California's Experience in Incorporating Non-Energy Benefits into Cost-Effectiveness Tests

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Presentation Overview

1. Introduction and Definitions
2. Low Income Energy Efficiency
3. Energy Efficiency and Demand Response
4. Recent developments

The *Standard Practice Manual* (SPM)

- Developed to measure the cost-effectiveness of Energy Efficiency programs; now used for Demand Response and Distributed Generation programs as well
- Use four tests to measure cost-effectiveness from four perspectives:
  - *"Society"*: The Total Resource Cost (TRC) test

    "Society" is actually Utility + Participant
  - *Program Administrator*: The Program Administrator (PAC) test
  - *Ratepayers*: The Ratepayer Impact Measure (RIM) test
  - *Participant*: The Participant Test
- The SPM also describes the "Societal Test," a variant of the TRC that includes externalities and uses a social discount rate.

What are demand-side programs?

- Energy Efficiency
- Low Income Energy Efficiency
  (Energy Savings Assistance or ESA Program)
- Demand Response
- Distributed Generation

California Energy Policy

- The State of California Energy Action Plan II (2005) describes a “loading order.”
- Identifies energy efficiency and demand response as the State’s preferred means of meeting growing energy needs; After cost-effective EE and DR, renewables.
- CA has 33% by 2020 renewables portfolio standard
- CA also requires GHG reductions

Non-Energy Benefits

- Participant NEBs accrue to program participants (e.g., increased property values, decreased water and sewer bills, increased comfort, health and safety).
- Utility NEBs are realized as indirect costs or savings to the utility (e.g., bill payment improvements, fewer service calls).
- Societal NEBs represent indirect program effects which accrue to society at large (e.g., job creation, reduced emissions and health care costs, other environmental benefits).

  There also may be non-energy costs, although many of these are included in value of service lost and transaction costs (which are estimated for Demand Response programs).

Cost and Benefits Used

	EE/DG TRC	EE/DG PAC	DR TRC	DR PAC	RIM	DR Participant	ESAP TRC	ESAP MPT (participant)	ESAP UCT
Administrative costs	COST	COST	COST	COST	COST		COST	COST	COST
Avoided costs of supplying electricity	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT		BENEFIT		BENEFIT
Bill Increases						COST			
Bill Reductions						BENEFIT		BENEFIT	
CAISO Market Revenue			BENEFIT	BENEFIT	BENEFIT				
Capital costs to participant	COST		COST			COST			
Capital costs to utility	COST	COST	COST	COST	COST		COST	COST	COST
Environmental benefits (GHG only)	BENEFIT	BENEFIT	BENEFIT	BENEFIT	BENEFIT		BENEFIT		BENEFIT
Incentives paid		COST		COST	COST	BENEFIT			
Increased supply costs	COST	COST	COST	COST	COST				
Market benefits			BENEFIT	BENEFIT	BENEFIT				
Non-monetary/Non-energy benefits			*BENEFIT*			*BENEFIT*		*BENEFIT*	*BENEFIT*
Revenue gain from increased sales					BENEFIT				
Revenue loss from reduced sales					COST				
Tax Credits	BENEFIT		BENEFIT			BENEFIT			
Value of service lost and transaction costs to participant			COST			COST			

MEASURE

Blue text indicates optional, hard-to-quantify benefits. (DR only)

Italic text indicates that value may be different for different tests.

Green text indicates values that are often considered to be externalities.

Measures in the ESA Program

Proposed Measure Categorization

Proposed Category	Measure
Non-resource	Furnace repair or replace
Non-resource	Hot water heater repair or replace
Resource	Lighting
Resource	Refrigerators
Resource	Hot water conservation measures
Resource	Clothes washers
Resource	Microwaves
Resource	Smart Strip
Resource	Furnace pilot light conversion
Resource	Central AC Tune-up
Uncertain	Air Sealing
Uncertain	Attic Insulation
Uncertain	Duct Test & Seal
Uncertain	Furnace Clean & Tune
Uncertain	Air conditioning

NEBs Included in the ESA Program Cost-effectiveness Tests

Participant:

- Water/sewer savings
- Fewer shutoffs
- Fewer calls to utility
- Fewer reconnects
- Property value benefits
- Fewer fires
- Moving costs / mobility
- Fewer illnesses and lost days from work/school
- Net benefits for comfort & noise
- Net benefits for additional hardship

Utility:

- Reduced arrearage cost
- Reduced bad debt written off
- Fewer shutoffs
- Fewer reconnects
- Fewer notices
- Fewer customer calls
- Fewer emergency gas service calls
- CARE subsidy avoided

NEB Values - Participant

NEB	SDG&E Value 2009	Value Range from SERA Study
Fewer reconnects	0.07	$0.03 to $0.08
Fewer shutoffs	0.16	$0.03 to $12
Fewer calls to utility	0.21	$0.18 to $0.30
Moving costs / mobility	1.53	< $1
Net benefits for additional hardship	1.58	
Net benefits for comfort & noise	3.56	$15 to $20
Fewer illnesses / lost days from work/school	3.92	$4 to $12
Property value benefits	4.78	$3 to $20
Fewer fires	4.64	$0.02 to $0.16
Water/sewer savings	$ 7.37	$4 to $15
Total	**$ 27.82**	**$26 to $80**

Values are per household, per year.

NEB Values - Utility

NEB	SDG&E Value 2009	Value Range from SERA Study
Fewer reconnects	0.04	$0.02 to $0.13
Fewer shutoffs	0.06	$0.05 to $0.13
Reduced emergency gas service calls	0.73	$0.10 to $0.40
Fewer notices	0.90	$0.30 to 1.50
Lower bad debt written off	1.20	$0.50 to $3.50
Fewer customer calls	2.75	$0.40 to $1.60
Utility rate subsidy avoided (CARE)	4.07	$3.30 to $24
Reduced carrying costs on arrearages	$ 4.91	$2 to $4
Total	**$ 14.66**	**$6 to $35**

Values are per household, per year

NEBs calculations for low income EE

- The model (LIPPT) used to estimate the NEBs allows input of basic assumptions for each utility.
- NEBs are estimated on a per household basis and then allocated across measures based on their share of energy savings, NOT on the benefits of the measure itself. Admin costs are also allocated this way.
- The standard energy efficiency calculator is then used to estimate the cost-effectiveness of each measure, using avoided costs, admin costs, and other inputs.

Re-evaluating the ESA Cost-Effectiveness Framework

- NEBs are be extremely difficult and costly to monetize; accuracy of the many NEBs estimates is questionable and controversial and very difficult to use effectively in modeling.
- It is difficult to attribute specific NEBs or administrative costs to specific measures, thus making it difficult to determine the cost-effectiveness of individual measures.

So…is there another way to quantify these benefits?

Proposed Equity Evaluation

Assess measures based on the following four criteria:

1. Eliminates combustion-related safety threat
2. Eliminates fire safety threat/Improves home security (crime prevention) and building integrity
3. Reduces or eliminates extreme temperatures and temperature variations inside the home/improves customer ability to manage in-home temperatures
4. Improves air quality, ventilation and/or air flow (e.g., reduces drafts and leakage)

Proposed Equity Evaluation (cont.)

Equity Evaluation to be performed by rating the extent to which every measure achieves each particular health or safety improvement:

- A rating of “5” indicates that the measure almost always results in that particular improvement in a home when it is installed.
- A rating of “3” indicates that the measure has about a 50% probability of making the improvement in a home when it is installed.
- A rating of “1” indicates that the measure has less than 25% probability of making the improvement in a home when it is installed.

Energy Efficiency

- Required by statute to perform “energy-only” cost-effectiveness; non-energy costs and benefits excluded.
- Cost of emissions mitigation, including permitting, included in avoided capacity costs.
- Avoided cost of GHG included; new GHG cap and trade market may result in better estimates of this value.
- Previously included a market adder to reflect impact of decreased demand on energy prices.

Demand Response

- Cost-effectiveness protocols established in 2010, so our experience is limited.
- Utilities *may* estimate and include environmental, market and other NEBs but it is optional.
- Utilities are required to describe them qualitatively if they do not estimate them.
- Demand Response participant costs are defined as “value of service lost and transaction costs.”

Cost-effectiveness tests for Demand Response

TEST: / INPUT:	TRC (Society)	PAC (Utility)	RIM (Ratepayers)	Participant
Administrative costs	COST	COST	COST	
Avoided costs of supplying electricity	BENEFIT	BENEFIT	BENEFIT	
Bill increases				COST
Bill reductions				BENEFIT
CAISO Market Participation Revenue	BENEFIT	BENEFIT	BENEFIT	
Capital costs to participant	COST			COST
Environmental Benefits	BENEFIT			
Incentives paid		COST	COST	BENEFIT
Increased supply costs	COST	COST	COST	
Market benefits	BENEFIT	BENEFIT	BENEFIT	
Non-energy/monetary benefits	BENEFIT			BENEFIT
Revenue gain from increased sales			BENEFIT	
Revenue loss from decreased sales			COST	
Tax Credits	BENEFIT			BENEFIT
Transaction costs to participant	COST			COST
Value of service lost	COST			COST

Water/Energy

Developing a framework to measure the energy benefits of water savings:

- Water-related energy use in CA is significant.
- Electric and gas utilities and ratepayers may benefit from embedded energy savings.
- Water utilities benefit from both energy and water savings.
- Recent RFP asks for research to include exploration of environmental benefits.

Social Cost Test (SCT)

Staff Proposal: Not adopted by the CPUC; not clear if it ever will be.

SCT is basically the TRC with 3 changes:

- Social discount rate
- Environmental Health benefits
- Avoided GHG costs (above and beyond the forecast carbon allowance price of CA's cap and trade program)

Thank you!

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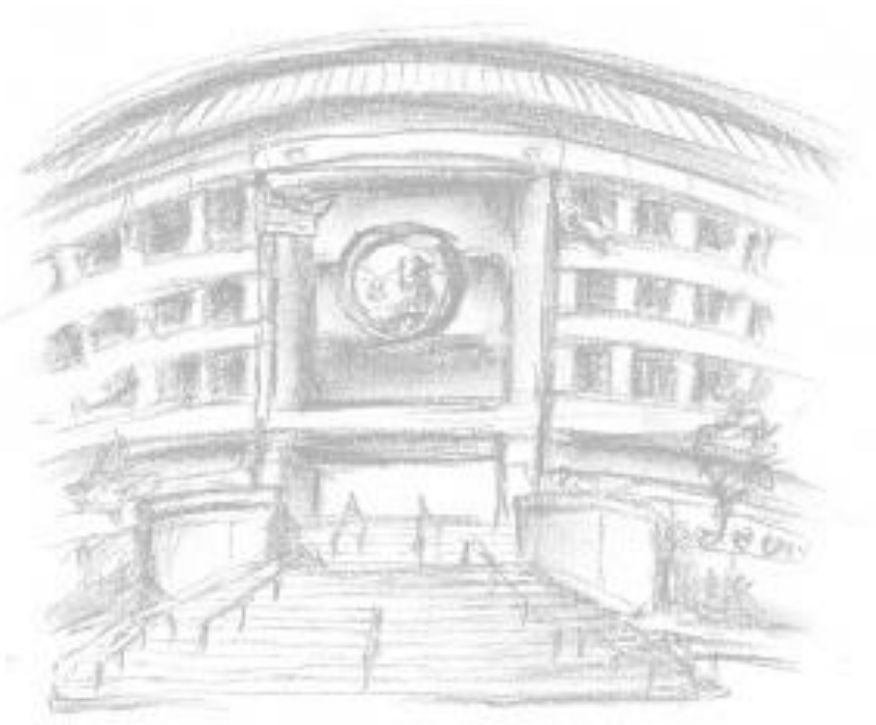


Appendix

Links

- CPUC Energy Efficiency cost-effectiveness page (includes links to SPM, Social Cost Test, and other materials):

http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/Cost-effectiveness.htm

- CPUC Demand Response cost-effectiveness page (includes link to Demand Response cost-effectiveness protocols):

http://www.cpuc.ca.gov/PUC/energy/Demand+Response/Cost-Effectiveness.htm

- ESAP white paper (Appendix A)

http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M060/K848/60848436.PDF

- ESAP white paper addendum (Appendix C)

http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M078/K062/78062052.PDF

California Energy Policy

The loading order … describes the priority sequence for actions to address increasing energy needs. The loading order identifies energy efficiency and demand response as the State's preferred means of meeting growing energy needs. After cost-effective efficiency and demand response, we rely on renewable sources of power and distributed generation, such as combined heat and power applications. To the extent efficiency, demand response, renewable resources, and distributed generation are unable to satisfy increasing energy and capacity needs, we support clean and efficient fossil-fired generation.

-- State of California Energy Action Plan II, 2005

Standard Practice Manual on Societal Test

- Societal test is a “secondary” test that attempts to quantify total resource costs to society as a whole, rather than only to the utility and its ratepayers
- Enumerated differences from the TRC:
  1. May use higher marginal costs if a utility faces marginal costs that are lower than other utilities or out-of-state suppliers.
  2. Tax credits are treated as a transfer payments and thus are left out. [if “society” is defined as California, federal tax credits would remain]
  3. Interest payments are considered a transfer payment since society actually expends the resources in the first year. Therefore, capital costs enter the calculations in the year in which they occur.
  4. A societal discount rate should be used.
  5. Includes externality costs of power generation not captured by the market system.
- Societal benefits specifically listed in SPM:
  - Avoided environmental damage [health impacts and CO2 costs]
  - Benefits of increased system reliability (e.g., avoided costs of supply disruptions, decreased System Operator costs to maintain reserve margin)
  - Non-energy benefits of reduced water use and waste streams.
  - Non-energy benefits for low income programs.
  - Benefits of fuel diversity

Equity Evaluation

- *Eliminates combustion-related safety threat* – Prolonged exposure to high levels of carbon-monoxide (CO) can have adverse effects on human health, including CO poisoning that can lead to severe headaches, fatigue, shortness of breath, dizziness, and nausea. Extended and severe exposure can lead to permanent neurological damage and even death. Ambient air readings in participant homes should not exceed certain maximum ambient air CO levels, both in the center of the room(s) and near combustion appliances. A Natural Gas Appliance Test (NGAT) is performed to check for dangerous levels of CO. Any or all faulty natural gas-fired water heaters or furnaces that contribute to excessive levels of CO in the room(s) are shut off, becoming candidates for ESA repair or replacement. If ventilation/infiltration measures have been installed, a second NGAT will be conducted to ensure that tightening the building envelope did not adversely affect operation of any gas appliances.
- *Eliminates fire safety threat/Improves home security (crime prevention) and building integrity* – While not necessarily within the scope of the ESA program at present, non-resource measures may address specific safety issues such as fire safety and improved home security/building integrity. This would include fire safety from hazards in the home with the exception of natural-gas combustion. An on-site property assessment, similar to what is performed as part of the ESA program, would identify fire safety threats and home security issues, including poor exterior lighting, broken/unsecure windows and doors, inadequate/makeshift heating and cooking devices, and structural deficiencies.

Equity Evaluation (cont.)

- *Reduces or eliminates extreme temperatures and temperature variations inside the home/improves customer ability to manage in-home temperatures* – Extreme temperatures in the home can lead to significant adverse health effects, including cold stress/hypothermia and heat stress/hyperthermia. Infiltration measures can help reduce temperature variation by minimizing air leakage into and out of the building envelope. Additionally, measures that reduce or eliminate extreme temperatures may also mitigate issues that arise from the use of inadequate, faulty and makeshift heating and cooling devices, leading to increased safety/security and decreased incidences of fire and asphyxiation. Attic insulation may help by decreasing the amount of conditioned air lost in the summer and the winter. Additional measures that address extreme temperatures may include new windows and heating/cooling units.
- *Improves air quality, ventilation and/or air flow (e.g., reduces drafts and leakage)* – Poor air quality, ventilation and air flow can lead to increased health risks from mold, dust mites, and other contaminants. These risks may be mitigated by reducing the number of entry points for pollen, insects, rodents and other pests. Improved air quality and ventilation may also diminish condensation. Measures in this category, such as new windows and doors, duct sealing, and improved temperature/humidity control, may address one or more air quality issues, and can help reduce temperature variation by minimizing air leakage into and out of the building envelope. Reducing temperature variation within the home may also minimize the flow of warm air to cool spaces.

Equity Evaluation (cont.)

Equity Evaluation be performed by rating the extent to which every measure achieves each particular health or safety improvement:

- A rating of “5” indicates that the measure almost always results in that particular improvement. In other words, almost all homes which receive the measure will see that improvement. For example, a measure which replaces faulty natural gas appliances would receive a “5” on criteria #1. Another way to think about a score of “5” is that it indicates that a measure has an extremely high probability of achieving the improvement in a home when it is installed.
- A rating of “3” indicates that the measure results in that particular improvement for about half the homes which receive it. For example, if a measure which provides insulation will likely reduce the occurrence of extreme temperatures in about half the homes where it is installed, that measure would receive a “3” on criteria #3. For certain measures, a more useful way to think about a score of “3” is that it indicates that a measure has about a 50% probability of making the improvement in a home when it is installed. For other measures, it may be more appropriate to think of a score of “3” as a result of a measure that partially achieves the improvement. For example, a measure may result in moderate, but not extreme, improvements in temperature variation in each home.
- A rating of “1” indicates that the measure results in that particular improvement for only a small number of homes which receive it. For example, if a measure which replaces non-energy-efficient appliances results in the replacement of appliances which are actually fire hazards about 10% of the time, that measure would receive a “1” on criteria #2. For certain measures, a more useful way to think about a score of “1” is that it indicates that a measure has less than 25% probability of making the improvement in a home when it is installed. For other measures, it may be more appropriate to think of a score of “1” as a result of a measure that somewhat achieves the improvement. For example, a measure may result in a small improvement in temperature variation in each home.

Social Cost of Carbon Summary

- **SCC Approach 1: Damage Cost**

	2010	2050
Lower	$32	$73
Upper	$1,024	$1,717

- **SCC Approach 2: Avoided Electricity Decarbonization Cost Approach**

	2013	2050
Lower	$195	0
Upper	$195	$500

- **Values chosen for the indicative SCT scenarios represent in round numbers the high and low ranges of both approaches**

	Scenario 1	Scenario 2
Carbon cost	$50	$200

Illustrative Damage Costs Using COBRA

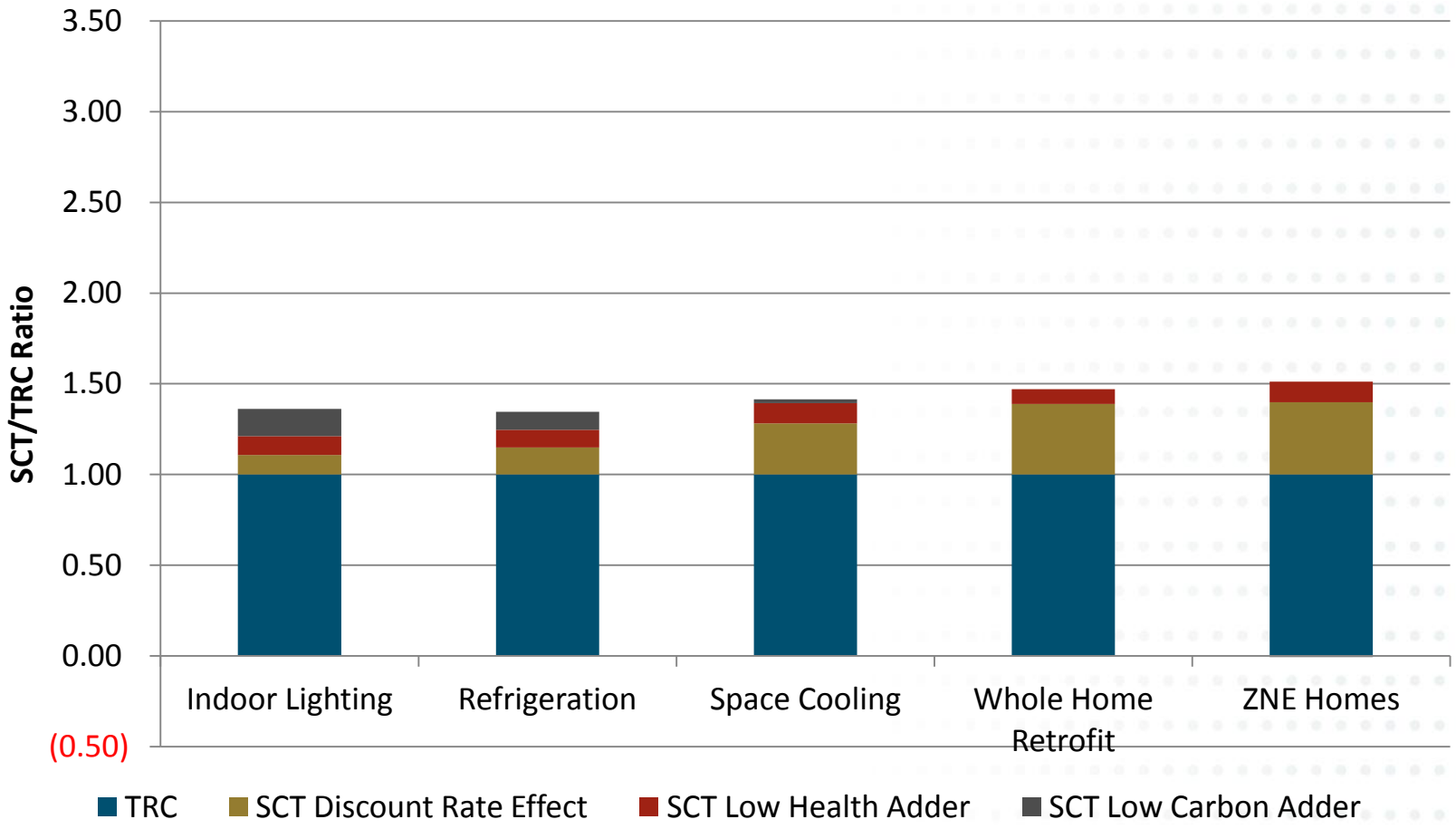
- **Benefits to Californians due to reductions of NO_X, $PM_{2.5}$, SO_2 in California in 2017 are considered (benefits to nearby states are excluded)**
- **Electricity Generation**
  - Reductions occur uniformly across California in 2017
  - Emissions factors from the CARB RES calculator are used to convert $/ton into $/MWh
  - Damage costs (in 2017) ~ $8/MWh - 20/MWh ($2010)
- **Natural Gas**
  - Emissions from commercial and institutional boilers category reduced by EE or DER measure
  - Damage costs (in 2017)
    - ~$1/MMBtu - $3.5/MMBtu (small boilers)
    - ~$1.3/MMBtu – $4.70/MMBtu (large uncontrolled boilers)

NAS estimate is $36/MWh

Input Values by Scenario

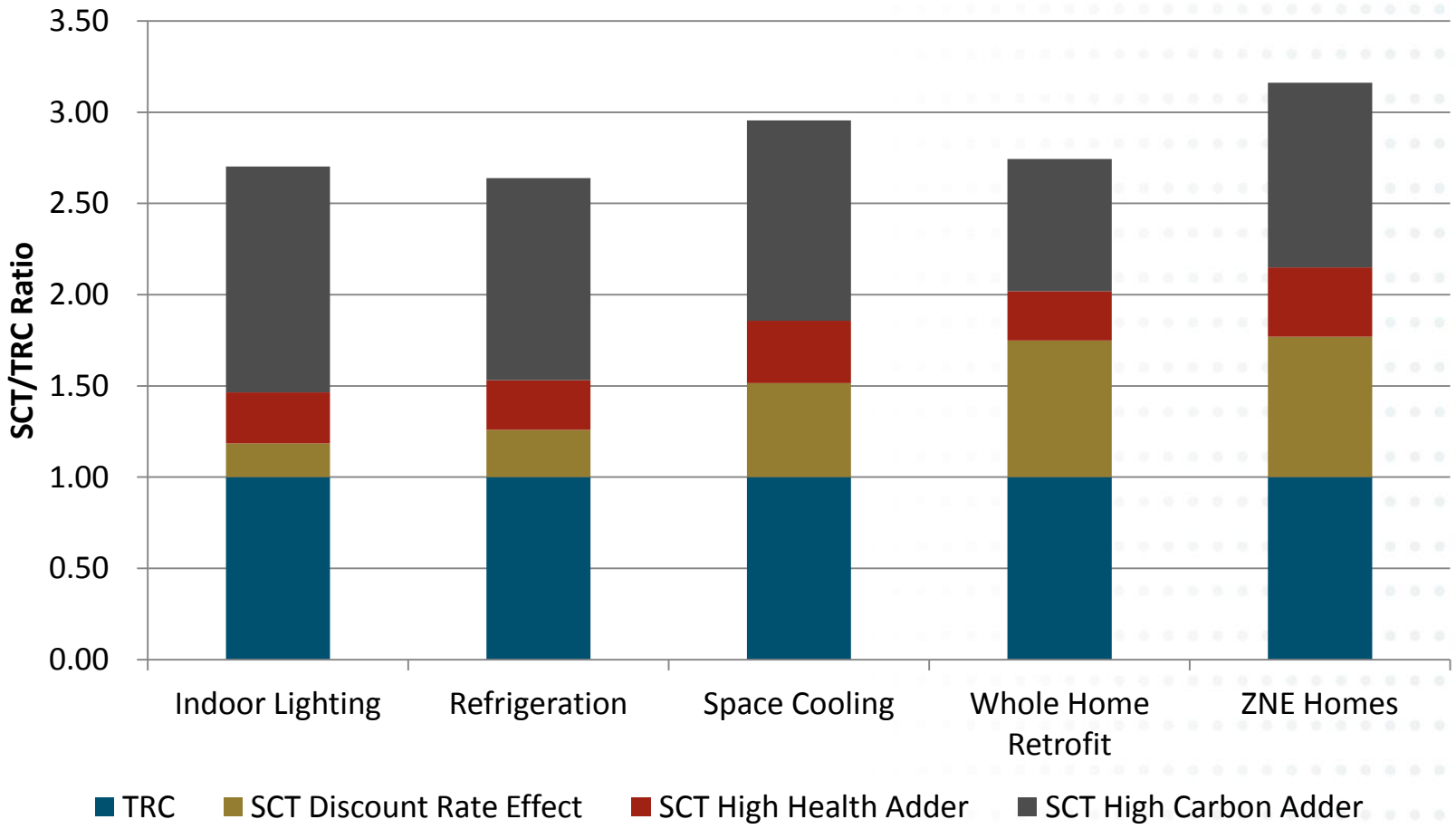
Key Driver	Scenario 1	Scenario 2
Social Discount Rate	3.0% real	1.4% real
Cost of Carbon	\$50/t CO_2	\$200/t CO_2
Health Benefits	\$0.8-\$2/MMBTU	\$2-\$5/MMBTU

SCT/TRC Ratio: Scenario 1 (Low)



Preliminary DRAFT. For discussion only

SCT/TRC Ratio: Scenario 2 (High)



Preliminary DRAFT. For discussion only