Optimal ENERGY Integrated Energy Resources

DSM Economics

For the Efficiency Maine Trust – October 15, 2009

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DSM Economics - Overview

- Why?
- Basics of Economics
  - Benefits
  - Costs
- Economic Test Overviews
- Economics of Sample DSM Programs
- Ongoing Cost-Effectiveness Issues
- Exercise – do a benefit/cost analysis of your program

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What is Cost-Effectiveness?

- Measures the relative performance or economic attractiveness of an energy efficiency investment compared to a baseline of not making the investment.
- Compares the present value of costs & benefits of efficient equipment with those of baseline (non-efficient) equipment.

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Why Do We Check?

- Failing to pass a cost-effectiveness test indicates that the efficiency technology, strategy, or program
  - Fails to improve a customer's financial position;
  - Increases overall energy costs to ratepayers
  - Lowers society's economic well-being
- Consequently, it's generally required

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Avoided Costs of Energy

- Represents estimates of current and future costs for energy *on the margin*
  - If considering DSM as an alternative to new supply, consider the new "supply" cost in lieu of avoided costs
- Avoided cost components typically include:
  - Generation (electric) or commodity (gas) energy
  - Peak capacity
  - Transmission and Delivery capacity
  - Above typically for different periods (e.g., summer on-peak/winter off-peak for electric, flip for gas)

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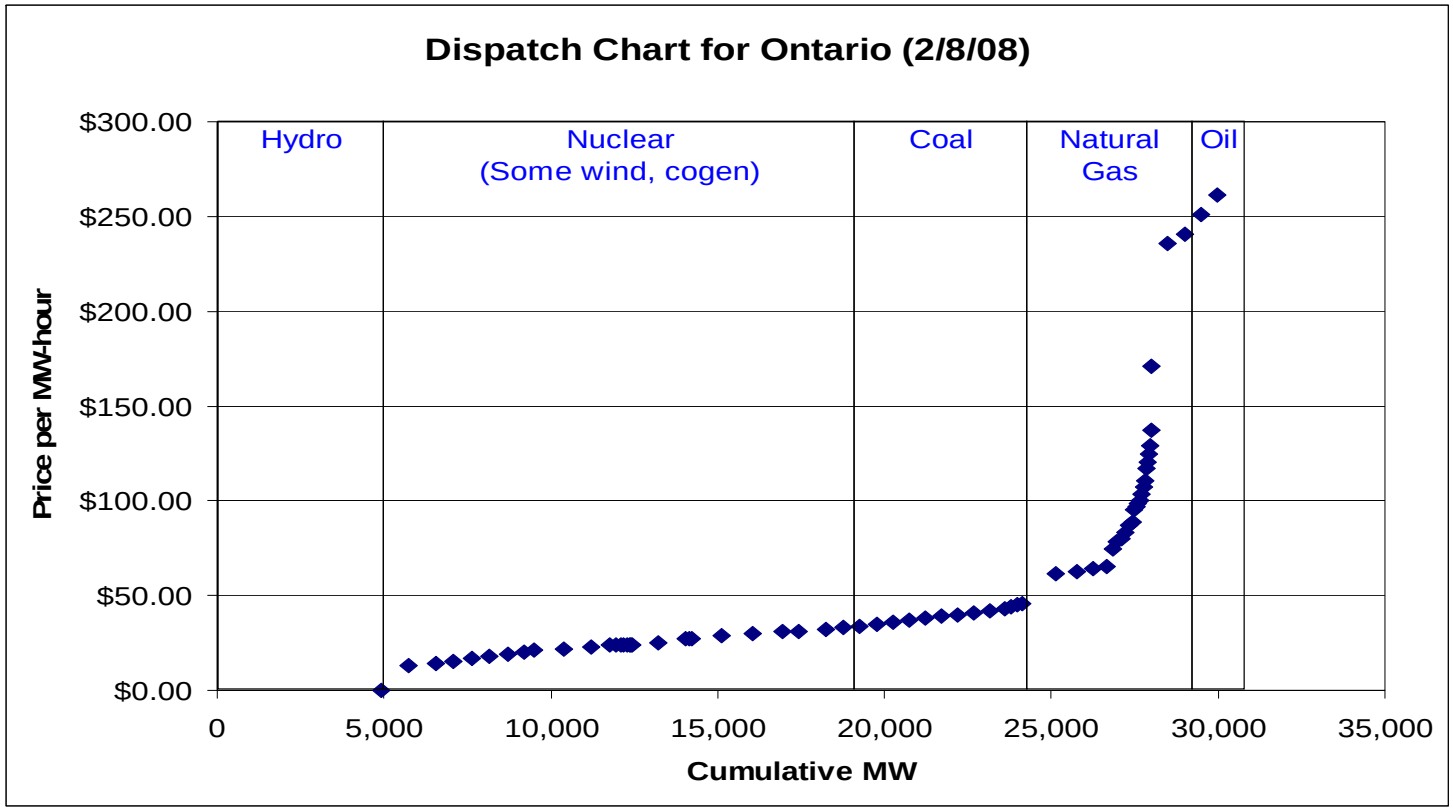
Why Look on the Margin?



Source: PowerLytix.com (February 8, 2008)

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Avoided Cost Inputs - Electric

- Avoided energy costs
  - Cost of fuel and O&M for power plants, T&D
  - At generation (or at the system boundary)
  - By energy period (season, peak/off-peak)
- Avoided capacity costs
  - Cost of building power plants, T&D systems
  - Demand (summer and/or winter)
  - Transmission & Distribution

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Valuing Maine's Efficiency Resources

- For 2010, avoided energy costs, including Demand Reduction Induced Price Effects (DRIPE), are:
  - Winter peak = 13.7 cents/kWh
  - Winter off peak = 9.8 cents/kWh
  - Summer peak =14.4 cents/kWh
  - Summer off-peak = 9.9 cents/kWh
  - Avoided externality costs are about 4 cents/kWh, regardless of period.
  - Avoided capacity costs are $65.84 per kW-yr for 2010.

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Valuing Efficiency Resources

- Electric Benefits = $\sum_{P}\left(kWh_p \bullet EAV_p\right)+\sum_{S}\left(kW_s \bullet PAV_S\right)$
  - Where: kWh_p = energy savings in period p
    EAV_p = energy avoided costs in period p
    kW_s = coincident peak demand savings in season s
    PAV_s = peak capacity avoided costs in season s
    (Σ generation, transmission and distribution capacity costs)
- Fossil Benefits
  - Replace kWh with DTh or Btu
  - EAV expressed in $/DTh or Btu

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Valuing Efficiency Resources

- Typical components include:
  - Electricity savings
  - Fossil fuel savings
  - Water savings
  - Non-resource benefits

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Costs of Efficiency Resources

- Costs include
  - All costs associated with installation of efficiency measures
  - All costs associated with programs
  - Any other increased costs (e.g., increased fossil use from lighting efficiency)
    - Though these could be counted as negative impacts on benefits …

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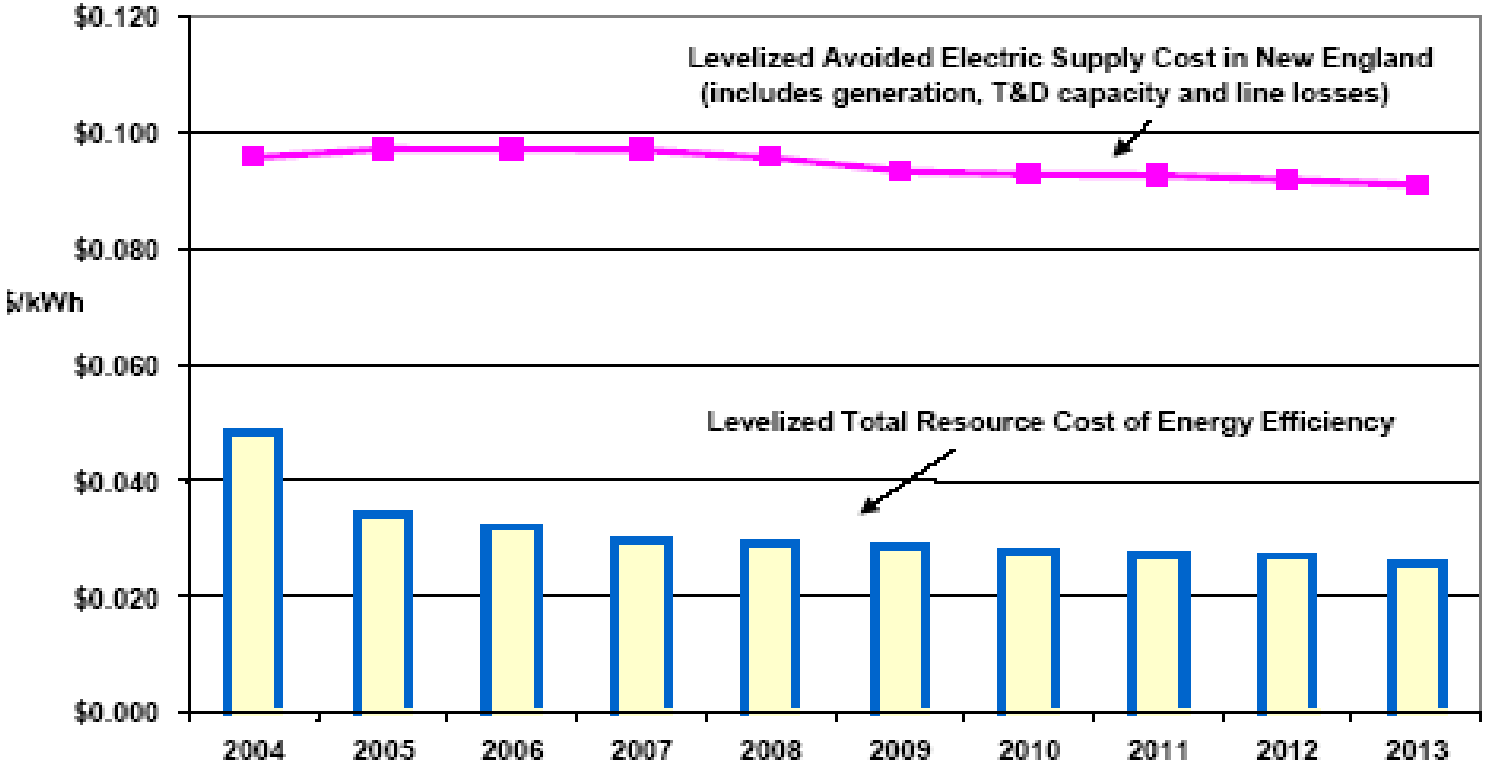
Calculating Levelized Costs

- Need to know
  - Cost
  - Savings
  - Duration of savings
  - Discount rate (real)
- Two ways to calculate

Sample Commercial Lighting Controls Project				Levelized Cost		
Cost	$	25,000.00	(A)	(A)/(C) =	$	0.0308
Savings (kWh/yr)		100,000	(B)	(D)/(B) =	$	0.0308
Life		10				
Discount Rate		5%				
Energy Present Value		810,782	(C)	NPV of 10 years of kWh savings		
Annual Project Payment	$	3,083.44	(D)	PMT for $25,000 over 10 years		

Efficiency vs. New England Marginal Electric Costs

Figure 5: Energy Efficiency is 67% Cheaper Than Supply



Source: Optimal Energy, *Economically Achievable Energy Potential in New England*, Published by NEEP, May 2005

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Economic Tests

- California Standard Practices Manual
- Cost-effectiveness Metrics
- Cost-effectiveness Tests
- Sample Programs

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California Standard Practices Manual (SPM)

- California Standard Practice Manual: Economic Analysis Of Demand-Side Programs And Projects (July 2002)
- Developed in 1983, revised every several years
- Specifies 4 cost-effectiveness tests
  - Identifies strengths and weaknesses of each
  - Provides generic calculations

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Cost-effectiveness Metrics

- Net Benefits ≥ 0

  Net Benefits = Gross Benefits – Gross Costs

- Benefit/Cost Ratio ≥ 1

$$BCR = \frac{\text{Gross Benefits}}{\text{Gross Costs}}$$

- Levelized cost (Less than avoided costs or rates)
  - $/kWh or $/DTh saved
  - $/kW reduced

Easy to relate to the cost of energy

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Cost-effectiveness Levels

- Measure level
  - Super T8 lighting retrofit, VFDs, etc.
- Program level
  - Commercial Retrofit, Residential Appliances, Low Income, Fuel Substitution, etc.
- Sector
  - Residential / Commercial / Industrial
- Portfolio – EMaine or Triennial Plan

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Cost-effectiveness Perspectives

- Electric and/or Gas Utility (Program Administrator)
- Society (Total Resource)
- Ratepayer
- Program Participant

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Cost-effectiveness Tests

	TRC/ Societal	Utility	Rate-payer	Partici-pant
Avoided energy costs (fuel, O&M of power plants and T&D lines)	Benefit	Benefit	Benefit	
Avoided capacity costs (constructing power plants, T&D lines, pipelines)	Benefit	Benefit	Benefit	
Participants' incremental cost (above baseline) of efficient equipment	Cost			Cost
Incentives (rebates)	Transfer	Cost	Cost	Benefit
Program administration costs (staff, marketing, evaluation, etc.)	Cost	Cost	Cost	
Other benefits (fossil fuel savings, water savings, equipment O&M, etc.)	Benefit (Cost)			Benefit (Cost)
Externalities (e.g., environmental benefits like emissions reductions)	**Benefit**			
Lost utility revenue / lower energy bills (due to lower sales)	Transfer		Cost	Benefit

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Discounting

- Real Discount Rate (RDR)
  - Discount future costs/benefits to one year
  - Reflects the time value of money (not inflation)
- Nominal Discount Rate (NDR)
  - Includes inflation
  - NDR = (1 + RDR)(1 + InflRate) - 1
- All inputs & outputs in one year's dollars
  - Use RDR for all discounting
  - Easier to interpret results

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Line Losses - Electric

- Savings inputs are at meter, avoided energy/capacity costs are at generation
- Can distinguish by sector and energy period

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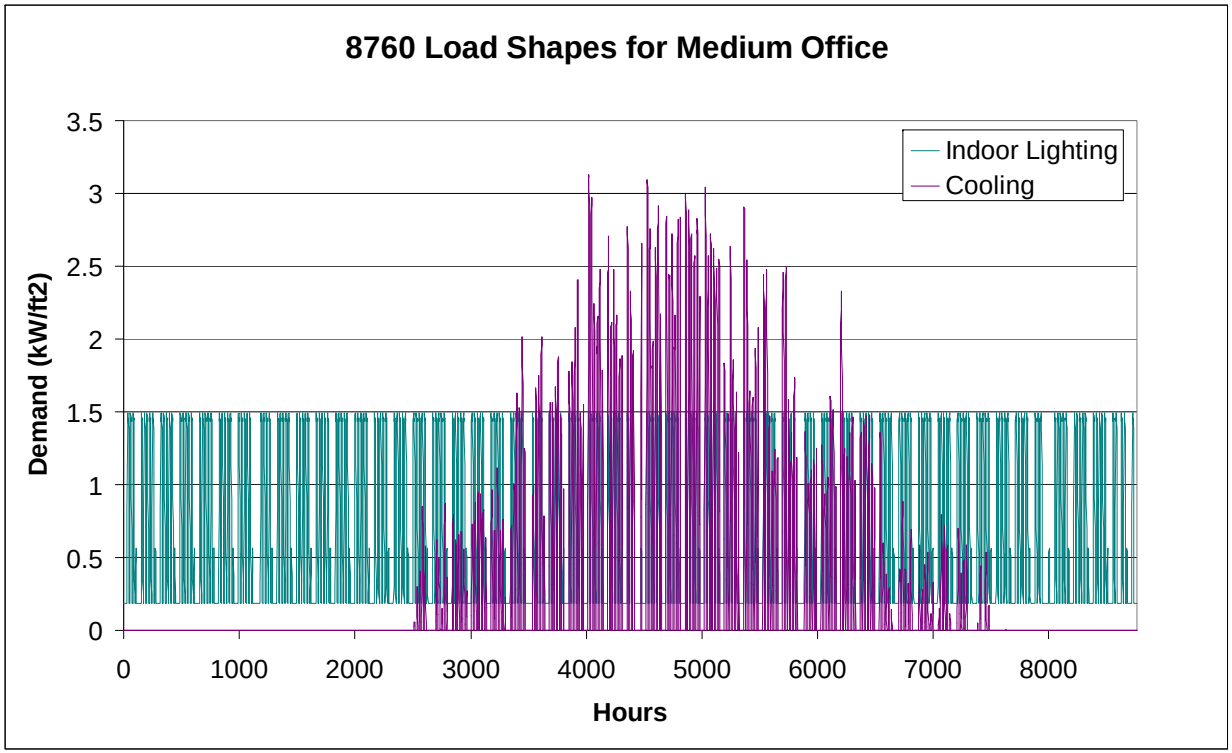
Loadshapes – Examples



- Distribute annual savings by energy period
- Generally by end use and building type
- Can derive from hourly 8760 usage data
- Specific to geographic region & climate

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Efficiency Measure Inputs

- Measure life
- Incremental installed cost
  - Cost above baseline equipment
- Incentive (rebate)
- Annual energy savings (at meter)
- Peak demand reduction (at meter)

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Measure Penetrations

- Participants in the program
- Free rider rate (FR)
  - % who would have implemented an efficiency measure even without the program
- Spillover ("free driver") rate (SO)
  - % who implement the measure due to the program but never collect the incentive
- Net measures = Participants * (1–FR+SO)

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Emissions Credits and Trading

- Monetary benefit for Utility & Ratepayer
- Monetized value of specific externalities for Societal Test
  - Account separately for greenhouse gases, other emissions, and other externalities
- No established “best practice” as yet

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Maine - Chapter 380

- Modified Societal Test:
  - Programs that are reasonably likely to satisfy the Modified Societal Test are cost effective.
  - The Modified Societal Test is satisfied when the program benefits exceed the program costs.
  - Costs and benefits shall be considered in the Modified Societal Test regardless of whether they are paid or experienced by the participant, the Conservation Program Fund, or any other individual, business, **or government agency**.

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Maine - Program Benefits

- **Avoided electric generation costs** including energy and capacity costs, using estimates of market prices and adjusting for line losses. These estimates may be differentiated by time periods that influence market prices, including but not limited to peak and off-peak periods and summer and winter periods;
- **Avoided transmission and distribution costs**, using estimates of transmission and distribution utility marginal transmission and distribution costs. These estimates may be differentiated by time periods that influence costs;
- **Avoided fossil fuel costs**, using estimated savings in oil, gas or other fossil fuel use, at estimated fossil fuel prices;
- **Other resource benefits**, such as reduced water and sewer costs;
- **Non-resource benefits**, including customer benefits such as reduced operation and maintenance costs, deferred replacement costs, productivity improvements, economic development benefits and environmental benefits, to the extent such benefits can be reasonably quantified and valued.

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Maine - Program Costs

- Direct program costs, including program design, administration, implementation, marketing, evaluation and other reasonably identifiable costs directly associated with the program.
- Measure costs. For new construction or replacement programs, measure costs are the incremental costs of the energy efficiency measure, including installation, over an equivalent baseline measure. For retrofit programs, measure costs are the full cost of the energy efficiency measure, including installation, less any salvage for the replaced measure.
- Ongoing customer costs, including costs such as increased operation and maintenance costs, reduced productivity, and lost economic development opportunities, to the extent such costs can be reasonably quantified and valued.

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Maine - Other Considerations

- **Discount rate assumption**. The discount rate used for present value calculations shall be the current yield of long-term (10 years or longer) U.S. Treasury securities, adjusted for inflation. The Commission may consider an alternative discount rate when characteristics of a program are inconsistent with use of long-term U.S. Treasury securities.

- **Net present value**. Cost effectiveness of an energy efficiency measure will be calculated based on the net present value of the costs and benefits over the expected life of the measure.

- **Post-program effects**. For those programs that are expected to influence the development of self-sustaining markets, program cost effectiveness will be calculated for a reasonable additional period after the program is terminated in order to capture post-program market effects.

- **Incentive Level Limitation**. When developing a program that satisfies the Modified Societal Test, the Commission shall, when setting incentive levels, consider the value of the program savings associated with electrical production and delivery.

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Sample DSM Program: Residential Lighting & Appliances

- Budget of $1,000,000/year
- Review
  - Economic and measure inputs
  - Annual savings
  - Economic test outputs

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Sample DSM Program: Economic Inputs

Economic Inputs

	2007	First year of analysis (all inputs/outputs in this year's $)
	3.00%	Real Discount Rate
$	0.07	Avoided cost of energy at generation ($/kWh)
$	50	Avoided capacity cost: demand at gen., T&D ($/kW-yr)
	7.0%	Line loss factor (% of meter)
$	0.09	Electric rate at meter ($/kWh)
	0.830	CO2 emissions impact (metric tons/MWh)
$	10	CO2 credit ($/metric ton)
$	0.01	Non-CO2 externalities ($/kWh)

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Sample DSM Program: Measure Inputs

Measure Inputs (can be program weighted average)	
9	Measure life
$ 2,000,000	Incremental installed cost (over baseline equipment)
$ 600,000	Incentive (rebate)
6,000,000	Annual energy savings at meter (kWh/yr)
1,000.0	Annual peak demand reduction at meter (kW-yr)
15%	Free rider rate
5%	Spillover rate

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Sample DSM Program: Annual Savings

Annual Savings for Each Install Year			
		2007	2008
Annual Savings at generation (kWh)	6,000,000 kWh * line loss * (free rider + spillover)	5,778,000	5,778,000
Peak Reduction at generation (kW)		963	963
CO2 reduction (metric tons)		4,795.7	4,795.7

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Sample DSM Program: Costs & Benefits

Costs and Benefits (discounted) for Each Install Year		2007	2008
Program Costs (non-incentive)		$ 400,000	$ 388,350
Incentives		$ 600,000	$ 582,524
Incremental installed costs		$ 2,000,000	$ 1,941,748
Avoided energy costs (measure life)	NPV of 5,778,000 kWh * $.07 for 9 years in 2007 and 2008)	$ 3,243,645	$ 3,149,170
Avoided capacity costs (measure life)	NPV of 963 kW * $50 for 9 years in 2007 and 2008)	$ 386,148	$ 374,901
Lost revenue / bill reductions	NPV of 5,400,000 kWh * $.09 for 9 years in 2007 and 2008)	$ 3,897,570	$ 3,874,049
CO2 reduction credits	NPV of 5,778 MWh * .83 tons/MWh * $10/ton for 9 years in 2007 and 2008	$ 384,604	$ 373,402
Other externalities benefit	NPV of 5,778,000 kWh * $.01/kWh for 9 years in 2007 and 2008	$ 463,378	$ 449,881

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Sample DSM Program:
Societal Test

Costs and Benefits (Discounted, 2007$) for Each Install Year

	2007	2008	2009	2010
Program costs (non-incentive)	**$ 400,000**	$ 388,350	$ -	$ -
Incentives (rebates)	$ 600,000	$ 582,524	$ -	$ -
Incremental installed costs	**$ 2,000,000**	$ 1,941,748	$ -	$ -
Avoided energy costs (measure life)	**$ 3,243,645**	$ 3,149,170	$ -	$ -
Avoided capacity costs (measure life)	**$ 386,148**	$ 374,901	$ -	$ -
Lost revenue / bill reductions	$ 3,897,570	$ 3,784,049	$ -	$ -
CO2 reduction credits	**$ 384,604**	$ 373,402	$ -	$ -
Other externalities benefit	**$ 463,378**	$ 449,881	$ -	$ -

Cost-effectiveness (Program Year 1)

	Costs	Benefits	Net Benefits	BCR
Societal Test	**$ 2,400,000**	**$ 4,477,774**	$ 2,077,774	1.87
Total Resource Cost (TRC) Test	$ 2,400,000	$ 4,014,396	$ 1,614,396	1.67
Utility (Program Admin.) Test	$ 1,000,000	$ 4,014,396	$ 3,014,396	4.01
Ratepayer Test	$ 4,897,570	$ 4,014,396	$ (883,174)	0.82
Participant Test	$ 2,000,000	$ 4,497,570	$ 2,497,570	2.25

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Sample DSM Program: Total Resource Cost (TRC) Test

Costs and Benefits (Discounted, 2007$) for Each Install Year

	2007	2008	2009	2010
Program costs (non-incentive)	**$ 400,000**	$ 388,350	$ -	$ -
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Sample DSM Program: Utility Test

Costs and Benefits (Discounted, 2007$) for Each Install Year

	2007	2008	2009	2010
Program costs (non-incentive)	**$ 400,000**	$ 388,350	$ -	$ -
Incentives (rebates)	**$ 600,000**	$ 582,524	$ -	$ -
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Sample DSM Program: Ratepayer Test

Costs and Benefits (Discounted, 2007$) for Each Install Year

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Sample DSM Program: Participant Test

Costs and Benefits (Discounted, 2007$) for Each Install Year

	2007	2008	2009	2010
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Slides for Handout

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Utility (Program Administrator) Test

- Asks:
  - Are the utility's revenue requirements lowered?
- Costs:
  - Program costs to utility (incentive and non-incentive)
- Benefits:
  - Avoided energy & capacity costs
- Pass the test
  - (Avoided Costs + Other Utility Savings) - (Incentive Costs + Other Utility Costs) > 0
- Revenue shifts are considered a transfer payment between participants and all ratepayers

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Utility (Program Administrator) Test

- Strengths
  - Doesn't include revenue shifts, so test results are not complicated by uncertainties of long-term rate projections
  - Costs are defined similarly to those of supply-side projects (no direct customer costs)
- Weaknesses
  - Reflects only a portion of the full costs
  - Rate impacts are not captured (as for Societal)

Societal/Total Resource Test

- Asks:
  - Is total resource or societal efficiency improved?
- Costs:
  - Resource/program costs to utilities & participants
- Benefits:
  - Avoided energy & capacity costs to utilities and participants
  - Externalities (for Societal Test, not TRC)
- Transfers between parties not included
  - Incentives (rebates)
  - Lower energy bills / lost utility revenue

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Societal/TRC Test

- Variant of Total Resource Cost (TRC) Test
  - Societal Test includes externalities (e.g., reduced emissions, increased productivity, national security)
- Emissions Markets Shift Test
  - As carbon credit values or taxes are used in economic analysis, their benefits move from societal to TRC tests.

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Societal/TRC Test

- Pass the test if benefits exceed costs
  - (Avoided Costs + Savings + Externalities) - (Program + Measure Costs) > 0
- If a program passes the Societal (or TRC) test, it's likely to improve economic efficiency
- Societal test can use a different (societal) discount rate
- Often considered the most appropriate single test

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Societal/TRC Test

- Strengths
  - Scope (total costs & benefits)
  - Can be used to compare demand- and supply-side options (if supply-side analysis includes total costs of generation & transmission)
- Weaknesses
  - Does not include the effect of revenue reduction, which is an effect of DSM programs
  - Includes participant costs, which are not included in supply-side options

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Ratepayer Impact Measure (RIM) Test

- Asks:
  - Are rates lowered or raised?
- Costs:
  - Program costs to utility (incentive and non-incentive)
  - Lost utility revenue (due to savings)
- Benefits:
  - Avoided energy & capacity costs
- Pass the test
  - (Avoided Costs) - (Utility Costs + Lost Revenue) > 0

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RIM Test

- Also known as “Non-Participant Test”
- Measures impact on customer rates due to changes in utility revenues & operating costs
- Results often expressed as lifecycle revenue impacts ($/kWh, $/kW, $/DTh)
  - The one-time change in rates over the program life to meet new revenue requirements
  - Can be expressed as $/customer

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RIM Test

- Strengths
  - Includes revenue shift due to DSM program, which (under some conditions) ratepayers must make up
- Weaknesses
  - Very sensitive to differences in long-term projections of marginal costs and rates (difficult to quantify)
  - Doesn't account for interactive effect of reduced energy demand on longer-term rates and customer bills
- People have moved away from the RIM test due to its limitations

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Participant Test

- Asks:
  - Is the participant better off?
- Costs:
  - Costs to participants (incremental costs of installing efficient equipment over baseline equipment)
- Benefits:
  - Incentives (rebates)
  - Bill savings (electric, fossil fuel, water)
  - O&M savings
- Pass the test
  - (Incentives + Bill Savings + Other Participant Savings) - (Incremental Measure Costs) > 0

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Participant Test

- Strengths
  - Indicator of desirability of program to customers
  - Useful input for designing appropriate incentives and participation goals
- Weaknesses
  - Many customers choose to participate for non-quantifiable benefits not captured by the test
  - Requires considerable judgment to interpret results