fold increase in annual LIW funding for each utility. Both utilities also continued their existing LIW programs, operated by

community-based organizations, at undiminished levels of funding.

Both utilities attempted to implement these programs using energy service companies (ESCOs) under a ''pay for performance'' approach, with ultimate payment to the ESCO calculated on the basis of *ex post* measured savings over a period of 4–5 years after treatment of each home.

PGE undertook the program at its own behest. The PP&L program was mandated as part of a Settlement Agreement of rate case litigation between PP&L and public interest groups, including the Utility Reform Project. Compliance with the LIW provisions in the Settlement Agreement is monitored by a 3-person Conservation Panel, with one member each selected by PP&L, by the Northwest Conservation Act Coalition (**NCAC**), and by Natural Resources Defense Council (**NRDC**).

Through competitive bidding, PGE selected SESCO, Inc., headquartered in New Jersey; PP&L chose ECONS, Inc., a Washington company. ECONS later changed its name or otherwise assigned the contract to UCONS, Inc., but is referred to in this paper as ECONS.

Both ESCOs commenced their work in 1993 and completed treatment of residences in 1995. SESCO treated 4650 homes. ECONS treated 2931 homes. *Ex post* measured savings for the first post-retrofit year (PY 1) are available for the 1139 homes treated by SESCO in 1993, the 2082 homes treated by SESCO in 1994, and all homes treated by ECONs.

Although similar on the surface, the two projects differed significantly in several respects, including:

1. comprehensiveness of treatments
2. actual savings achieved
3. cost-effectiveness of savings
4. system for pricing kWh saved
5. measurement and verification of savings

THE UTILITIES

PGE and PP&L are investor-owned utilities headquartered in Portland, Oregon. PGE sold about 1700 average megawatts (MWa) of electricity at retail in 1994, all in northwest Oregon (primarily in the Portland and Salem metropolitan areas in the northern Willamette Valley).

PP&L, a subsidiary of PacifiCorp, had Oregon 1994 retail sales of about 1500 MWa in service areas scattered throughout the state. The PP&L service areas east and south of the Willamette Valley have somewhat harsher climates (colder winters and hotter summers) than the Willamette Valley. Of the homes treated in the PP&L-ECONS project, however, 80% were located in or near the Willamette Valley, which has relatively mild winters and cool summers. Space heat requirements there are around 4500 annual heating degree days (HDD) and can occur in all months of the year. Residential cooling loads are negligible.

The Pacific Northwest has a legacy of abundant,relatively low cost hydroelectric energy, causing a high penetration of residential electric space and water heating. A combination of higher prices for electricity, increased availability of low-cost natural gas, and bifurcated energy codes (with more stringent energy efficiency building codes for new electric-heated residences) have reduced new installations of electric heating. But use of electric heating applications in multifamily and older single-family housing stock in western Oregon remains high. As a result, low-income electrically heated residences represent a significant customer service and DSM resource opportunity.

RESULTS

Comprehensiveness of Treatments

Both utilities allowed the ESCO to install measures that the ESCO believed would be cost-effective, limited by the utility's pre-approval of measures and materials for long-term savings persistence and for safety and customer satisfaction. Table 1 indicates that the PGE-SESCO project installed a wider variety of measures, including several that were not installed by the PP&L-ECONS project, such as compact fluorescent bulbs, outlet and switch gaskets, door sweeps and thresholds, sash locks, and joist insulation. SESCO installed caulking and weatherstripping in more homes (overall 90% v. 28% for ECONS) and applied more linear feet of weatherstripping per home treated (300 v. 23 for ECONS). SESCO appeared to direct more attention to attic penetrations by providing insulation of attic hatches and pulldowns and sealing attic hatches and other by-passes.

While both ESCOs installed floor insulation in about 30% of the homes treated, ECONS installed far more square footage (870 v. 76) per home than did SESCO; SESCO primarily repaired existing floor insulation. ECONS installed attic insulation more often (51% of homes v. 46% for SESCO) but installed less square footage per treated home (789 v. 1195 square feet for SESCO), probably because the homes treated by ECONS were on average significantly smaller (see Table 9). ECONS installed setback thermostats in 11.7% of the homes, while SESCO installed only one.

Table 1. *Measures Installed by ECONS and SESCO*

	Units	SESCO % of Homes Receiving Measure	SESCO Average Quantity Where Installed	ECONS % of Homes Receiving Measure	ECONS Average Quantity Where Installed
Lighting Efficiency					
compact fluorescent bulbs	#	99.6%	5.1		
Furnace Efficiency					
Duct caulking	linear feet	24.3%	69.4		
Ducting insulation	linear feet	26.9%	54.3	0.4%	74.0
Setback thermostat	#		1.0	11.7%	1.0
Water Heating Efficiency					
Pipe insulation	linear feet	98.8%	48.2	78.0%	3.0
Water heater insulation wrap	#	87.1%	1.1	73.9%	1.0
Reset water heater temperature	#	42.4%	1.1		
Showerheads low-flow	#	85.8%	1.6	78.4%	1.1
Aerators	#	97.4%	3.3	89.9%	2.1
Building Shell Measures					
Attic Insulation	square feet	46.0%	1,195.2	51.3%	788.6
Floor Insulation	square feet	27.3%	75.6	30.1%	870.1
Wall Insulation	square feet			0.9%	874.4
Hatch/Pulldown Insulation	square feet	50.2%	7.7		
Joist Insulation	linear feet	26.0%	95.3		
Weatherstripping	linear feet	92.2%	300.0	53.5%	23.0
Caulking	linear feet	89.8%	433.0	20.6%	342.0
Seal Bypasses	#	99.1%	20.9		
Outlets Insulation	#	98.9%	31.2		
Switches Insulation	#	98.8%	23.3		
Outlet cap	#	98.4%	40.4		
Sash locks	#	90.0%	3.7		
Door sweeps	#	88.7%	2.6		
Range vent sealing	#	62.4%	1.0		
New door threshold	#	43.3%	1.7		
Attic hatch seal	#	35.8%	1.4		
Chimney plug	#	28.3%	1.2		
Pulley plug	#	7.4%	7.6		
A/C cover	#	6.0%	1.2		

Table 2 again shows the percentage of homes treated by SESCO and ECONS receiving each type of measure, along with recent percentages from the regular LIW programs funded by PGE and PP&L and in PGE's program for all customers. The utility programs installed large numbers of storm windows and doors, with less emphasis on water heating and lighting measures. For comparability to the PGE-SESCO project, which PGE limited to single-family homes, the PGE data on Table 2 includes only the single-family homes treated.

Actual Savings Achieved

The programs were implemented in climate zones that would appear to offer the PP&L program a greater opportunity to achieve energy savings. The PGE-SESCO project was entirely in the Willamette Valley, near Salem, Oregon, west of the Cascade Range. The PP&L-ECONS project allowed ECONS to treat homes in the Willamette Valley, in the Umpqua River Valley, and in the Rogue River Valley—all with similar climate zones—and in the colder reaches east

Table 2. *Percentage of Treated Homes Receiving Each Type of Measure Installed in ESCO and Utility Programs*

	SESCO	ECONS	PGE 1994 Low-Income	PGE 1994 Other	PP&L 1991 Low-Income
Lighting Efficiency					
compact fluorescent bulbs	99.6%				
Furnace Efficiency					
Duct caulking	24.3%				
Duct insulation	26.9%	0.4%	16%		4%
Setback thermostat		11.7%		4%	
Water Heating Efficiency					
Pipe insulation	98.8%	78.0%			
Water heater insulation wrap	87.1%	73.9%	25%		
Reset water heater temperature	42.4%				
Showerheads low-flow	85.8%	78.4%			
Aerators	97.4%	89.9%			
Building Shell Measures					
Attic Insulation	46.0%	51.3%	64%	49%	69%
Floor Insulation	27.3%	30.1%	35%	41%	47%
Wall Insulation		0.9%	21%	20%	21%
Storm Windows or Doors			82%	80%	68%
Hatch/Pulldown Insulation	50.2%				
Joist Insulation	26.0%				
Weatherstripping	92.2%	53.5%	63%	13%	51%
Caulking	89.8%	20.6%	57%	14%	2%
Seal Bypasses	99.1%				
Outlets Insulation	98.9%				
Switches Insulation	98.8%				
Outlet cap	98.4%				
Sash locks	90.0%				
Door sweeps	88.7%				
Range vent sealing	62.4%				
New door threshold	43.3%				
Attic hatch seal	35.8%				
Ground cover			25%	35%	
Chimney plug	28.3%				
Pulley plug	7.4%				
A/C cover	6.0%				

Sources: PGE 1995; PP&L 1994; Reeves 1996a.

of the Cascade Range, around Klamath Falls, Oregon. As it turned out, 80% of the homes treated by ECONS were in the Willamette/Umpqua/Rogue valleys. The other 20% of the homes, east of the Cascade Range, experienced 80% higher savings than the ECONS-treated homes in the river valleys west of the Cascades and thus raised the overall average level of savings achieved by ECONS.

Tables 3 shows the available first post-retrofit year (PY 1) *ex post* measured kWh savings results, as determined by the measurement and verification studies called for in the contracts between the utilities and the ESCOs. Applying uniformly the PRISM methodology specified in the PGE-SESCO contract and also applied to the PP&L-ECONS data by the PP&L-ECONS verification contractor, the overall

Table 3. *SESCO and ECONS First Post-Retrofit Year Measured Savings Using Contractual Methodologies*

	Homes Treated	*Ex post* Savings per Home (kWh) PRISM Method	*Ex post* Savings per Home (kWh) BCI Regression Method	Total PY 1 Savings (kWh)	Savings-Weighted Average Measure Life[a]
SESCO 1993 Cohort	1,139	3,358		3,824,762	
SESCO 1994 Cohort	2,082	2,528		5,263,296	
SESCO Total	3,221	2,822		9,088,058	22
ECONS	2,931	760	859		25

Sources: BCI 1996b; WECC 1995; Reeves 1996b, 2–4.
[a]Savings-weighted average measure life is estimated by the authors, using PP&L-assumed measure lives for both projects.

results in PY 1 kWh saved per home treated are 2822 kWh for SESCO and 760 kWh for ECONS.

The PGE-SESCO contract, signed December 1992, included a fully specified method for using a PRISM model to determine *ex post* measured savings, based on utility billing records, local weather data, and utility-selected control groups. As part of their contract, PGE and SESCO agreed to hire Wisconsin Energy Conservation Corporation (WECC) as an independent measurement contractor to conduct the savings calculations for the program. Because the method was fully specified in the contract, not allowing modifications, the model should produce the same result for anyone who implements it.

The PP&L-ECONS contract, signed July 1993, contained less specific measurement provisions, requiring only use of a pooled regression model to be developed later. PP&L later hired Barakat & Chamberlin, Inc. (BCI), with the approval of ECONS, to develop a specific model. BCI then performed the measurement studies using the ''contract'' model and its own variants on the model, all using utility billing records, weather data, and control groups.

For comparison purposes, PP&L also asked BCI to determine the results of ECONS treatments, using the fully-specified PRISM measurement methodology previously specified in the PGE-SESCO contract. BCI concluded that the PGE-SESCO PRISM method found PY 1 savings of 760 kWh per home treated by ECONS, or about 12% less overall than the PP&L-ECONS ''contract'' method.

Thus, the different measurement methods appeared to produce similar results, if applied to the same data, although the PGE-SESCO PRISM model produced 12% lower savings results than the PP&L-ECONS ''contract'' method, applied to the same data on homes treated by ECONS.

BCI also applied other methods in its PP&L-ECONS measurement studies, finding that results of its other methods would suggest PY 1 savings for about 3.5% higher than the PP&L-ECONS ''contract'' method (889 kWh) or 6.8% higher than the PGE-SESCO PRISM method (812 kWh). This paper focuses on the most directly comparable results, those produced by using the same fully-specified PRISM model on all of the data.

PGE's recent study of kWh savings from its 1991 standard LIW program found PY 1 savings at treated single-family residences averaging 1009 kWh (control group consisting of program non-participants, similar to the control group used in the WECC calculations for the PGE-SESCO project) or 1674 kWh (control group consisting of past program participants). PGE 1994, Table 4. Based upon this, it appears that the PGE-SESCO project is achieving savings between 70% and 180% higher than PGE's standard LIW effort.

PP&L's recent study of kWh savings from its 1990–91 regular LIW program these PY 1 savings:

Table 4. *PP&L 1990–91 Low-income Weatherization Program First Post-Retrofit Year Measured Savings*

Housing Type	Savings per Home (kWh) PP&L Standard Program	ECONS Project
Single-family	614	1,093
Multifamily	1,138	764
Mobile homes	961	1,001
Overall	849	889

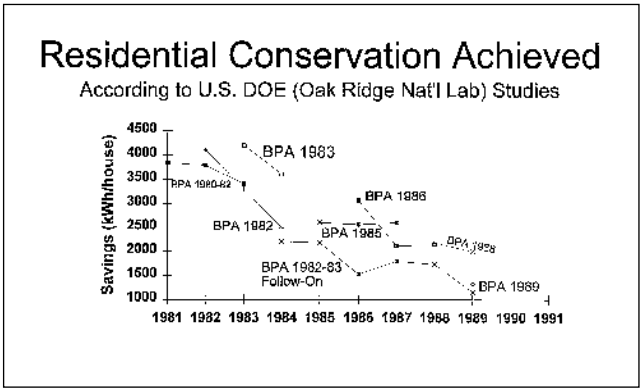
Sources: BCI 1996b, 11 (not using ''contract'' method); PP&L 1994, 17.

If we disregard that these studies did not use the same methodologies, it appears that the PP&L-ECONS project is achieving about the same overall savings level (+ 5%) as PP&L's standard LIW effort. But the ECONS project appears to be saving 78% more in single-family homes, 33% less in multifamily homes, and 4% more in mobile homes, compared with the PP&L standard LIW program.

Savings Persistence

In several studies, residential weatherization savings have tended to drop significantly after the first post-retrofit year. Figure 1 indicates that the savings in the weatherization program funded by the Bonneville Power Administration (BPA) in the Pacific Northwest experienced such deterioration.

Figure 1. *BPA Residential Weatherization Program Savings Persistence.*



Sources: BPA 1992, ERC 1991

The PGE and PP&L performance pilots were designed to offset this potential for savings deterioration by requiring that measurement and payment be stretched over several years.

No data on savings beyond the first post-retrofit year (PY 1) for the ECONS project has been made available. For SESCO, Table 5 shows that the weather-adjusted savings for the 1993 Cohort Treatment Group of 1139 homes increased by 212 kWh per house (6.4%) in PY 2 v. PY 1. The 1993 Cohort's control group, however, experienced a large reduction in weather-adjusted usage (534 kWh), so that the 1993 Cohort's net savings for payment purposes was 322 kWh less in PY 2 than in PY 1, a reduction of 9.6%. While this is significantly less than the average yearly deterioration experienced in similar programs in the same region, a final answer will depend upon the overall PY 2 and PY 3 results.

Cost-Effectiveness of Savings

The PGE-SESCO project produced kWh savings at a significantly lower cost than the PP&L-ECONS project.

PGE-SESCO. PGE's annual payments (for 5 years) to SESCO are $.074/kWh for Tier 1 savings (the first 1200 kWh per house per year) and $.176/kWh for Tier 2 savings (all savings in excess of Tier 1). These prices were approximately equal to 40% and 90%, respectively, of PGE's avoided cost. PGE's first such performance payment occurs after verification of PY 1 *ex post* measured savings by the independent contractor, WECC, or on average 22 months after SESCO has installed the measures. PGE then repeats the payment annually for the following 4 years (post-retrofit months 35, 47, 59, and 71) but not for any subsequent years. Thus, on average, SESCO receives its payment for a treated home about 4 years (47 months) following treatment.

To reduce financing costs, PGE pays SESCO $450 per treated house (within 45 days after invoicing), which SESCO must repay to PGE out of PY 1 and PY 2 payments due to SESCO for the *ex post* measured savings. If the PY 1 and PY 2 savings do not equal a credit of at least $450, SESCO must repay the $450, with interest.

Table 6 shows the resulting payment stream to SESCO, assuming that the PY 1 average savings for all 3 annual cohorts remains at the 2822 kWh level demonstrated by the 1993 and 1994 Cohorts and that there is no deterioration in savings during PY 2 and PY 3. The result is an overall payment in 1994 dollars (discounted at an 8% discount rate per annum) of 54 cents per PY 1 kWh saved. Using measure

Table 5. *PGE-SESCO Cohort Savings in Post-retrofit Years 1 & 2*

Post-Retrofit Year (PY)	Treatment Group Gross Savings (kWh)	Control Group Savings (kWh)	Treatment Group Net Savings (kWh)
1	3296	−63	3,359
2	3508	471	3,037
Change	212	534	−322

Sources: WECC, 1995, 2; Reeves 1996b, 2–4.

lives and *ex ante* savings estimates developed by PP&L, the average savings-weighted life of the SESCO treatments is about 22 years. If the savings are not discounted, the present valued cost becomes about 2.45 cents per life-cycle kWh saved (1994 dollars).

PP&L-ECONS. PP&L's payments to ECONS were based on what evolved in their contract negotiations into a 3-tier system. Tier 1 is half of the *ex ante* estimated life-cycle savings per measure installed multiplied by 40% of the utility's residential avoided cost (7.6 cents per kWh in 1994 dollars). Tier 2 is zero and applies to all *ex post* measured savings up to 50% of the *ex ante* estimated savings; the ESCO receives no additional payment, unless *ex post* measured savings exceed 50% of the *ex ante* estimated savings. Tier 3 is 40% of the utility's avoided costs for any *ex post* measured kWh in excess of 50% of the *ex ante* estimated savings.

ECONS received the Tier 1 payment approximately a month after invoicing for each treated home. Tier 3 was to be paid to ECONS over the first 5 post-retrofit years, based on *ex post* measured savings. Because the actual PY 1 savings, using any method, are less than half of the *ex ante* estimated savings of 2,499 kWh per home, it appears that PP&L will not need to make further payments to ECONS, unless the homes receive additional work. There is no requirement for ECONS to repay any of its initial payments, if the 50% realization ratio is not achieved.

Table 6 shows the resulting payment stream to ECONS. Because *ex post* measured savings appear to be less than half of the *ex ante* estimated savings, the actual savings achieved per home and the prospect for future deterioration of savings have become irrelevant. The payment stream to ECONS ends up based totally on *ex ante* estimated savings. The result is an overall payment in 1994 dollars (discounted at an 8% discount rate per annum) of $1.38 per PY 1 kWh saved. Using measure lives and *ex ante* savings estimates developed by PP&L, the average savings-weighted life of the ECONS treatments is about 25 years. If the savings are not discounted, the present valued cost becomes about 5.52 cents per life-cycle kWh saved (1994 dollars).

But the PP&L-ECONS contract is not entirely clear on this matter. It is possible that it requires PP&L to pay ECONS an additional amount equal to the effective contract price (3.04 cents per kWh, as explained later in this paper) times 50% times the *ex post* measured savings, which equals an additional $326,000 (1994 dollars). Such payments would increase the cost per life-cycle kWh saved by 11%, to 6.13 cents per kWh.

PGE's recent study of its 1991 regular LIW program reported a average cost of $1,975 per home treated, with PY 1 savings pegged at 1347 kWh (the average of the 1009 kWh and 1674 kWh calculations described under actual savings achieved above). The result is a cost of $1.47 per PY 1 kWh saved. Using the control group consisting of program non-participants only would show a cost of $1.96 per PY 1 kWh saved; using past participants as the control group shows cost of $1.18 per PY 1 kWh saved [PGE 1994].

PP&L's recent study of its 1990–91 regular LIW program reported an average cost of $1,634 per home treated, with PY 1 savings averaging 849 kWh. The result is a cost of $1.92 per PY 1 kWh saved.

Table 7 shows that both the SESCO and ECONS projects appear to achieve *ex post* measured savings more cost-effectively than the regular utility LIW programs.

Table 6. *Payments to the ESCOs and Resulting Cost-effectiveness*

	SESCO	ECONS
Initial Payment upon Treatment of Homes (occurred on average in 1994)	1,449,450	3,085,047
Payment After Measurement of:		
PY 1	480,523	0
PY 2	480,523	0
PY 3	1,205,248	0
PY 4	1,205,248	0
PY 5	1,205,248	0
Total Payment (nominal dollars)	6,026,240	3,085,047
Total Payment (1994 dollars)[a]	4,894,545	3,085,047
Homes Treated for Which PY 1 Results Available	3221	2931
Average Annual Savings per Home (based on PY 1 PRISM results)(kWh)	2822	760
Cost per PY 1 kWh Saved (1994 dollars)[a]	0.54	1.38
Savings-Weighted Average Measure Life (years)	22	25
Cents per Life-cycle kWh Saved (1994 dollars)[a]	2.45	5.52

[a]Annual discount rate of 8 percent.

REASONS WHY THE RESULTS WERE DIFFERENT

Comprehensiveness of Treatments

The apparently greater comprehensiveness of the SESCO treatments may have resulted from (1) the type of housing PGE did not allow SESCO to treat (multifamily and mobile homes) and (2) the authentic ''tiered pricing'' system adopted by PGE.

PGE's Restrictions on Housing Types Treated. The PGE program required that SESCO treat only single-family houses, not multifamily housing or mobile homes. Bidders had been required to offer a price for single-family and multifamily residences, but PGE decided to allow treatment of single-family units only.

The PP&L program did not limit ECONS to single-family homes or require that it treat multifamily housing or mobile homes. Table 8 shows that, of the homes selected for treatment by ECONS, 38% were single-family, 51% were in multifamily units, and 10% were mobile homes. Conse-

Table 7. *Cost-effectiveness of ESCO and Utility Low-income Weatherization Programs*[a]

	PGE-SESCO Project(1994 $$)	PGE Standard Program(1991 $$)	PP&L- ECONS Project(1994 $$)	PP&L Standard Program(1991 $$)
Cost per Home Treated	$1,519	$1,975	$1,052	$1,634
Post-Retrofit Year 1 (PY 1) Savings per Home(kWh)	2822	1347	760	849
Cost per PY 1 kWh Saved	0.54	1.47	1.38	1.92

[a]This table understates the cost differences between the ESCO and utility projects. The PGE-SESCO and PPL-ECONS columns are expressed in 1994 dollars. The PGE Standard and PP&L Standard columns are expressed in 1991 dollars. Also, the kWh savings results may not be comparable, as the utility standard programs were not evaluated with the PRISM methodology used to determine the savings for the SESCO and ECONS projects.

quently, the homes treated by SESCO were on average larger than the ECONS-treated units.

Table 4 shows, however, that the ECONS project did not save a great deal more per home in single-family dwellings than in multifamily residences or mobile homes. The differential in type of housing treated seems to have accounted for about 10% of the 2062 kWh per home PRISM-measured savings differential between the programs. This may be because ECONS did not concentrate on duct work and shell infiltration measures in the single-family homes, as SESCO did.

PGE's Tiered Pricing System. PGE recognized the possibility that a ''pay for performance'' ESCO, to be paid a flat price per actual kWh saved, might engage in ''cream skimming,'' attempting to maximize profits by:

1. installing only the least expensive measures in every residence, such as water heater blankets and attic insulation, while

2. not installing measures thought to produce somewhat more expensive (though still cost-effective) savings, such as floor insulation, comprehensive infiltration sealing, and compact fluorescent bulbs.

To avoid this, PGE implemented a tiered pricing system for kWh savings on a house-by-house basis. Under the PGE plan, the ESCO is paid a lower price for the first increment of measured savings in each home and a higher price for any additional savings in that home. PGE decided that the lower price should apply to the first 1200 kWh of annual savings per treated residence (Tier 1), as PGE believed that its existing LIW program was achieving that level of savings. The higher price would apply to all additional savings per treated residence (Tier 2). PGE decided to set the higher, Tier 2 price equal to about 90% of its long-run avoided cost. PGE asked that each bidder set the Tier 1 price as a principal component of its bid. SESCO offered the winning Tier 1 price, equal to about 40% of PGE's avoided cost.

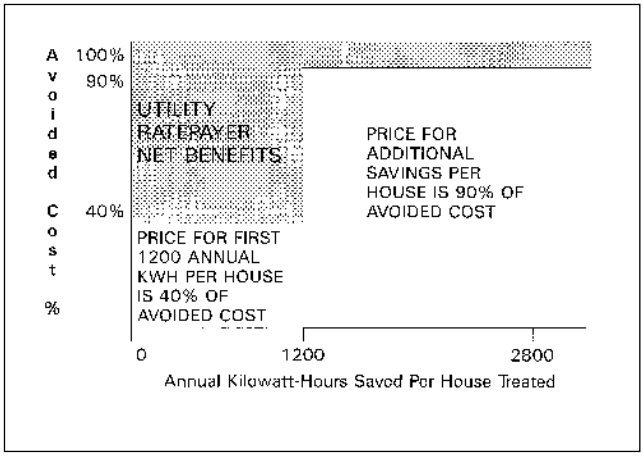
PGE's tiered pricing system effectively replicated the historic ''S'' curve between costs and comprehensiveness inherent in most residential weatherization analyses. The average price paid to SESCO varies from a low of 40% of avoided cost for net annual savings below 1200 kWh/house to about 75% of avoided cost if annual savings average 4000 kWh/house or more.

Figure 2 illustrates how tiered pricing provides financial incentive for comprehensive treatment, while helping to ensure that utility ratepayers benefit from the program. If SESCO had installed only the least expensive measures and had saved only 1200 kWh per year per house, PGE would have paid SESCO a price equal to only 40% of avoided cost. SESCO had to achieve higher levels of savings per house in order to earn payment for any kWh at 90% of avoided cost. At the level of the verified PY 1 measurement studies and assuming no savings deterioration prior to PY 2 and PY 3 measurements, SESCO will eventually receive payment equal to 69% of PGE's avoided cost.

Table 8. *Composite Pre-Treatment Characteristics of SESCO and ECONS Treatment Cohorts*

		SESCO	ECONS	SESCO %	ECONS %
Type	Single Family	3,229	1,126	100%	38%
Type	Multi Family	—	1,502	0%	51%
Type	Mobile	—	303	0%	10%
Heating System	Zoned	1,257	—	39%	0%
Heating System	Forced Air	961	—	30%	0%
Heating System	Stove	4	—	0%	0%
Heating System	Heat Pump	1,007	—	31%	0%
Heating System	Not reported	—	2,931	0%	100%
Heating Fuel	Electric	3,219	2,928	100%	100%
Heating Fuel	Gas	8	—	0%	0%
Heating Fuel	Other	2	3	0%	0%
Wood Stove?	Yes	1,857	—	58%	0%
Wood Stove?	No	1,372	—	42%	0%
Wood Stove?	Not Reported	—	2,931	0%	100%
Water Heat	Electric	3,183	2,919	99%	100%
Water Heat	Gas	44	11	1%	0%
Water Heat	Other	2	1	0%	0%
Duct Insulation	No ducts	1,264	—	39%	0%
Duct Insulation	0	166	—	5%	0%
Duct Insulation	<R-11	566	—	18%	0%
Duct Insulation	R-11+	1,229	—	38%	0%
Duct Insulation	Not reported	4	2,931	0%	100%
Under Floor Access	Yes	2,798	1,126	87%	38%
Under Floor Access	No	431	526	13%	18%
Floor Insulation	0	2,150	1,120	67%	38%
Floor Insulation	<R-21	889	203	28%	7%
Floor Insulation	R-21+	190	2	6%	0%
Floor Insulation	Not Reported	—	1,307	0%	45%
Attic Insulation	0	174	500	5%	17%
Attic Insulation	<R-13	474	1,049	15%	36%
Attic Insulation	R-13 – R-26	1,660	1,803	51%	62%
Attic Insulation	R-26+	787	383	24%	13%
Attic Insulation	Not reported	134	391	4%	13%
Average Floor Area	Square feet	1,834	881		

Figure 2. *PGE Tiered Pricing System: Price per kWh/ House Saved.*



With tiered pricing, the utility ratepayers receive their share of the economic benefits first, by paying a very low price for the Tier 1 savings. As savings per house increase into Tier 2, the ESCO is paid a higher price, yet the utility ratepayer benefit continues to increase, as PGE set the Tier 2 price at less than its avoided cost.

The incrementally higher price for annual kWh savings in excess of 1200 per home provided a major added incentive for SESCO to install measures SESCO believed were more expensive than the average price of the project yet less expensive than the Tier 2 price. For example, doubling the average annual savings from 1200 kWh to 2400 kWh per home will more than triple the payments to the ESCO. Since each block of kWh savings is incrementally more expensive to capture, tiered pricing provides a major incentive to the ESCO to maximize cost-effective energy savings.

Had the PGE-SESCO program only secured the 760 kWh per home savings achieved by the PP&L-ECONS project, SESCO would have received only 16% of the payments it earned at the 2822 kWh level actually realized. PGE's tiered pricing performance payments program provided the incentive to pursue the additional savings.

PP&L's Tiered Pricing System. The PP&L program's tiered pricing program reversed these incentives. In effect, PP&L paid its performance contractor:

(1) a very high price for the first block of savings, because the payment was 50% of the *ex ante* estimated savings, even if the *ex post* measured savings turned out to be small or zero;

(2) a price of zero for the next block of *ex post* measured savings (between zero and 50% of the *ex ante* estimated savings); and

(3) a price of 40% of PP&L's avoided cost for all savings in excess of the *ex ante* estimated savings.

Figure 3 shows the incremental payment (in cents per life-cycle kWh) that each system actually offered to the ESCO. The initial PP&L-ECONS payment was based on *ex ante* estimated savings, so the payment to ECONS, expressed in cents per *ex post* measured kWh saved, could in theory have been infinite (payment for zero savings). To avoid scaling the Y-axis to infinity, Figure 3 assumes annual *ex post* measured savings of at least 600 kWh per home for ECONS.

Figure 4 translates the incremental payments into the average price per life-cycle kWh saved under each system. The average payment per kWh saved to SESCO increases with larger savings per home treated. For ECONS, the average payment per kWh saved declines with larger savings per home.

Figure 3. *Incremental Payment to ESCOs per kWh/House Saved.*

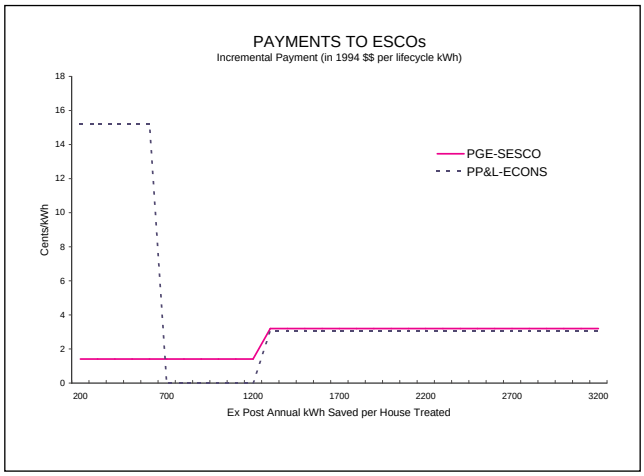
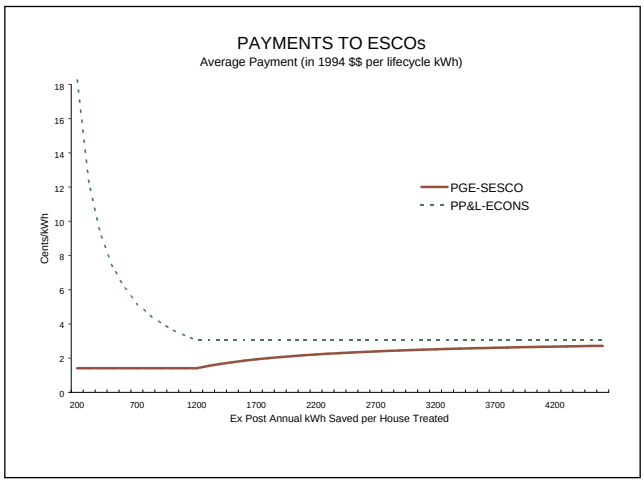


Figure 4. *Average Payment to ESCOs per kWh/House Saved.*



The pricing system adopted in the PP&L-ECONS contract was contrary to the tiered pricing principles adopted by the Conservation Panel overseeing the PP&L project. The Conservation Panel had stated that the contractor should be paid nothing for Tier 1 savings and should be paid an amount per kWh equal to PP&L's conservation cost-effectiveness limit for Tier 2 savings, thereby providing the maximum incentive for the ESCO to install a comprehensive set of measures, all of which are cost-effective. The dividing line between Tier 1 and Tier 2 was to be determined by the winning bid, with the bidders competing to offer a larger amount of ''free'' Tier 1 savings, in kWh per dwelling unit treated (and differentiating between single-family, multifamily, and mobile homes). The PP&L RFP specifically stated: ''Tier 1 shall be an amount of electric energy savings in kWh per housing unit, as designated by the bidder, that will be supplied without charge.''

Instead of ranking bids on the basis of the level of Tier 1 kWh each offered, PP&L accepted the ECONS bid, which did not offer tiered pricing at all. Instead of offering a number of Tier 1 kWh per housing unit, the ECONS bid stated that 60% of all kWh saved would be priced at zero, while the remaining 40% would be priced at 7.6 cents per kWh (the PP&L residential conservation cost-effectiveness limit in 1994 dollars). The mathematical result of this is payment to ECONS of 3.04 cents per kWh for every kWh saved, with no tiering on the basis of the quantity of kWh saved per dwelling unit treated. This eliminated the incentive for comprehensive treatments that tiered pricing was designed to provide.

One bidder offered PP&L a ''free'' Tier 1 of 950 kWh per single-family house treated. If PP&L had accepted that bid, and that ESCO had produced the same results as did ECONS (1093 kWh per single-family house, using the more generous regression method of measurement), PP&L would have paid for only 143 kWh per house, or less than $300,000 for the project. Instead, PP&L is paying ECONS over $3 million.

Savings Persistence

Residential weatherization savings deterioration may be due to any number of factors, such as:

(1) reliance upon short-lived, fast deteriorating measures or upon those quickly removed or ignored, such as showerheads or thermostats;

(2) improper education producing significant but short-lived results; or

(3) insufficient or improper follow-up for measures which need maintenance.

PGE's Payment Weighting System. To encourage the ESCO to work on assuring little or no deterioration, PGE weighted its payment plan so that the actual results for post-retrofit years 2 and 3 carry one and a half to twice the value as the savings in the first post-retrofit year. Table 9 shows the payment weighting system, which bases SESCO's payments 22% on post-retrofit year 1 (PY 1), 45% on PY 2 savings, and 33% on PY 3 savings. Thus, 78% of all payments to SESCO are based upon the actual measured savings occurring during PY 2 and PY 3 for each house. Because PGE grouped the houses into annual instead of monthly cohorts for measurement, the average time between treatment and the beginning of measurement is over 6 months. Thus, on average, PY 2-3 savings are those occurring during post-retrofit months 18–42.

In sum, PGE's ultimate payments to SESCO depend heavily upon the *ex post* measured savings results during the period 18–42 months following installation of measures. This provided SESCO an incentive to install measures in a manner to minimize savings deterioration. SESCO further seeks later-year savings by again contacting residences where PY 1 *ex post* measured savings is less than expected and performing any needed repairs or replacements to the installed measures.

PP&L's Payment Weighting System. Because PP&L paid ECONS upon installation an amount equal to 50% of the *ex ante* estimated savings for each home treated, and the PY 1 *ex post* measured results show the homes in aggregate to be saving only 35% of the estimate, the weighting of the PP&L payments was 100% upon installation. The Conservation Panel had directed that payments be based on *ex post*

Table 9. *PGE-SESCO Payment Weighting Scheme Rewards Later-Year Savings*

Payment After:	Payment is Based on Measurement of *Ex Post* Savings for:	Resulting Weighting of Each Year's *Ex Post* Measured Savings
PY 1	PY 1	22%
PY 2	PY 1 + PY 2	45%
PY 3	PY 2 + PY 3	33%
PY 4	PY 2 + PY 3	
PY 5	PY 2 + PY 3	

measured savings and be made over a period not less than 5 years. The PP&L-ECONS contract contemplated such payments (7.5% after each of the first 4 post-retrofit years, with 20% at the end of PY 5), but the initial payment of 50% of *ex ante* estimated savings rendered that system essentially irrelevant. An ambiguous term of the contract may require PP&L to pay ECONS an additional $326,000, assuming zero savings deterioration through PY 5, but that amounts to only 11% of the initial payments to ECONS.

Motivation for Expanding Low-income Weatherization Efforts

At first glance, it might appear that essentially simultaneous decisions by the Oregon utilities to launch similarly sized DSM programs would be the result of a regulatory mandate to do so. But the Oregon Public Utility Commission had no direct involvement in the genesis of either initiative.

At noted in the introduction, PGE undertook this program voluntarily, while PP&L's efforts were required by a Settlement Agreement with public interest groups, including a requirement that PP&L implement ''*a $5 million LIRC [low-income residential conservation] program for housing units located in PP&L's Mid-Willamette valley, Northeast Portland, and Douglas/Josephine/Jackson county service areas . . . on a pay for performance (PFP) basis.*'' The PP&L effort ran into many difficulties, with PP&L and the Conservation Panel frequently clashing.

Selection of Residences Eligible for Treatment

The PGE-SESCO contract allowed SESCO to treat a maximum of 5000 single-family residences from a list of 15,000 residences in low-income neighborhoods in and around Salem, Oregon, compiled by PGE. PGE maintains a system of small districts, each encompassing a few square blocks within cities or larger areas outside of cities. PGE rank ordered its districts by the number of Low-Income Heating Assistance Program (LIHEAP) qualified applicants within each district. PGE then aggregated sufficient districts in its Southern Division (in and around Salem) to furnish a list of somewhat more than 15,000 single-family residences in what PGE called ''low-income neighborhoods.'' PGE personnel then toured the selected districts by car and removed from the list the houses in areas that did not appear to be ''low-income,'' thus producing a list of 15,000 single-family homes.

PP&L allowed the contractor to select for treatment any low-income dwelling unit or house (income 125% or less of federal poverty guideline) anywhere in PP&L's western Oregon service areas. ECONS initially expected to begin operations with a geographically targeted program in Portland, moving into other parts of western Oregon as the program expanded. Considerable effort was spent unsuccessfully searching for low-income customers in Portland. Installations accelerated dramatically a year into the program, as contacts improved with community action agencies in central and southern portions of western Oregon. Program implementation remained low in Portland throughout the program (less than 2% of total installations), even though PP&L's Portland service area includes the largest identifiable concentration of low-income customers in the state.

CONCLUSIONS

Given the similarity between the demographics and energy consumption patterns of the residential customers of the two utilities, the difference in results between the PGE and PP&L programs is striking in several respects.

(1) The PGE-SESCO project is saving about 3.7 times as many *ex post* measured first post-retrofit year kWh per home treated as the PP&L-ECONS project (2822 kWh v 760 kWh). If only single-family houses are considered, then the PGE-SESCO project appears to be saving 2.6 to 3.0 times as much (2282 kWh v. 934—1093 kWh).

(2) The PGE-SESCO project is achieving *ex post* measured savings at a cost of about 2.4 cents per life-cycle kWh saved (1994 dollars). The cost of the PP&L-ECONS project, comparably expressed, is 5.5 cents per life-cycle kWh or, if PP&L makes additional payments to ECONS under ambiguous terms of the contract, could be 6.13 cents per life-cycle kWh.

(3) The PGE-SESCO project installed a greater variety of measures and substantially more weatherstripping, caulking, and other building shell infiltration reduction measures, along with more duct measures and compact fluorescent bulbs.

(4) A system of tiered pricing (paying a lower price for the first several hundred kWh per home treated and a higher price for higher levels of savings) can induce ESCOs to install a greater variety and larger quantities of measures, providing more comprehensive treatments.

(5) Basing ultimate payments upon *ex post* measured savings, and truing up any initial payments to the *ex post* measured results, will result in higher levels of *ex post* measured savings. A true ''pay for performance'' DSM program produces superior results to a ''pay for deemed savings'' approach.

(6) Basing payments on *ex post* measured savings achieved after the first post-retrofit year will encourage ESCOs to install longer-lived measures and to take steps to avoid savings deterioration.

(7) You get what you pay for. Both ESCOs examined here responded rationally to the financial incentives provided by the utilities.

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