

Deep Energy Retrofits (DEEPER) for Massachusetts Housing

Analysis Results of
Cost Effective Improvement Packages

Presented to

Massachusetts Energy Efficiency Advisory
Council

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Summary of Presentation

- Goals/Objectives
- Key Findings
- Methodology
- Baseline Home Descriptions
- Customer Economics examples
- Customer Economics and TRC Results Tables
- Observations

Goals/Objectives

- Deep savings in existing homes will be critical to meeting State climate goals
 - Governor's Zero Net Energy Buildings Task Force recommendations
- Determine maximum savings from deep energy retrofits within current TRC cost-effectiveness constraints
- Develop cost-effective packages of energy savings and renewables for three residential home types
 - Single family detached (SFD)
 - Triple decker
 - Six unit, two story, multifamily house
- Use results to inform on-going PA's Deep Energy Retrofit pilot and policy discussions on deep energy retrofit activities

Key Findings

- **40-81%** overall savings; **40-74%** for efficiency only
- Nearly all packages pass TRC test when federal tax incentives included
 - Most non-energy costs not included
 - Non-energy benefits (NEBs) also excluded
- Packages produce net lifetime savings for home owner when PA, state and federal incentives and tax credits included
- Consumer economics are sensitive to interest rate and fuel escalation rate assumptions
 - **Base case:** 5% interest rate and 2% fuel escalation

Methodology

- Develop representative baseline home models
- Identify and develop improvement measures
- Model baseline homes, improvement measures, and packages using REM Rate software
 - Efficiency (thermal and mechanical) package
 - Efficiency + solar domestic hot water (DHW) package
 - Efficiency + photovoltaic (PV) package
 - Efficiency + solar DHW + PV package
- Quantify energy and cost impacts of measures & packages
- Screen measures and packages for TRC BCR
- Develop customer economics scenarios

Baseline Home Descriptions

Housing Types Modeled Baseline Characteristics	Cond'd Floor Area (sq ft)	Annual Energy Consump (MMBtu)	Total kWh (includes cooling)	Heating (MMBtu)	Cooling (kWh)	DHW (MMBtu)	HERS Index
Single Family Detached (uncon'd bsmt) 1960s era, 2 story	2,096	179	11,692	111	1,903	27	120
Triple Decker (uncon'd bsmt) 1930s era, not insulated	5,136	547	14,559	458	2,676	39	146
Multi Family 6-plex (slab) 1960s era, 3x2-story	5,166	361	41,754	218	2,645	54	104

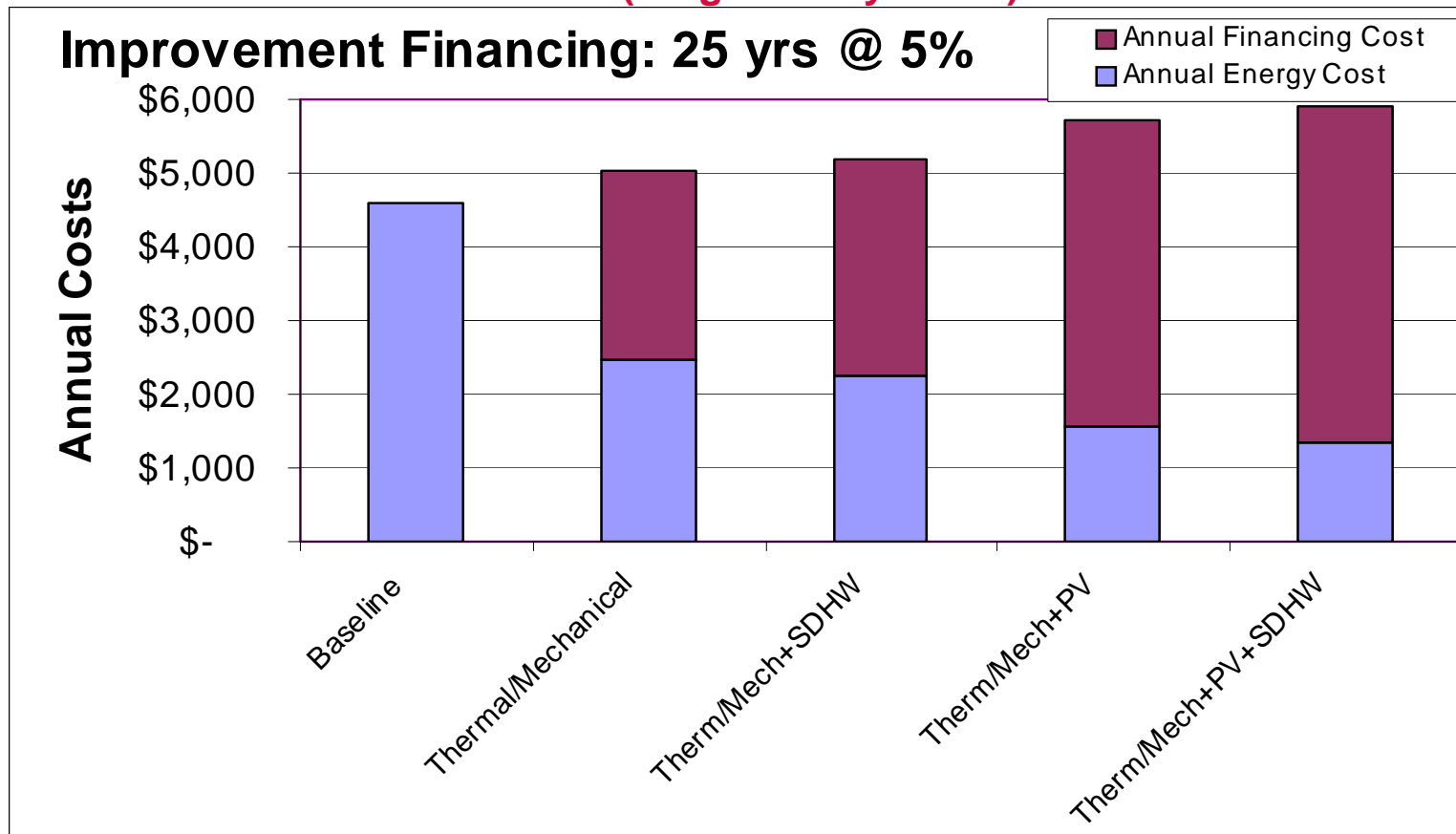
Reference homes modeled to data from 2009 RASS study, and 2006 RLW potential study

Customer Economics Single Family Detached Examples

- **Example 1:** Federal tax credits only – 5% financing
- **Example 2:** PA incentives (75% of efficiency measures up to \$42K); \$3/watt state PV incentive & Federal tax credits – 5% financing
- **Example 3:** Federal tax credits only – 0% financing

Customer Economics

Federal tax credits only – 5% Financing
Energy Efficiency Improvement costs only
(Single family home)





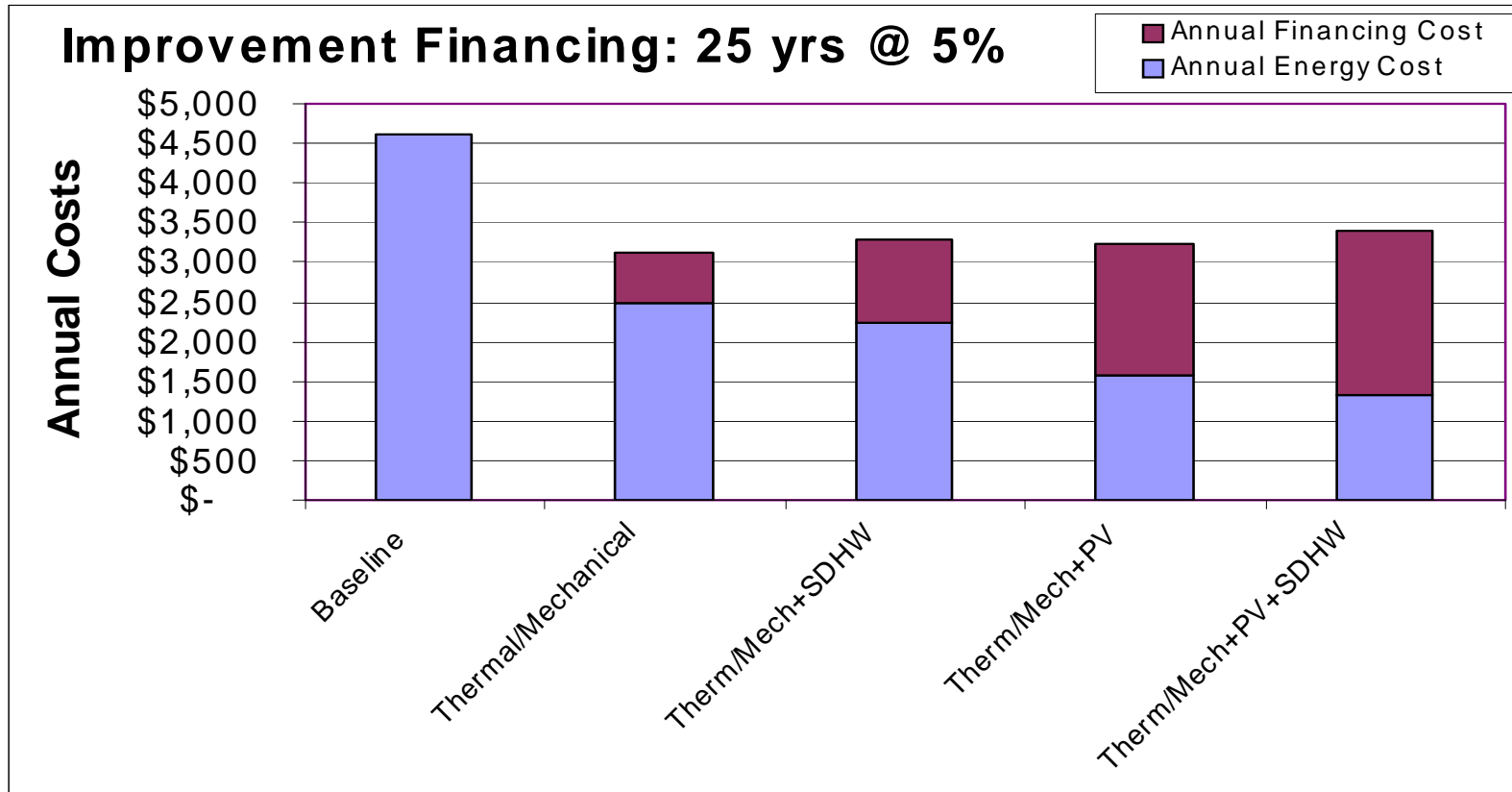
Customer Economics

with State and PA Incentives & Federal tax credits – 5% Financing

75% of energy efficiency related improvement costs, capped at \$42k

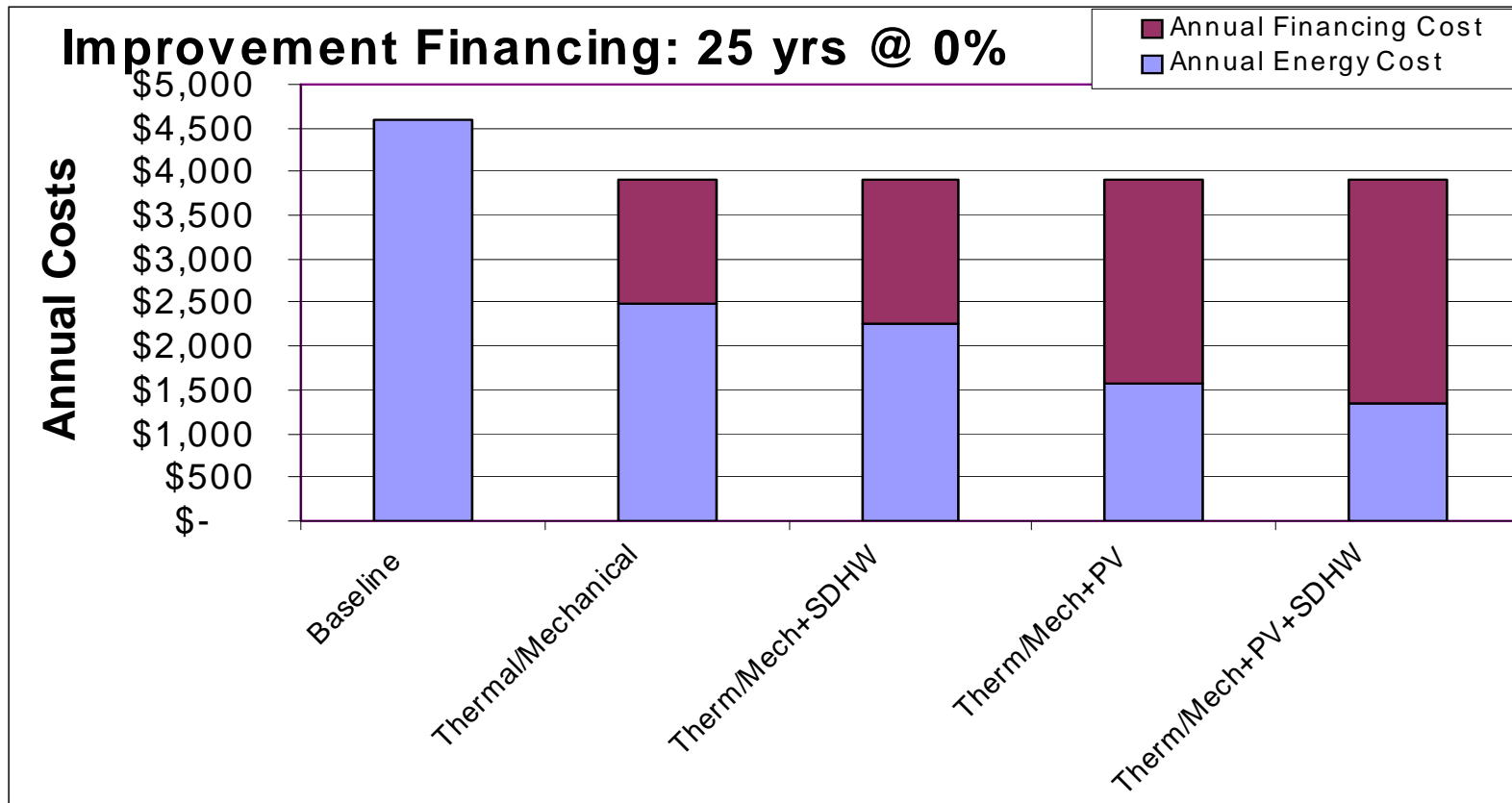
\$3.00/watt state PV incentive, plus federal tax credits

(Single family home)

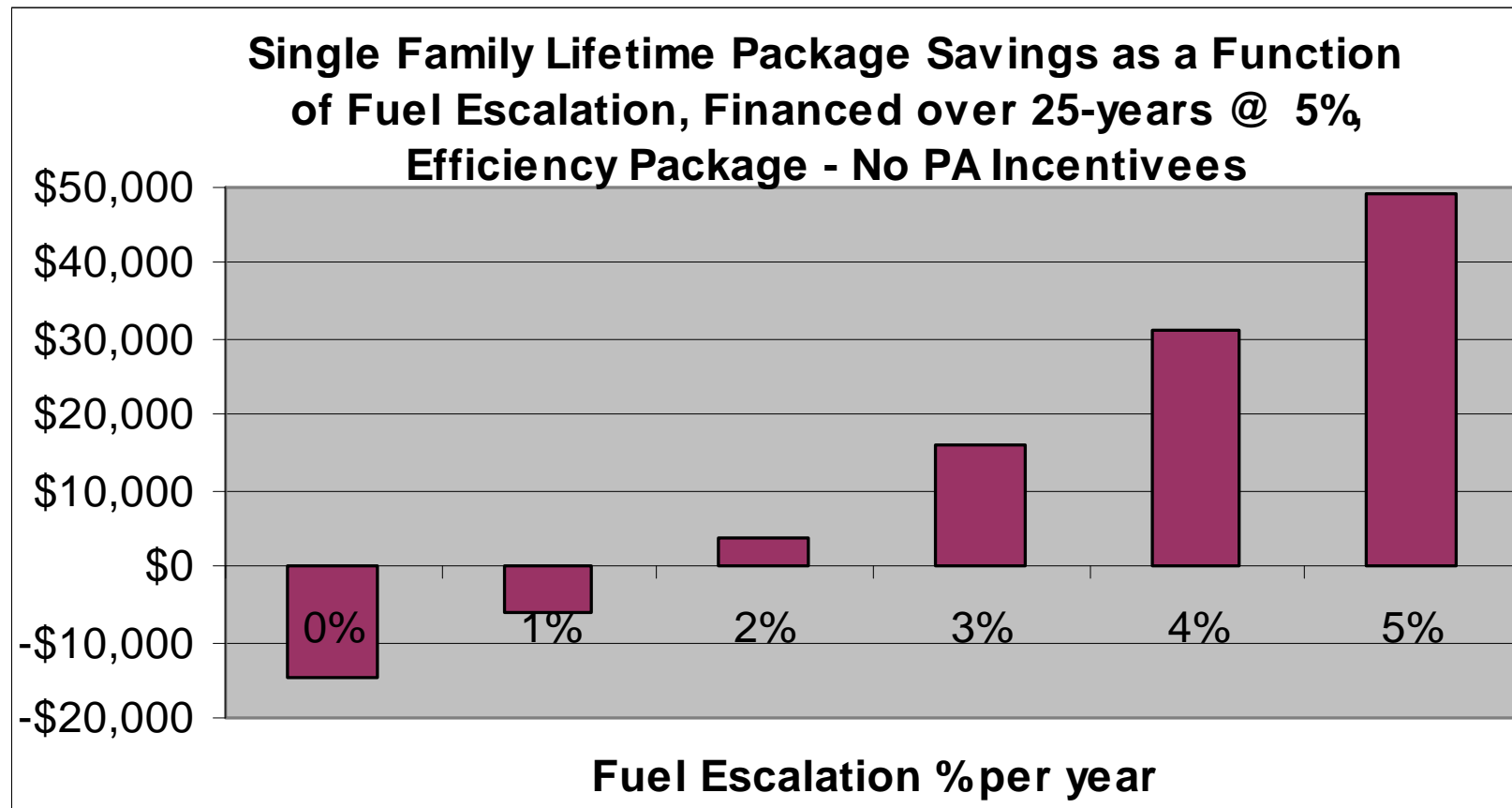


Customer Economics

Federal tax credits only - 0% Financing
Energy Efficiency Improvement costs only
(Single family home)



Consumer Fuel Escalation/Savings Threshold



Summary of Package TRC BCRs and Consumer Economics for Three Building Types

- Nearly all packages pass TRC test when federal tax incentives are included
 - 0.96 – 1.39 BCR
 - Most non-energy costs not included
 - Non-energy benefits (NEBs) also excluded
- TRC package costs reduced by federal tax credit amounts as per DPU order
- PA and state PV incentives do NOT affect TRC results
- MMBtu savings are at site - kWh savings do not reflect generation plant conversion efficiencies

Single Family Detached Packages	Package Installation Cost	Customer Costs*	Savings Over Baseline (% MMBtu)	Net Lifetime Package Savings ‡	% better than IECC06 UA/Cost**	TRC BCR***
Package One, Thermal/Mechanical (T/M)	\$37,306	\$8,952	58%	\$53,932	29.1 / 25	1.28
Package Two, T/M+SDHW	\$45,306	\$14,552	65%	\$51,579	29.1 / 31.8	1.18
Package Three, T/M+PV	\$69,906	\$23,372	68%	\$58,160	29.1 / 51.9	1.11
Package Four, T/M+SDHW+PV	\$77,906	\$28,972	75%	\$55,807	29.1 / 58.8	1.07

*includes federal, state, and PA incentives for efficiency improvements and renewables. Non-Energy improvement costs are not included in package costs except for ventilation

**Code compliance can be measured by either energy (UA) or cost performance

***Screening results assume early retirement of appliances where applicable

‡Net lifetime package savings include financing cost and 2% energy escalation

Triple Decker Packages	Package Installation Cost	Customer Costs *	Savings Over Baseline (% MMBtu)	Net Lifetime Package Savings ‡	% better than IECC06 UA/Cost**	TRC BCR***
Package One, Thermal/Mechanical (T/M)	\$105,801	\$63,801	74%	\$134,206	29.4 / 35.4	1.32
Package Two, T/M+SDHW	\$121,801	\$75,001	76%	\$121,352	29.4 / 38.6	1.23
Package Three, T/M+PV	\$154,701	\$85,431	79%	\$140,547	29.4 / 56.5	1.19
Package Four, T/M+SDHW+PV	\$170,701	\$96,631	81%	\$127,447	29.4 / 60.3	1.13

*includes federal, state, and PA incentives for efficiency improvements and renewables. Non-Energy improvement costs are not included in package costs except for ventilation

**Code compliance can be measured by either energy (UA) or cost performance

***Screening results assume early retirement of appliances where applicable

‡Net lifetime package savings include financing cost and 2% energy escalation

Multi Family Packages	Package Installation Cost	Customer Costs *	Savings Over Baseline (% MMBtu)	Net Lifetime Package Savings ‡	% better than IECC06 UA/Cost**	TRC BCR***
Package One, Thermal/Mechanical (T/M)	\$81,204	\$29,905	40%	\$108,852	28.6 / 23.4	1.05
Package Two, T/M+SDHW	\$118,704	\$56,155	53%	\$90,639	28.6 / 33.3	1.39
Package Three, T/M+PV	\$179,004	\$73,165	54%	\$121,535	28.6 / 55.7	0.96
Package Four, T/M+SDHW+PV	\$216,504	\$99,415	67%	\$103,322	28.6 / 65.6	1.18

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Observations

- Which non-energy benefits and costs to consider in customer and utility economics
- Questions as to how long to value savings
 - Many measures last 50+ yrs
 - Typical program screening is 20 years
- Longer the analysis, the greater the uncertainty as to fuel escalation
- Even with generous PA, state and federal incentives, deepest retrofits will be costly
- What type of financing mechanisms might work best for large residential efficiency and renewable investments?
 - On utility bill
 - On property tax bill
 - State revolving loan fund
 - State guaranteed mortgage write down program