Selecting Technologies and Practices for New Market Transformation Initiatives

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ABSTRACT

With the market transformation approach increasing in popularity, utilities and regional and national organizations are looking to identify technologies and practices which are most appropriate for new market transformation initiatives. Pacific Gas & Electric, Boston Edison, Northeast Energy Efficiency Partnerships, the Northwest Energy Efficiency Alliance, and the Consortium for Energy Efficiency have all undertaken efforts to screen and rank different technologies and practices (collectively called measures) for their suitability for new market transformation initiatives. These screening approaches typically involve comparing measures in terms of energy savings, likelihood of success, cost-effectiveness, and other factors. This paper summarizes and compares the different methodologies used in, and results of, each of these screening exercises. This paper also discusses how each of these organizations have applied their screening results and reviews lessons learned from these different screening exercises.

Introduction

The market transformation approach is gaining in popularity. The Connecticut legislature, public utility commissions in California, Massachusetts, New York and Wisconsin and a special panel appointed by four northwestern governors have made formal decisions endorsing the market transformation approach and encouraging utilities and other public benefit program implementers to develop and participate in market transformation initiatives (Connecticut General Assembly 1998; Nadel and Latham 1998). As a result, utilities and other organizations in these states are reviewing on-going national and regional market transformation initiatives, as well as other energy-saving measures (including both technologies and practices) that could be targeted by new market transformation initiatives, and making decisions about which initiatives to participate in over the next few years.

As an aid to making these decisions, these utilities and organizations are frequently conducting screening exercises, in which prospective targets for market transformation initiatives are systematically compared and contrasted, and ultimately ranked based on specified criteria. Such screening allows decision-makers to order and make sense of the many considerations that affect their decision. Screening can also be used to identify the most promising opportunities for more detailed investigation and likewise to separate out options with limited promise which are not worth investigating further. Of course, not all of the factors that affect final decisions on which market transformation initiatives to pursue can be objectively screened and ranked, and thus screening results must be combined with such factors as professional and political judgement before final decisions can be made.

To date, market transformation screening exercises have been conducted by Pacific Gas & Electric, Boston Edison, Northeast Energy Efficiency Partnerships, the Northwest Energy Efficiency Alliance, and the Consortium for Energy Efficiency. In this paper we discuss the methodologies used in these different studies, their results and how these results are being used. We conclude with a discussion of lessons taught by these past studies.

Screening Study Approaches and Methodologies

Pacific Gas & Electric

The Pacific Gas & Electric Company (PG&E) screening study is the first of the market transformation screening studies. The PG&E study provided the foundation for most of the other screening studies discussed in this paper. For this reason, we describe the PG&E methodology in more detail than the other studies, and in subsequent sections just discuss how the other studies differed from the PG&E approach.

Work on the PG&E study began in the fall of 1996 and initial results were available in the spring of 1997, allowing the results to be used to plan 1998 programs. For the screening study, PG&E and its consultants (ACEEE, Xenergy and E-Source) selected 64 measures to screen. Measures were selected that will be suitable for mass-promotion programs during the 1998-2000 period (e.g., measures that are unlikely to be commercialized by 1998 were excluded). The study was designed to identify new measures that PG&E was not currently promoting, so measures already included in existing PG&E programs (e.g. tumble-action clothes washers, advanced refrigerators, and LED exit signs) were also excluded. Since PG&E is a dual-fuel utility, measures that save electricity and/or natural gas were included.

For the PG&E study, four screening factors were identified, and data compiled on each measure for each of the four factors. The four factors were:

- Potential energy savings;
- Measure cost effectiveness;
- Likelihood a market transformation initiative could be successful; and
- Relationship to California's energy efficiency goals.

Potential energy savings are important because in order to justify the substantial work and effort to develop and implement a market transformation initiative, substantial savings must be achieved. Initiatives with only small savings may not justify the costs of putting an initiative into place. All other things being equal, new market transformation initiatives with high savings will be more advantageous than initiatives with smaller savings. Potential energy savings were assessed by comparing likely market trends in the absence of a program to the market trends that can be realistically achieved if a market transformation initiative is successfully implemented. For the PG&E study, energy savings that can be achieved in 2010 were estimated; 2010 was selected because it is far enough away for new market transformation initiatives to have significant impact yet is close enough to be within current resource planning time horizons. The general approach used to estimate energy savings was to compute the product of projected energy use in 2010 for the specific end-use affected times the proportion of potential applications for which the measure is technically feasible and cost-effective (as discussed below) times the proportion of the market that could be impacted by 2010 (e.g. 100% for retrofit measures, equipment turnover for measures implemented when existing equipment wears out, and new buildings for measures only appropriate in new construction). Thus, implicit in the energy savings estimates were aggressive penetration rate assumptions. Such penetration rates may be achievable for measures with a high likelihood of success. For measures with a lower likelihood of success, penetration rates will probably be lower, but this difference was captured in the likelihood of success score (discussed below) and not the energy savings score. Separate energy savings estimates were developed for electricity and natural gas.

Measure cost-effectiveness is important for several reasons. First, measure cost-effectiveness is very important for convincing consumers to implement a measure. If measures are very expensive relative

to the benefits, achieving substantial market share will be near impossible. Second, prioritizing DSM programs has typically relied on the utility, participant, and total resources cost (TRC) tests; measure cost is a primary element in all of these costs. Measure cost-effectiveness was examined on a levelized cost of saved energy basis over the measure lifetime, assuming a 6% real discount rate, resulting in $/kWh and $/therm indices.

For measures that have annual operating costs or savings besides energy (e.g., reduced or increased maintenance costs), changes in annual maintenance costs were included in the cost calculations. This analysis approach is very similar to the traditional participant cost test. Where measures were cost-effective (defined for our purposes to mean levelized costs less than or equal current PG&E retail energy prices) in some applications but not in others, levelized costs were calculated for typical cost-effective applications and the energy savings estimates adjusted to only include cost-effective applications.

Likelihood a market transformation initiative can be successful is perhaps the most critical factor in selecting market transformation targets. If an initiative is unlikely to be successful, it is generally not worth pursuing. Likelihood of success in turn depends on an analysis of the major market barriers that are impeding each initiative and the likelihood that program interventions can overcome these barriers. Likelihood of success also depends on the how well the technology or practice addresses customer needs — does the measure have additional benefits besides energy savings, or is the measure less desirable than conventional measures from a consumer perspective?

Likelihood of success was rated on a five-point scale by PG&E's consultants, the results reviewed and discussed with PG&E staff, and final ratings developed. Ranks were assigned based on guidelines developed by PG&E and its contractors. For example, a rating of one was assigned to measures for which achieving success will be very difficult; there are many large barriers to overcome, the benefits are limited, and little work has taken place thus far. And a rating of five was assigned to measures for which there is an excellent chance of success; the measure has been proven technically and has significant benefits; extensive work has taken place already, and the measure lends itself to a clear exit strategy such as codes, mandatory standards, or an easy to meet voluntary standard as with power management in PC's.

Relationship to California's energy efficiency goals was assessed by PG&E staff and was designed to capture how well each measure fit within California's current energy efficiency goals and PG&E's assessment of how effectively a program for the measure could be implemented (based on prior experience with, interest in, and expertise related to each measure). These ratings were assigned by PG&E staff using a 1 to 3 scale.

In order to arrive at an overall rank for each factor, measures were ranked from highest to lowest on each factor and 100 points assigned to the highest ranked measure, 0 points to the lowest ranked measure, and intermediate points to other measures based on their score on that factor. Weighted average scores were then calculated, weighting energy savings by 30%, likelihood of success by 35%, cost-effectiveness by 15%, and relationship to California's energy efficiency goals by 20%. These weighting factors were jointly selected by PG&E and its consultants. Potential energy savings was heavily weighted because saving energy is the primary objective of these market transformation programs. Also, it was through this factor that measures that will likely prosper in the market without intervention were ranked low (since savings are relative to expected activity in the absence of additional market intervention). Likelihood of success was heavily weighted because PG&E is interested in savings that can be achieved in practice and not just in theory. Cost of saved energy was weighted less than the previous two factors because measures with a high cost of saved energy will generally have a low likelihood of success score (due to the barriers of high measure costs and/or limited measure benefits) and PG&E did not want to overweight this factor. Relationship to California's energy efficiency goals was considered important by

PG&E and was assigned a medium weight.

Northeast Energy Efficiency Partnerships

Northeast Energy Efficiency Partnerships (NEEP) is a consortium of utilities, state government agencies and public interest organizations in New England and the Mid-Atlantic states. NEEP conducted its first screening exercise in late 1996. Additional measures were screened in the fall of 1997. Between the two studies, 26 measures were screened.

NEEP selected five principal screening factors:

- Potential to achieve big kWh or kW savings;
- Savings are distributed regionally;
- High likelihood of success;
- There is a reasonable prospect of developing and executing an exit strategy; and
- NEEP is the appropriate entity to provide the push.

For each factor, a score of 1-5 was assigned by NEEP staff based on professional judgement. Initial ratings were reviewed by the Program Committee of the NEEP Board and the ratings refined. The energy savings and likelihood of success factors were very similar to those used in the PG&E study as discussed above, except that NEEP considered measure cost-effectiveness as part of the likelihood of success score. On the other hand, PG&E included availability of an exit strategy as part of likelihood of success, while NEEP made it a separate category. The factor for regional distribution was used to give greater weight to measures that are suitable throughout the northeast, versus measures that are primarily suitable in portions of the region but not others (e.g., suitable in the cold climate of northern New England but not in the warmer mid-Atlantic region). Appropriateness for NEEP was a simple yes/no/maybe factor that considered whether NEEP had a useful role to play or some other organization(s) were already adequately addressing the measure.

NEEP developed an overall score for each measure based on a simple average of the first four individual factor scores. With this approach, NEEP assigned 50% weight to the combination of likelihood of success, cost-effectiveness and exit strategy, the same weight that PG&E assigned to this combination of factors.

Relative to the PG&E screening approach, the NEEP approach was more subjective, but also much easier and quicker to carry out.

Boston Edison

Boston Edison Company (BECo) examined 23 different potential initiatives in its screening study, including initiatives being operated by NEEP, the Consortium for Energy Efficiency (discussed below), the U.S. EPA and DOE, the New England Energy Efficiency Council, and by its team of consultants (GDS and ACEEE). These initiatives were screened based on three criteria:

- Energy savings in 2010 assuming achievement of aggressive but realistic goals for a market transformation initiative in operation from 1998-2002.
- Likelihood of sustained success by 2002.
- Meeting Boston Edison's needs.

In addition, a fourth criteria, benefit-cost ratio, was identified to be added to the analysis at a later point.

Energy savings were estimated for each potential initiative through a series of calculations based

on explicit assumptions that were reviewed by BECo staff, the BECo consultant team, and a group of outside parties who were interested in BECo's program proposals. Based on the results of these calculations, a savings score was assigned to each measure using a five-point scale.

Likelihood of success was rated on a 1 to 5 scale based on the answers to the following series of questions:

- Does the program seem practical and doable?
- Is there interest and enthusiasm among potential allies?
- Is the infrastructure in place or can it be quickly developed?
- Does information about the market already exist?
- Does the initiative coincide with the agenda of others?
- Does the concept need another push and is not happening anyway?
- Has some momentum already been developed?
- Do the barriers appear surmountable in five years (by 2002)?
- Is an exit strategy available?
- Is the measure cost-effective to consumers? What is the typical simple payback?
- Are non-energy benefits available that will also help sell the measure?

In assigning scores, likelihood of an exit strategy by 2002 (a relatively short time-frame) proved to be a key factor. This timeframe was chosen because it was the end of the period covered by a settlement agreement reached between BECo and outside parties to its restructuring docket.

In addition to the two primary criteria discussed above, the Company also has a number of other criteria against which potential initiatives need to be measured as follows:

- Can the initiative be administered without high administrative costs?
- Can the effects be measured?
- Is the initiative likely to satisfy regulators and other public officials?
- Will the initiative help advance BECo's relations with the public?

Answers to these questions were compiled and a single rating developed as to how likely an initiative is to meet these needs. Ratings were on a three point scale, with a score of three most likely to meet the Company's needs. Like PG&E, BECo assigned weights to each factor in order to develop an overall score. Weights were 50% to likelihood of success, 30% to energy savings, and 20% to meeting BECo's needs. In addition to these weights, several alternative weighting scenarios were also analyzed.

Northwest Energy Efficiency Alliance

The Northwest Energy Efficiency Alliance (NEEA) study built on the PG&E study but included some measures not included in the PG&E study. NEEA administers market transformation programs for a four state region, with funding provided by electric utilities in the region, and policy set by a Board which includes equal representation from public utilities, investor-owned utilities, and government/public interest officials. A total of 36 measures were screened in the NEEA study, all of which save electricity. Screening and ranking was done based on three factors — potential energy savings in 2010, cost-effectiveness (i.e., levelized measure cost) and likelihood of success. In addition, three other factors were included, to help guide decision-making outside the ranking process. These were:

- Need for intervention (rated high, medium or low).
- Fuel share impact (will an initiative cause significant fuel switching which is something northwest policy-makers want to avoid) (rated yes, maybe, or no).

- Non-electric fuel benefits (will an initiative save substantial natural gas or propane, which since NEEA's budget is funded by electric utilities, is not considered desirable) (rated high, medium, or low).

Other significant changes relative to the PG&E study included: (1) NEEA assumed more gradual measure adoption rates in developing energy savings estimates, with rates varying depending on the need for intervention score (the lower the need for intervention, the higher the assumed penetration rate). (2) The NEEA savings estimates included savings not yet achieved but that were likely to happen without NEEA action. NEEA reasoned that in this manner, measures with high savings would be ranked high, but that if much of the savings would happen anyway, NEEA could adjust the types and level of market intervention accordingly. (3) The NEEA study refined the criteria for rating likelihood of success. The NEEA criteria are summarized in Table 1.

Table 1. Factors Used to Assign Likelihood of Success Scores in NEEA Study.

Dimension	Rating				
	1	2	3	4	5
Barriers	very difficult to overcome	difficult to overcome	some but not all barriers can be significantly reduced over time	all can be overcome	all can be overcome
Progress to date	very limited	some	significant	significant	significant
Benefits	limited	can be substantial	substantial	substantial	substantial
Exit strategy	none	none	not clear	difficult or controversial	clear

NEEA was particularly interested in selecting measures that were cost-effective and maximized energy savings. Based on these criteria, measures with a levelized cost above 30 mils (the approximate marginal cost of energy in the northwest) were placed at the bottom of the rankings, and other measures were scored by weighting energy savings 45%, likelihood of success 35%, and cost of saved energy 20%. Alternative weighting scenarios were also prepared.

Consortium for Energy Efficiency

The Consortium for Energy Efficiency (CEE) study built on both the PG&E and NEEA studies. CEE is a national consortium of utilities, government agencies and public interest groups interested in market transformation. Of the screening studies conducted to date, only the CEE study is national in scope. A total of 56 measures were screened by CEE using a process nearly identical to that used by NEEA. The only significant differences were that CEE: (1) Used national average energy consumption levels to estimate energy savings and cost-effectiveness. For measures that were cost-effective in some regions but not others (due to differences in weather and equipment operating hours), the energy savings potential was estimated for cost-effective applications, where "cost-effective" means on a life-cycle cost basis assuming current national average energy prices. (2) More heavily weighted likelihood of success (40%) and cost-effectiveness (20% weight, but without a 30 mil cutoff) than NEEA, and assigned a slightly lower weight (40%) to energy savings. However, the CEE study also included several alternative weighting scenarios.

To provide a better indication how CEE (and also PG&E and NEEA) analyzed measures, a sample measure data sheet is included in Table 3.

Screening Study Results

Overall results for the CEE study are summarized in Table 2. We present the CEE results because they are the most recent and national in scope. The measures ranked in the top 10 are generally those with either likelihood of success scores of 4 or 5, or measures with very large energy savings and likelihood of success scores of 3 or 3.5. However, given minor differences in scores between adjacent measures, the prime usefulness of this analysis is not to identify which measure ranks first and which second, but rather to separate high-ranked measures, from medium-ranked measures, from low-ranked measures.

In most of the screening studies, several alternative scenarios are run in which the weights assigned to the different screening factors are changed to see how sensitive the results are to the particular weights used. In general, results of these sensitivity analyses are remarkably similar to the basecase results. Individual measures will shift up or down a few places in the rankings, but there are generally no dramatic shifts. This is illustrated in Table 4 which summarizes the results of the sensitivity analysis for the NEEA screening study.

Comparison of Screening Study Results

It is also interesting to compare results between the different screening studies. Table 5 lists the measures that were ranked in the top 10 in at least one of the five screening studies. Across the five studies, three measures were included in at least four studies and were in the top ten in all studies that included them — commissioning existing buildings, low energy/water dishwashers and tumble-action clothes washers. In addition, nine measures were included in at least three studies and were in the top 20 in all of the studies that included them — commercial packaged refrigeration, coin-operated clothes washers, TVs/VCRs and other home electronics with low standby energy use, compact fluorescent lamps and/or fixtures, commercial building integrated design, LED traffic signals, commercial packaged air conditioners, residential duct sealing, and residential central air conditioners.

Overall, there was a surprising amount of agreement across the different studies, despite differences in screening methods and factors, climates, and fuel types. As noted above, twelve measures were ranked in the top 20 in all studies that included them. Differences in methodology between studies did not appear to have a large impact, since similar factors were analyzed in the different studies and the weights attributable to each factor are of secondary importance (recall Table 4).

However, there were also many differences in study results. Among the factors that contributed to these varying results were differences in climate (which reduced the rank of air conditioning measures in studies in the northeast and northwest where air conditioning loads are modest); sector size (the northwest has a very large industrial sector which resulted in several industrial measures making the top 20, while PG&E and BECo have large commercial sectors which resulted in high ranks for chillers and dry type distribution transformers); fuel share (e.g., California homes tend to use natural gas for space and water heating while in the northwest, electricity is more common, which affected the ranks for gas and electric residential water heaters); and whether likely future increases in market penetration are included or excluded in the savings estimates (which affects whether high-efficiency water heaters or LED exit signs are high-ranked or not). Other differences were due to the fact that some measures were included in some of the studies but not others. These differences in turn were attributable to such factors as whether gas-

Table 2. Summary of Screening Results in CEE Study

	Measure/Practice	Elec Savings (TWh)	Gas Savings (TBtu)	Total Savings (TBtu)	Elec CSE ($/ kWh)	Gas CSE ($/ therm)	Likelihood of Success	SCORE
1	Commercial building retrocommissioning	59.7	189.6	804.0	0.023	0.224	3	77.11
2	High efficiency clothes washers	20.0	118.0	323.6	-0.018	-0.406	4	67.76
3	LED commercial/industrial exit signs	9.7	NA	100.1	-0.057	NA	5	64.48
4	High efficiency electric water heating	9.2	NA	94.8	0.006	NA	5	62.59
5	Efficient standby power operation	31.4	NA	323.5	0.009	NA	3.5	61.37
6	High efficiency residential central a/c	13.2	NA	135.9	0.020	NA	5	61.07
7	Coin-op clothes washers	1.0	9.5	19.4	NA	-0.262	5	60.41
8	High efficiency gas storage water heaters	NA	113.9	113.9	NA	0.189	5	58.67
9	T8 lamps/electronic ballasts	16.3	NA	167.7	0.005	NA	4	58.64
10	Low energy/water dishwashers	2.9	46.8	77.0	-0.022	-0.440	4	55.31
11	LED traffic signals (red only)	3.2	NA	33.3	0.025	NA	5	54.60
12	Duct sealing	15.4	203.2	362.2	0.027	0.219	3	54.46
13	Comm'l packaged a/c — Tier 1	3.4	NA	35.0	0.030	NA	5	53.36
14	Screw-in compact fluorescent lamp	21.3	NA	219.7	0.012	NA	3	51.28
15	Furnace and boiler installation & maintenance	NA	257.0	257.0	NA	0.216	3	48.95
16	Efficient new homes	15.7	225.6	386.8	0.054	0.474	3	47.72
17	New comm'l buildings -- integrated design	20.7	65.8	278.9	0.039	0.316	3	46.95
18	High efficiency pkgd refrigeration equipment	4.2	NA	43.5	0.011	NA	3.5	46.80
19	Residential efficient windows	10.0	128.5	231.1	0.031	0.256	3	46.60
20	Residential a/c installation & maintenance	18.0	NA	185.1	0.025	NA	3	46.23
21	Light-colored roof surfaces - residential	8.4	low	86.6	0.006	NA	3	46.21
22	LED traffic signals (red and green)	3.7	NA	38.1	0.029	NA	4	45.90
23	Light colored roof surfaces - commercial	4.1	NA	42.4	-0.025	NA	3	45.57
24	Dry-type distribution transformers	3.6	NA	37.6	0.031	NA	4	45.18
25	Improved lighting design practices	14.9	NA	153.0	0.024	NA	3	44.84
26	High efficiency comm'l gas furnaces and boilers	NA	45.0	45.0	NA	0.280	4	44.05
27	Optimization of chiller and tower systems	5.4	NA	55.6	0.009	NA	3	43.79
28	Residential fluorescent lighting fixtures	6.8	NA	70.5	0.013	NA	3	43.63
29	Occupancy controls	16.6	NA	170.7	0.034	NA	3	43.20
30	New building commissioning	7.0	26.7	98.4	0.024	0.133	3	42.95

31	High quality comm'l a/c installation & maintenance	13.2	NA	135.6	0.029	NA	3	42.68
32	Industrial air compressors	6.1	NA	62.4	0.015	NA	3	42.67
33	High efficiency freezers	2.4	NA	24.8	0.039	NA	4	42.59
34	Optimization of cleanroom HVAC systems	2.4	NA	24.9	0.012	NA	3	41.52
35	Premium efficiency motors	2.5	NA	26.1	0.015	NA	3	40.94
36	Very high efficiency refrigerators	4.7	NA	48.1	0.050	NA	4	40.79
37	Integrated space/water heating heat pumps	5.3	NA	54.8	0.021	NA	3	40.75
38	High quality motor repair practices	2.0	NA	20.7	0.018	NA	3	39.90
39	Heat pump water heaters - add on	30.4	NA	313.5	0.044	NA	2	39.77
40	Very high efficiency residential central a/c	11.3	NA	116.5	0.070	NA	4	39.05
41	Improved code implementation	1.9	27.8	47.1	0.025	0.209	3	38.89
42	Commercial heat pump water heaters	1.4	NA	14.4	0.022	NA	3	38.31
43	Industrial pumps, fans, and blower systems	15.3	NA	157.1	0.020	NA	2	38.14
44	Dual source heat pumps w/desuperheater	1.9	low	19.1	0.027	NA	3	37.34
45	Comm'l packaged a/c — Tier 2	2.1	NA	21.8	0.062	NA	4	36.36
46	Desiccant cooling for supermarkets	3.6	NA	36.8	0.035	NA	3	36.09
47	Infiltration reduction	15.4	227.6	385.8	0.074	0.607	2	35.32
48	High efficiency gas cooking	NA	29.8	29.8	NA	0.300	3	34.60
49	A-line halogen IR lamps	6.4	NA	65.8	0.017	NA	2	34.28
50	Very high efficiency room a/c	1.1	NA	11.3	0.077	NA	4	32.00
51	Daylight dimming controls	12.9	NA	132.8	0.041	NA	2	31.55
52	Advanced commercial window glazing	11.6	66.2	185.9	0.046	0.460	2	30.85
53	Energy Star furnaces and boilers	NA	41.8	41.8	NA	0.462	3	29.64
54	Integrated gas-fired space/water heating systems	NA	117.3	117.3	NA	0.395	2	27.77
55	Instantaneous gas water heaters	NA	66.8	66.8	NA	0.389	2	25.41
56	Ground source heat pumps w/DHW	1.8	low	18.4	0.046	NA	2	24.39

Table 3. Sample Data Sheet for Tumble-Action Clothes Washers.

Measure Name:	**High efficiency clothes washers**	
Measure Information:		
Measure description:	Tumble-action washer, commonly front-loading but can load from top	
Market sector:	RES	
End uses:	DHW	
Energy types:	ELEC, GAS	
Market segment:	NEW, REP	
Base Case Information:		
Base case description:	Vertical axis clothes washer, standard dryer	
Base case efficiency:	1.18	cf/kWh/cycle (EF)
Base case annual energy use:	1,182	kWh; 43 therms
New Measure Information:		
New measured description:	Efficient washer w/high spin speed	
New measure efficiency:	3.25	EF; 50% RMC
New measure annual energy use:	705	kWh; 22 therms
Measure life:	14	years
Savings Information:		
Electric savings/year:	477	kWh; includes dryer savings
Gas savings/year:	21	therms; includes dryer savings
Percent savings:	40%	electric; 49% gas
Feasible applications:	95%	
Likely penetration w/o initiative	Low	
Savings potential in 2010:	20.0	TWh
	118.0	TBtu gas
	323.6	TBtu total
Cost Information:		
Current measure cost:	$250-650	incremental
Projected future measure cost:	$175	
Other direct costs/savings:	$21.02	annual water and sewer savings
Cost of saved energy:	($0.018)	per kWh
	($0.406)	per therm
Data Quality Assessment	A	
Likelihood of Success		
Major market barriers:	Product availability and stocking, comfort with technology	
Effect on customer utility:	Cleaner clothes, less wear from washing	
Current activity promoting measure:	WashWise, CEE program, E Star level	
Possible exit strategies:	Controversial standard scheduled for around 2005	
Likelihood of success rating (1-5):	4	
Rationale for likelihood of success:	Significant progress has been made in addressing barriers; standards are a clear but controversial exit strategy.	
Add'l factor for future use		
Sources:		
Savings estimates:	CEE (1996); Eckman (1997)	
Cost estimates:	Maytag & Frigidaire; industry experts	
Measure life estimates:	DOE (1997)	
Other key sources:		
Principal contact(s):	Lois Gordon, PECI, 503-248-4636 Christine Egan, CEE 617-589-3949 Charlie Stephens, OOE, 503-378-4298	
Notes:	Assumes water savings of 5110 gallons per year and avoided water and sewer costs of $4.11 per 1000 gallons per Eckman (1997). Assumes new standard in 2005.	

Table 4. Impact of Weighting Factors on NEEA Measure Rankings.

	Rank		
	Base Weighting	Even Weighting	Reverse Weighting
Potential Energy Savings	0.45	0.33	0.35
Cost of Saved Energy	0.20	0.33	0.20
Likelihood of Success	0.35	0.33	0.45
Measure			
Tumble-action clothes washers	1	1	1
High-efficiency electric storage water heaters	2	2	2
Commissioning of existing buildings	3	5	5
Low energy/water residential dishwashers	4	4	4
Optimization of microelectronics HVAC systems	5	6	6
Commercial/industrial exit signs	6	3	3
Industrial pumps, fans, and blower systems	7	8	14
Residential duct sealing	8	10	10
High-efficiency packaged commerciall refrigeration equipment	9	7	8
Screw-in compact fluorescent lamps	10	22	18
Premium efficiency motors	11	11	12
Manufactured housing	12	16	11
Integrated space/water heating heat pump systems	13	23	24
Industrial air compressors	14	14	15
Residential fluorescent lighting fixtures	15	15	16

Note: These results are from the draft final report; small changes may occur in the final report.

saving measures were included in the analysis (BECo and NEEA only considered electric saving measures), and when the study was conducted (e.g. home electronics and gas heating system installation and maintenance were not included in some of the earlier studies as they have more recently caught the attention of program planners).

Use of the Screening Results

For all but the CEE study, preliminary or final results were available by the fall of 1997. In all four cases, the screening results contributed to the development of 1998 program plans as well as preliminary work to develop programs for 1999. In the case of NEEA, the screening also contributed to 1997 program plans.

For NEEP, while there was no specific policy, the screening was primarily used to eliminate low-ranked measures from near-term consideration. All of the programs NEEP has decided to implement scored 3.5 or higher on their five-point scale. However, choices between measures with scores of 3.5 of more were primarily made on the basis of utility and funder interest and timing considerations (e.g., whether a measure was ripe for action in 1997, or whether efforts could or should be postponed), with little consideration paid to whether a measure had a score of 3.5 versus 4.5. As of this writing, NEEP is now implementing or developing full-scale initiatives targeted at tumble-action clothes washers, residential lighting, premium-efficiency motors, high-efficiency commercial packaged air conditioners, improved residential air conditioning equipment efficiency and installation practices and improved building codes. Other initiatives are being considered for 1999.

Table 5. Comparison of Screening Study Results.

	Study					
Measure	CEE	PG&E	NEEA	BECo	NEEP	Summary
Commissioning existing buildings	A	A	A	A	A	5A
Low energy/water dishwashers	A	A	A	A	A	5A
Tumble-action clothes washers	A	NI	A	A	A	4A
High-effic. packaged comm'l refrigeration	B	A	A	B	A	3A,2B
Coin-op clothes washers	A	A	NI	NI	A	3A
TVs, VCRs & other home electronics	A	NI	NI	A	A	3A
Residential CFLs & fixtures	B	A	A&B	B	NI	2A,3B
Commercial building integrated design	B	B	B	A	B	1A,4B
LED traffic signals	B	A	B	B	NI	1A,3B
Commercial packaged air conditioning	B	A	NI	B	B	1A,3B
High-efficiency residential central a/c	A	B	NI	NI	A	2A,1B
Chillers & cooling towers		A		A	B	2A,1B
Dry-type distribution transformers		B		A	A	2A,1B
LED exit signs	A	NI	A	NI	NI	2A
High-efficiency electric water heaters	A	NI	A	NI	NI	2A
High-efficiency gas storage water heaters	A	A	NI	NI	NI	2A
Building code implementation & upgrades				A	A	2A
Duct sealing	B	B	A	NI	NI	1A,2B
Industrial air compressors			B	NI	A	1A,1B
Residential a/c installation & maintenance	B		NI	NI	A	1A,1B
Energy Star Homes	B	NI		A	NI	1A,1B
Motor repair					A	1A
T8 lamps/electronic ballasts	A	NI	NI	NI	NI	1A
Optimize microelectronics HVAC			A	NI	NI	1A
Industrial fans & pumps			A	NI	NI	1A
Evaporative pre-cooler for residential a/c	NI	A	NI	NI	NI	1A

Key: A = top 10 rank; B = ranked 11th-20th; Blank = ranked but not in top 20; NI = not included in study.

For PG&E, the screening exercise identified several new measures that PG&E is addressing in new 1998 initiatives, or actively investigating in 1998 for possible programs in 1999 and beyond. For example, in 1998, PG&E launched a residential energy-efficient lighting fixture program and began preliminary work on LED traffic light and "natural cooling" (primarily indirect evaporative cooling) programs. In addition, PG&E is increasing its efforts on chiller system optimization, building commissioning, integrated commercial building design, lighting controls, and efficient windows. Furthermore, in 1998 PG&E is conducting additional research and evaluation on other measures in the screening study such as low water/energy dishwashers, domestic water heaters, and integrated space/water heating heat pumps (PG&E 1997). However, PG&E's ability to develop new initiatives for 1998 is hampered by the fact that under the terms of restructuring legislation adopted in California, it is unclear whether PG&E or someone else will implement energy efficiency programs in 1998.

For BECo, their fall *1997 Energy Efficiency Plan* (BECo 1997) filed with the Massachusetts utility

commission was closely based on their screening results, with 16 out of 17 top-ranked initiatives included in their plan (one program was deemed to need additional research before a decision could be made on whether or not to pursue it). BECo is participating in many NEEP initiatives, but planning work for the other initiatives has barely begun due to broad policy questions about BECo's energy efficiency program budget which must be resolved before full implementation of BECo's plan can begin.

For NEEA, of the 20 top-ranked measures, 12 are now being pursued in some fashion. Of these, initiatives were already in place for six when the screening exercise was done (clothes washers, duct sealing, residential lamps and lighting fixtures, premium-efficiency motors, and manufactured housing), initiatives have since been adopted for three of these measures (optimization of microelectronics HVAC, industrial air compressors, and agricultural scheduling systems), planning is now underway for two additional initiatives (commissioning of new and existing buildings and industrial fan and pump systems), and one additional measure (efficient water heaters) is being promoted through active participation in the federal rulemaking to set a new minimum efficiency standard.

Issues, Lessons Learned and Recommendations

Overall, the five market transformation screening studies examined in this paper appear to have served a useful purpose by distilling large amounts of data into a format which decision-makers can consider as they make decisions on which market transformation initiatives to pursue. In particular, these studies can focus attention on high-ranked measures which decision-makers may not be fully aware of. However, in all five cases, decision-makers also considered factors not explicitly in the screening analysis, as they rightfully should, since no screening analysis can include and properly weight all factors that are relevant to a decision.

While there were many differences in the approach used in all five studies, the overall general approach was similar, in that all five studies explicitly examined potential energy savings and likelihood of success, all explicitly or implicitly examined measure cost-effectiveness, and many included one or more other factors that were germane to their decision-making processes. On the other hand, the different studies show that there is a lot of room to adapt screening methodologies to the specific needs of each organization — factors can be added or subtracted, weights varied, and pass-fail criteria added (e.g., a cost-effectiveness threshold). However, care should be used when employing pass-fail criteria, because some exceptions may be warranted. For example, a measure with a levelized cost of $0.06 or even $0.10 per kWh may be justified if it primarily saves energy during periods of peak demand when marginal energy costs can be two to three times average annual costs.

All of the studies also included a mix of objective and subjective analysis. In most of the studies, energy savings and cost-effectiveness were analyzed based on specific data and assumptions. However, underlying these calculations is substantial subjectivity, since there are many judgement calls that need to be made in making these calculations. Also, in conducting these calculations, a degree of analytic vigor is needed so that all measures are treated fairly. This rigor needs to be applied to such issues as how to fairly and consistently compare gas-, electric- and dual-fuel-saving measures and handle measures which involve switching from one fuel to another. Methods to address these issues are too detailed and technical to discuss in this paper, but are discussed at length in the PG&E and CEE screening reports (Suozzo, Nadel, Reed and Shepard 1998; Suozzo and Nadel 1998).

In all of the studies reviewed, likelihood of success was a particularly important factor, as none of the programs now being pursued received a likelihood of success rating of poor or fair (e.g., 1 or 2). Likelihood of success is inherently a subjective assessment. Increasingly, guidelines are being developed

to help guide these judgements. Also, due to the subjective nature of these judgements, it is important to explicitly provide the rationales used to make these judgements, and to subject the judgements and rationales to review by knowledgeable experts.

Another issue that faces screening analysts is the degree to which related measures should be aggregated or disaggregated. As measures are disaggregated, they become easier to analyze, but as measures are aggregated, their savings generally increase (because two measures will generally save more energy than either one alone). Also, in implementing programs, it sometimes makes sense to combine several related measures in a single initiative (such as high-efficiency air conditioners and improved air conditioner installation practices). At other times it makes sense to implement a measure in pieces, targeting first some market segments before proceeding to others. There is no simple answer to these questions — measure-specific judgement calls must be made. Decision-makers need to understand how these judgements can affect screening results. And they also need to realize that even though two measures are screened separately or together, when programs are actually implemented in the field, different judgements can be made.

In sum, screening is a mixture of both art and science. There is no single correct screening score for a measure. Screening will not make decisions, but screening can be an important aid to decision-making, particularly when decision-makers understand the strengths and weaknesses of the screening exercises they are asked to review.

Finally, the large amount of consistency across studies indicate substantial opportunities for national and regional coordination on market transformation initiatives. Of the twelve measures that were high-ranked in all of the studies that included them, comprehensive national and regional initiatives are underway for four (residential clothes washers, commercial packaged air conditioners, residential central air conditioners and residential compact fluorescent lamps and fixtures), and emerging efforts built around Energy Star have begun for two (residential dishwashers and home electronics). The remaining six of these measures (commissioning existing buildings, packaged commercial refrigeration equipment, coin-op clothes washers, commercial building integrated design, LED traffic signals and residential duct sealing) are the subject of some activity (Suozzo and Nadel 1998) but merit additional attention.

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