

NON-ENERGY BENEFITS (NEBS)

What have we learned in 20 years?

Capturing the Multiple Benefits of Energy Efficiency – Roundtable on Energy Provider and Consumer Benefits

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20 YEARS OF NEBS PROGRESS...*

**Random, theorized lists → Drivers, 3
main beneficiaries / perspectives**

(1990)

1994-1996

**Arrearrages & minimal others →
Tested methods & BPs including HTM**

1996-2002+

**Low income results → Ranges / focus
→ Models & broad 3-perspective
results for varied programs,
measures, portfolios, sectors**

1996 onward

**Applications in Low inc. policy &
mktg → Broad applications incl. C/E**

1996 ... recent

**Skepticism → Improving acceptance;
chicken & egg**

1994, 90+ programs/portfolios in US, int'l, 4 BMP reviews, 50 papers

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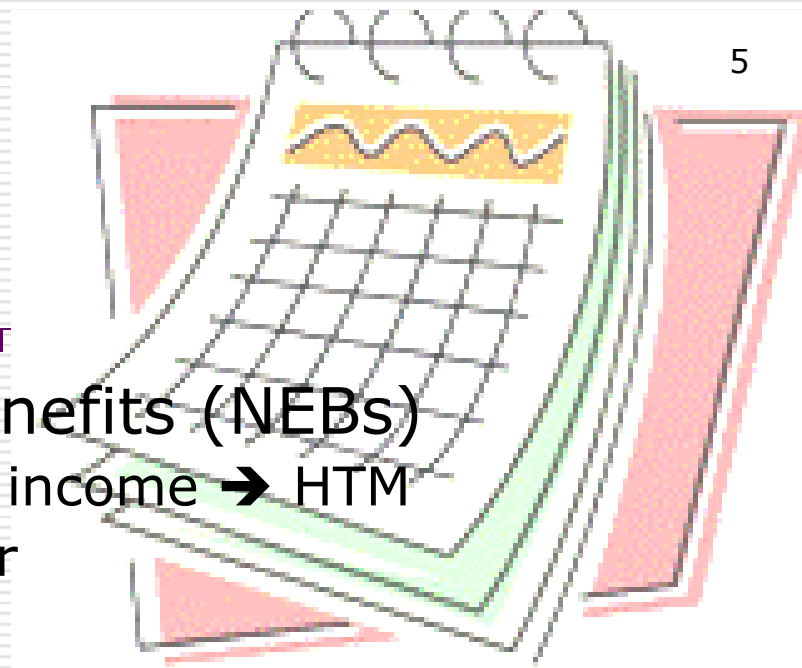
Skepticism → Improving acceptance;
chicken and egg

But there still isn't agreement on name! - NEB, OPI, NNEB, MB...

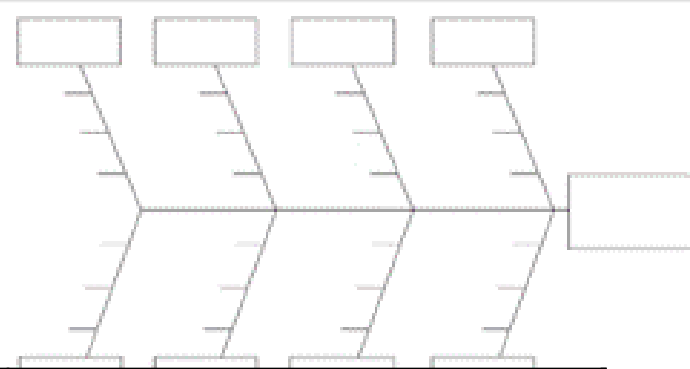
***NEB BACKGROUND /
REVIEW / CONTEXT***

BACKGROUND / HISTORY*

- 20 years of Non-energy benefits (NEBs)
 - Random + arrearage → Low income → HTM
 - Low income policy → broader
- Motivation
 - Implicit assumption of “0” is wrong, B/C bias, Granger, evaluation to guide decision-making
 - Theory / “bundled features”, positive and negative effects other than energy savings
- 3 Beneficiaries, drivers (1994-5)
 - Utility
 - Society
 - Participants



NEB DRIVERS, 3 BENEFICIARIES



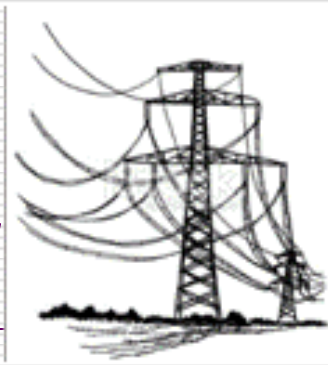
Utility/ Ratepayer	Societal	Participant (all)
<ul style="list-style-type: none"> ○ Payments/ financial ○ Debt collection efforts / calls ○ Emergencies / insurance ○ T&D, power quality, reliability ○ Subsidy (LI) ○ Other 	<ul style="list-style-type: none"> ○ Economic development / job / multipliers ○ Tax impacts ○ Environmental ○ Emissions ○ Health ○ Water & other resources / utilities ○ National security ○ Wildlife/ Other 	<ul style="list-style-type: none"> ○ Payments & coll'n ○ Education ○ Building stock ○ Health ○ Equipment service incl. productivity, comfort, maint, etc. ○ Other utilities (water, etc.) ○ Other (transactions, enviro, psychic, etc.)

NEB CATEGORIES BY PERSPECTIVES – FROM DRIVERS

Utility	Society	Participant	(res & com'l)
<ul style="list-style-type: none"> • Carrying cost on arrearages • Bad debt written off • Shutoffs • Reconnects • Notices • Customer calls / bill or emergency-related • Other bill collection costs • Emergency gas service calls (for gas flex connector and other programs) • Insurance savings • Transmission and distribution savings (usually distribution) • Fewer substations, etc. • Power quality / reliability • Reduced subsidy payments (low income) • Other 	<ul style="list-style-type: none"> • Economic development benefits – direct and indirect multipliers • Tax effects • Emissions / environmental (trading values and/ or health / hazard benefits) • Health and safety equipment • Water and waste water treatment or supply plants • Fish / wildlife mitigation • National security • Health care • Other 	<ul style="list-style-type: none"> • Water / wastewater bill savings • Operating costs (non-energy) • Equipment maintenance • Equipment performance (push air better, etc.) • Equipment lifetime • Shutoffs / Reconnects • Property value benefits / selling • (Bill-related) calls to utility • Comfort • Aesthetics / appearance • Fires / insurance damage (gas) • Lighting / quality of light • Noise • Safety 	<ul style="list-style-type: none"> • Control over bill • Understanding / knowledge • “Care” or “hardship” (low income) • Indoor air quality • Health / lost days at work or school • Fewer moves • Doing good for environment • Savings in other fuels or services (as relevant) • GHG and environmental effects • Negatives

Source: (Skumatz/SERA, 1996 on)

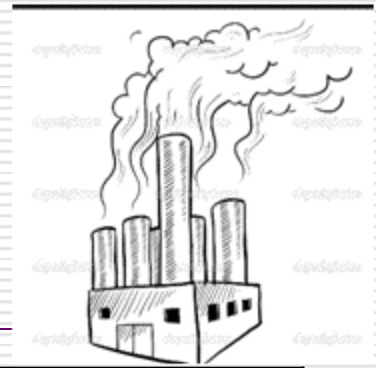
UTILITY BENEFITS – INDIVIDUAL CATEGORIES



Utility Benefits – changes in... ... valued at utility marginal costs, or similar

- | | |
|---|--|
| <ul style="list-style-type: none">• Carrying cost on arrearages• Bad debt written off• Shutoffs• Reconnects• Notices• Customer calls / bill or emergency-related• Other bill collection costs | <ul style="list-style-type: none">• Emergency gas service calls (for gas flex connector and other programs)• Insurance savings• Transmission and distribution savings (usually distribution)• Fewer substations, etc.• Power quality / reliability• Reduced subsidy payments (low income)• Other |
|---|--|

SOCIETAL BENEFITS – INDIVIDUAL CATEGORIES



Societal Benefits – changes in...

... Valued at relevant societal values for the category.

- Economic development benefits – direct and indirect multipliers
- Tax effects
- Emissions / environmental (trading values and/or health / hazard benefits)
- Health and safety equipment
- Water and waste water treatment or supply plants
- Fish / wildlife mitigation
- National security
- Health care
- Other



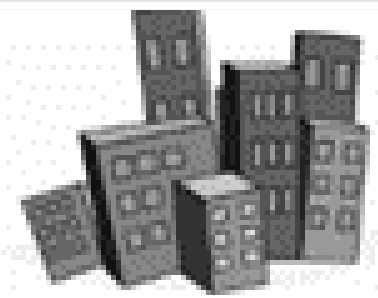
PARTICIPANT BENEFITS – RESIDENTIAL



Residential Participants – changes in... ...Valued at household marginals.

- | | |
|---|--|
| <ul style="list-style-type: none">•Water / wastewater bill savings•Operating costs (non-energy)•Equipment maintenance•Equipment performance (push air better, etc.)•Equipment lifetime•Shutoffs / Reconnects•Property value benefits / selling•(Bill-related) calls to utility•Comfort•Aesthetics / appearance•Fires / insurance damage (gas)•Lighting / quality of light•Noise•Safety | <ul style="list-style-type: none">•Control over bill•Understanding / knowledge•“Care” or “hardship” (low income)•Indoor air quality•Health / lost days at work or school•Fewer moves•Doing good for environment•Savings in other fuels or services (as relevant)•GHG and environmental effects
•NEGATIVES include: Installation hassles / mess, negative values from items above. |
|---|--|

PARTICIPANT BENEFITS – C&I



Commercial/Industrial Participants – changes in...

- | | |
|---|--|
| <ul style="list-style-type: none">•Water / wastewater bill savings•Operating costs (non-energy)•Equipment maintenance•Equipment performance (push air better, etc.)•Equipment lifetime•Productivity•Tenant satisfaction / fewer tenant complaints•Comfort•Aesthetics / appearance•Lighting / quality of light•Noise•Safety | <ul style="list-style-type: none">•Ease of selling / leasing•Product losses (mostly refrigeration at grocery)•Labor requirements•Indoor air quality•Health / lost days at work•Doing good for environment•Reliability of service / power quality•Savings in other fuels or services (as relevant)•GHG and environmental effects
•NEGATIVES include: Production disruption during installation. Others are included above (e.g. troublesome maintenance, etc.) |
|---|--|

NEBs – BEST PRACTICES*

□ History:

- Primary vs. secondary and tertiary effects (NEBs)...
- Noted key applications; then went “conservative” until comfort level increased & more estimations
- *Chicken and Egg – important uses* ← → *trusted uses*; (won’t incorporate effects until well-measured; no money at measurement unless “serious” applications...)

□ Best practices / issues – “NET NEBs”

- Redundancy / perspective
- Net positive / negative
- Net standard efficiency
- Net free riders

- Minimizing overlap / double-counting (drivers)
- Application subsets
- Attribution & precision; depends; relative to use; net
- MONETARY terms

NEB ESTIMATION APPROACHES

BACKGROUND – MEASUREMENT OF NEBS



- Early – arrearages and related (low income budgets)
- Challenge – “Hard to Measure” (HTM) – stuck, no progress
 - Traditional WTP/WTA; unsuccessful; ferry & academic (1996)
 - Methods progress - 20 years of research; hundreds of studies; US & international
 - Functions/objective vs. perceptions
- Goals and practical tradeoffs for defensible estimates
 - Need reasonable data quality
 - Need ability to collect data
 - Need sufficient number of observations for reliability / transferability / bias issues
 - Need quality responses
 - Singular NEBs issue / overlap
 - → Accuracy, consistency, unbiased, large sample...

NEBs MEASUREMENT – 4 MAIN MEASUREMENT APPROACHES*

Direct Measurement	Secondary + Lit/Meas	Modeling	Survey-Based
<ul style="list-style-type: none"> • → Records, billing data, market info; regression • Utility, arrears, debt, calls, notice, subsidies; broader individ. • Sample size 	<ul style="list-style-type: none"> • → Incremental incidence * valuation • Water savings, insurance, O&M, etc. • Many factors available 	<ul style="list-style-type: none"> • → 3rd party or specialized models • Emissions, Economics • Many straight-forward, but also slippery slope 	<ul style="list-style-type: none"> • → Multiple approaches • Participant effects (HTM) -only option for some <p>Survey options</p> <ul style="list-style-type: none"> • CV (WTP/WTA; open v. bounded) • Relative scaling (LMS, comparative, numeric) • Ranking (Ord. Logit, AHP, rank, conjoint) • Hedonic Regr • Other

Story of a ferry... then it's academic

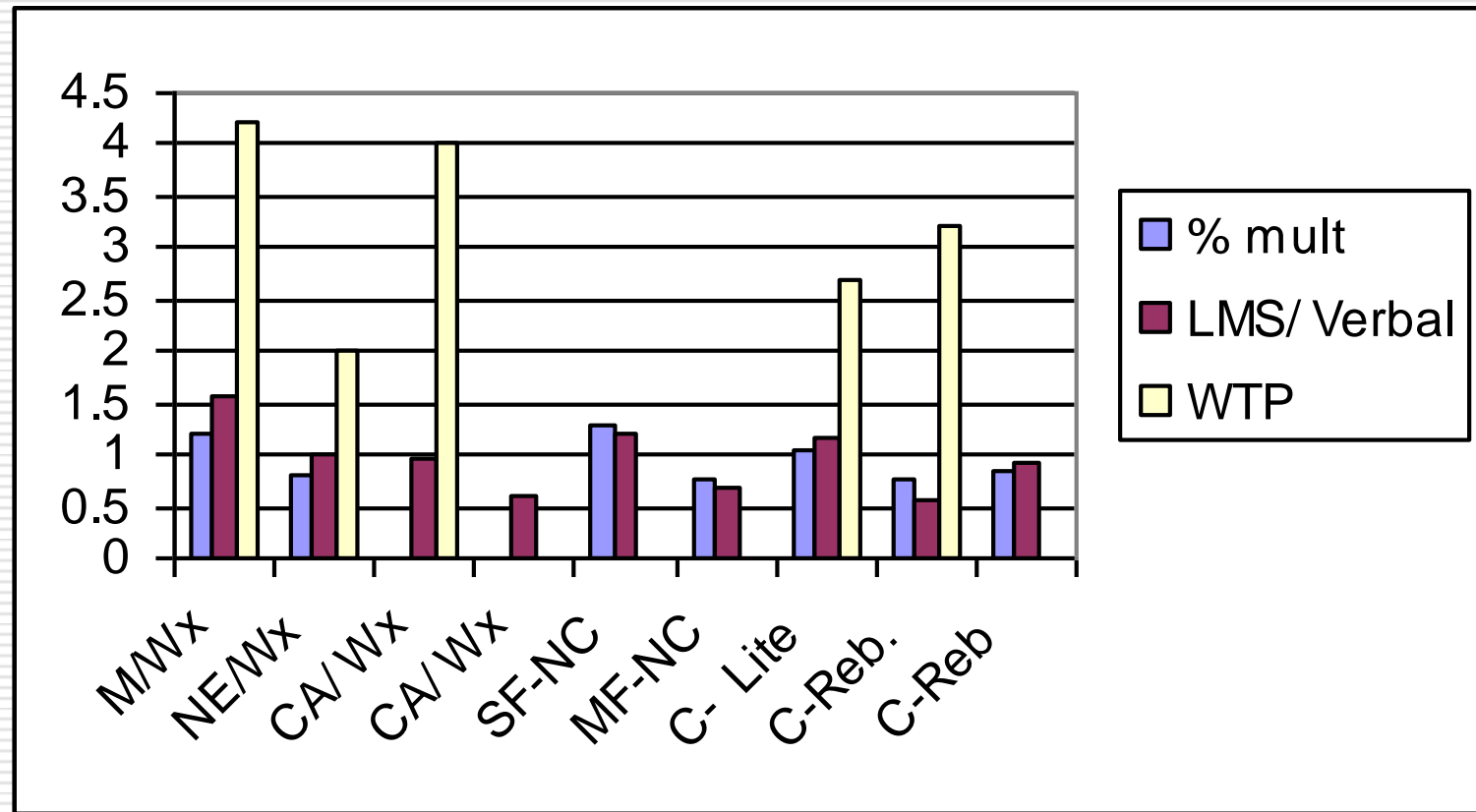
Strengths & weaknesses

Balancing precision & practical

Avoid bias, achieve high numbers

False comparisons?

PARTICIPANT MEASUREMENT METHODS COMPARISON – STATED PREFERENCE



Other papers compare WTP,
Bounded WTP, LMS (SERA/WEA 2006)

(Source: Skumatz/SERA
ACEEE paper 2002)

EMPIRICAL RESULTS – STATED PREFERENCE COMPARISONS

- Survey of boiler vendors
- Hi-efficiency versus standard boilers

Question format	NEB value (\$)
Relative scaling	75
Discrete CV	70
Rank-order	85
Open-ended CV (avg)	611
Open-ended CV (med)	36

ASSESSMENT OF NEB MEASUREMENT & DATA COLLECTION METHODS*

Assessing Participant NEB Measurement & Data Collection Methods

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	LOW PERFORMANCE →	→	→	→	HIGH PERFORMANCE
LOW COST ↓	<ul style="list-style-type: none"> ○ Willingness to Pay (WTP) (volatile) ○ Willingness to Accept (WTA) 				<ul style="list-style-type: none"> ○ Verbal scaling, LMS ○ Comparative / numeric
					<ul style="list-style-type: none"> ○ Bounded WTP/WTA
↓					<ul style="list-style-type: none"> ○ Discrete choice
HIGH COST	<ul style="list-style-type: none"> ○ Direct valuation (obs, bias) ○ Market valuation (obs, bias) 				<ul style="list-style-type: none"> ○ Ranking ○ Ordered logit ○ Regression (ltd categ) ○ Intercept survey

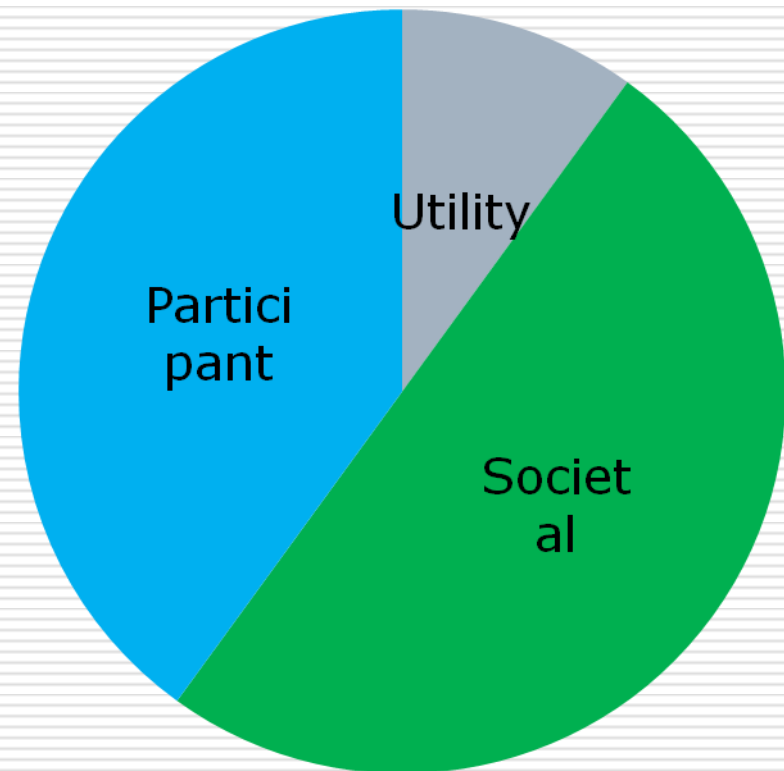
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Based on SERA tests, comparisons, studies

NEB RESULTS: EXAMPLES

WHICH SOURCES OF NEBS ARE HIGH VALUE?

- Results sample of ~100 programs we've done & lit review
- Which sources dominate?
- Utility 10%; Societal 40-60%, participant 30-50%
- Considerable variation by program, climate, measures



WHICH NEBS ARE HIGHEST VALUE?*



- Utility (10%)
 - Few, low value (arrearages, subsidies)
- Societal (40-60%)
 - Emissions
 - Economic development
 - Potentially health (not well measured yet)
- Participant (30-50%); *(often higher for low income)*

Residential

- Comfort
- Avoid moving / homelessness; home value
- Illness / health
- Ability to pay other bills / savings
- Green

Commercial

- Tenant satisfaction
- Maintenance
- Comfort
- Ability to sell
- Productivity
- Green

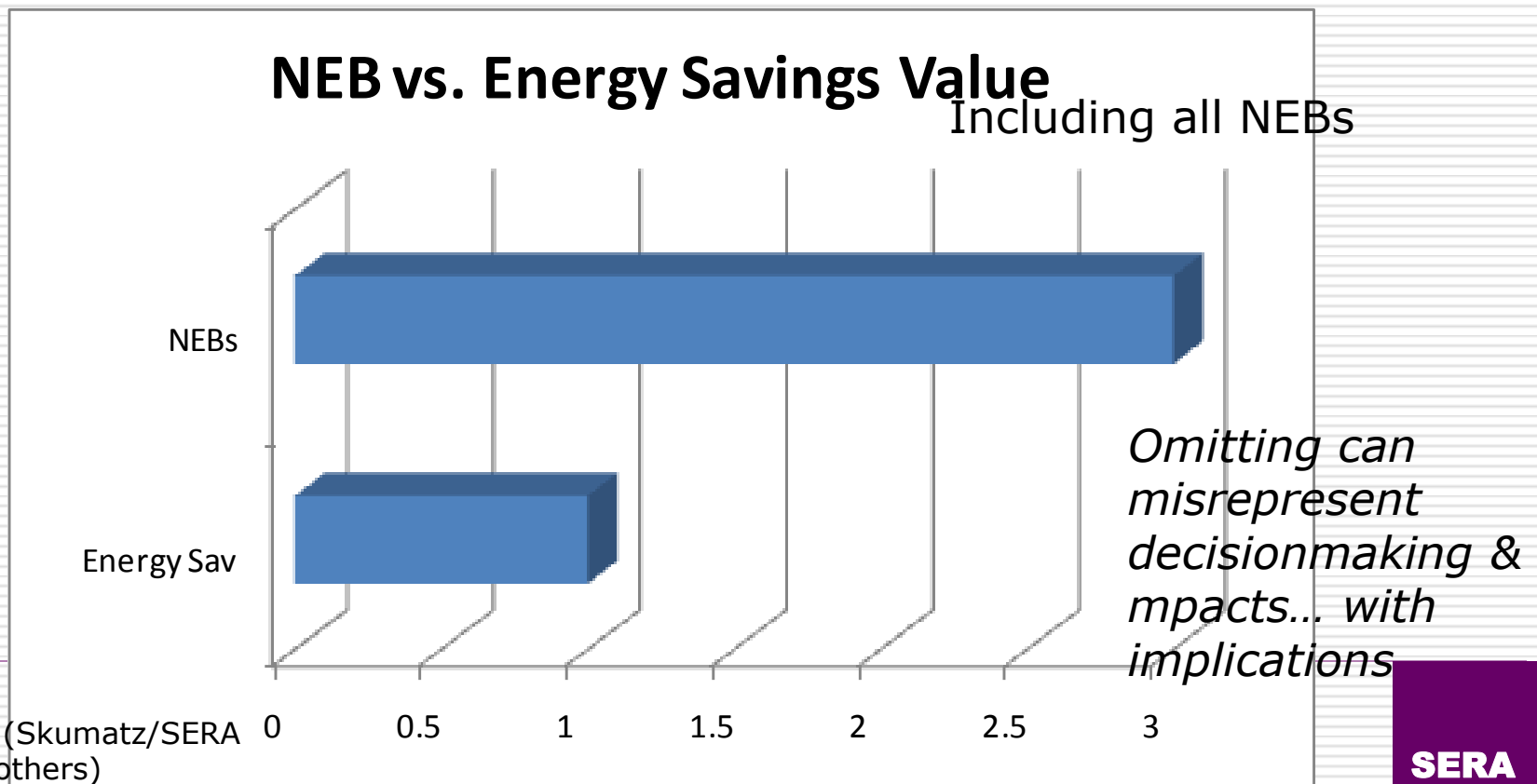
- Gaps

- Health & safety, peak, infrastructure, security, hardship



ARE NEBS HIGH VALUE?

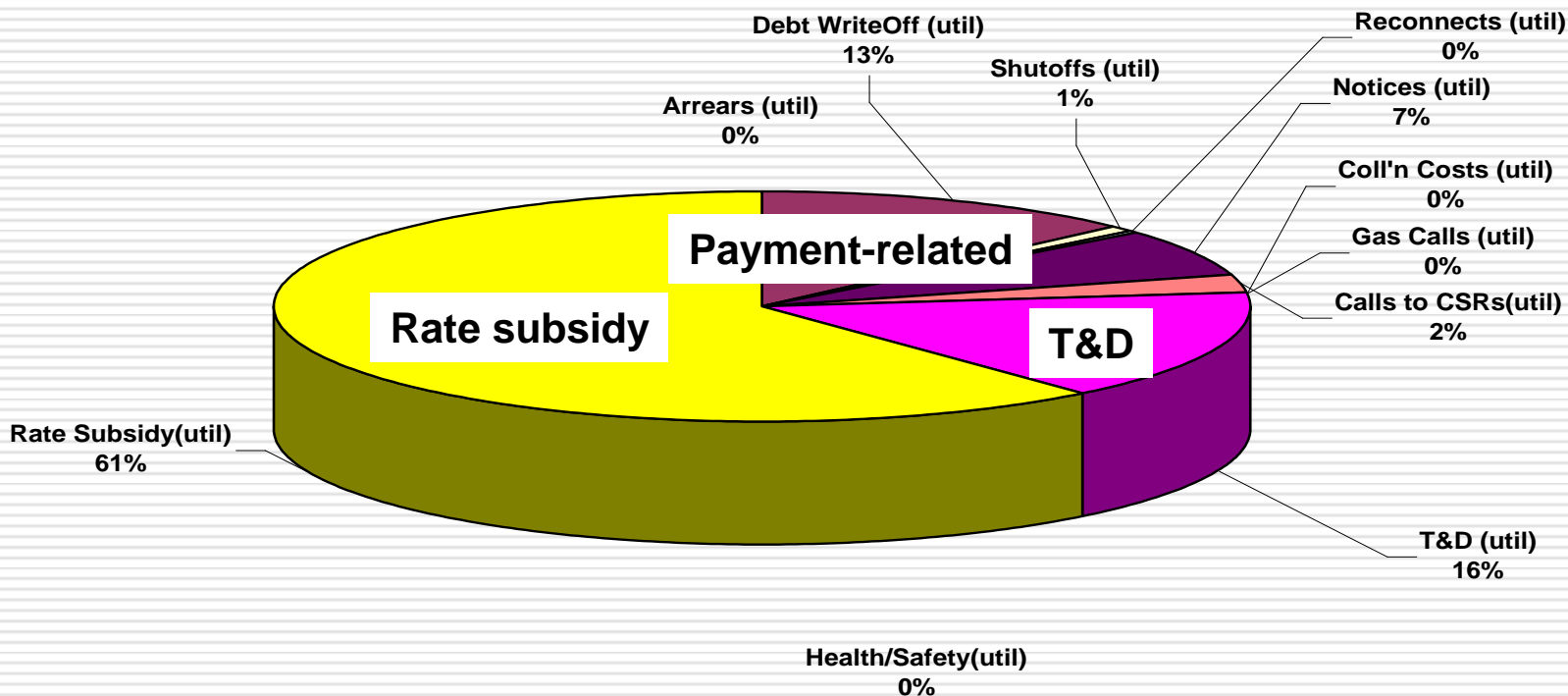
- *Energy savings are less than 1/4 of benefits from low income weatherization programs – less than 1/10 for some programs*



UTILITY NEBS

EXAMPLE: LOW INCOME WX

Utility NEBs for Template Program

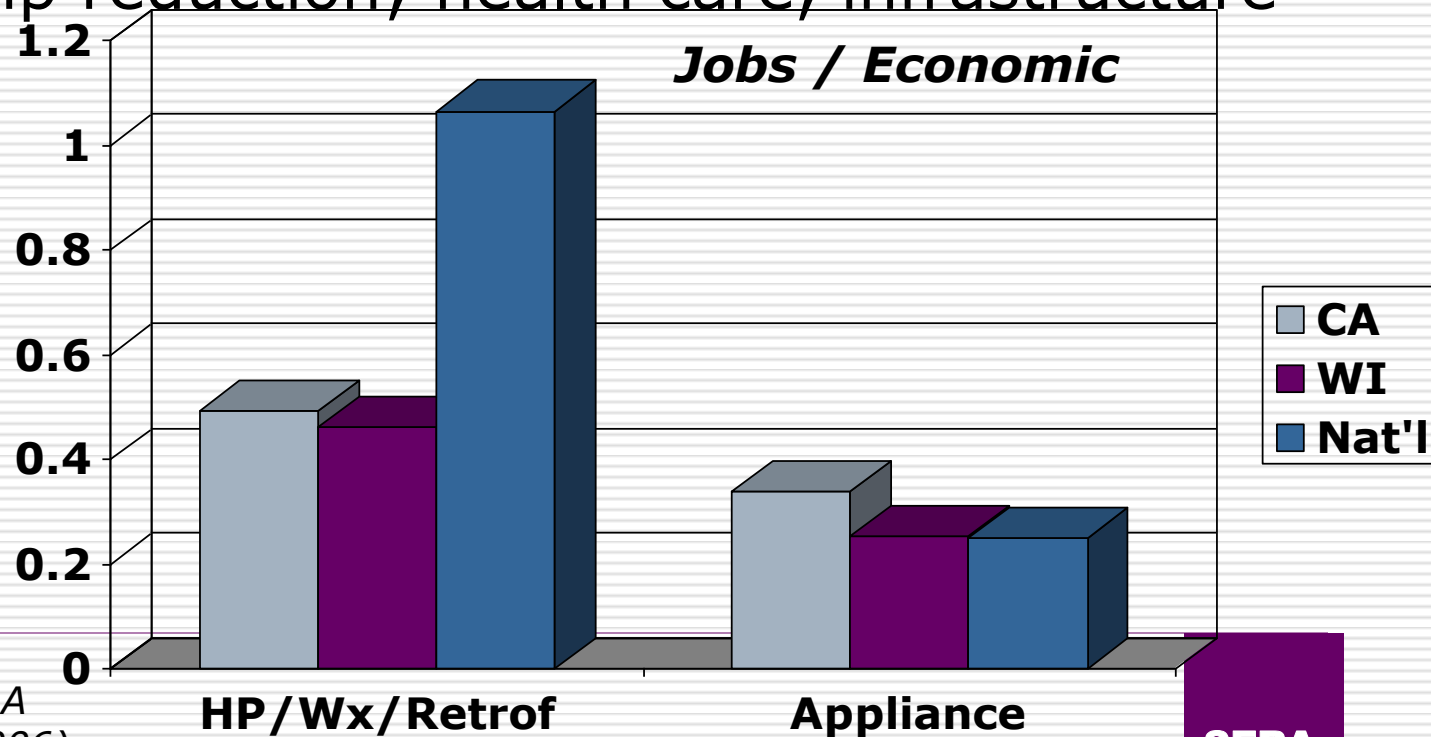


MODELS

Source: Skumatz Economic Research Associates research

SOCIETAL IMPACTS

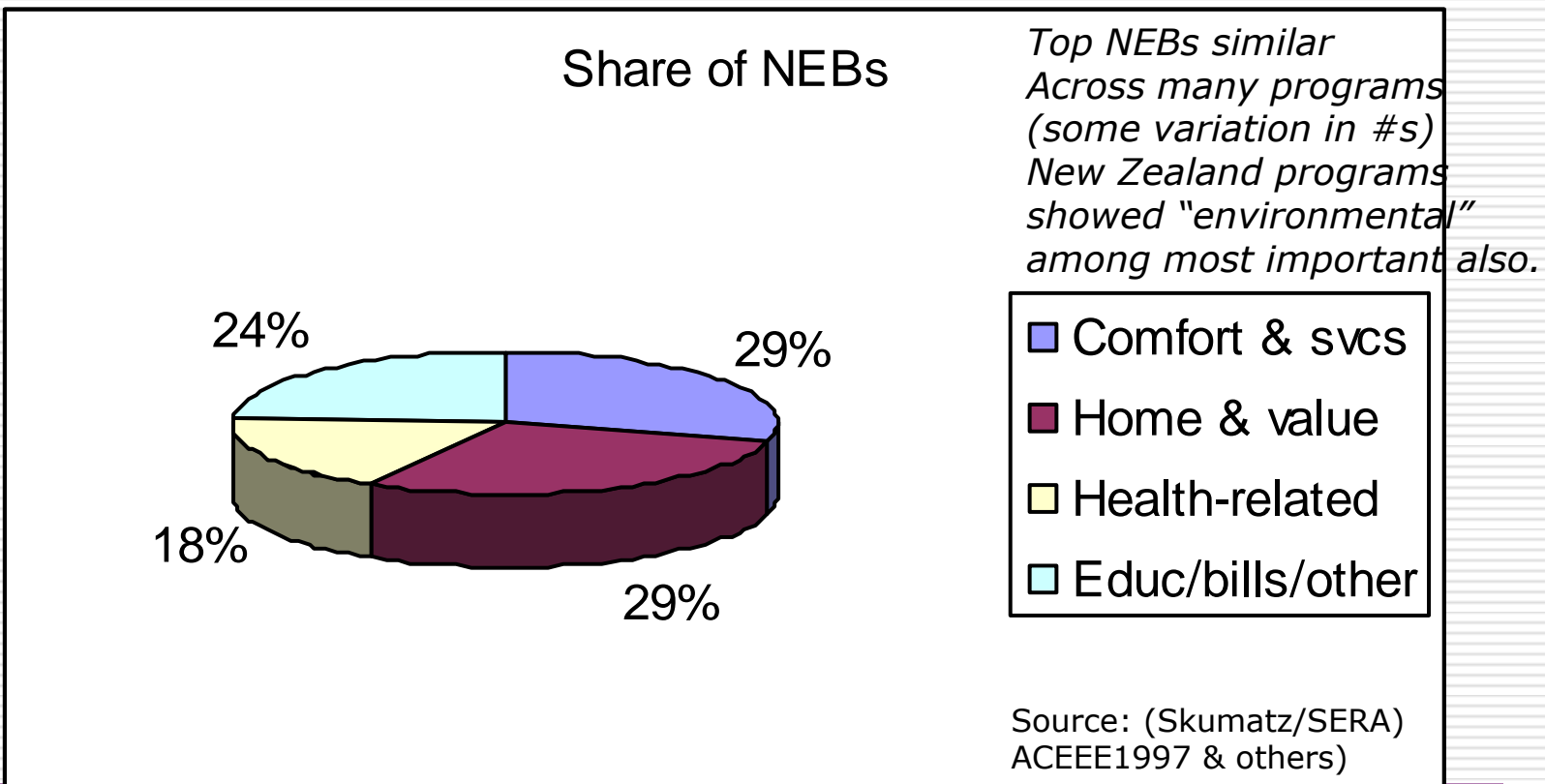
- Strong economic development performance
- Emissions – vary by generation; much measurement
- Hardship reduction; health care, infrastructure
- Gaps



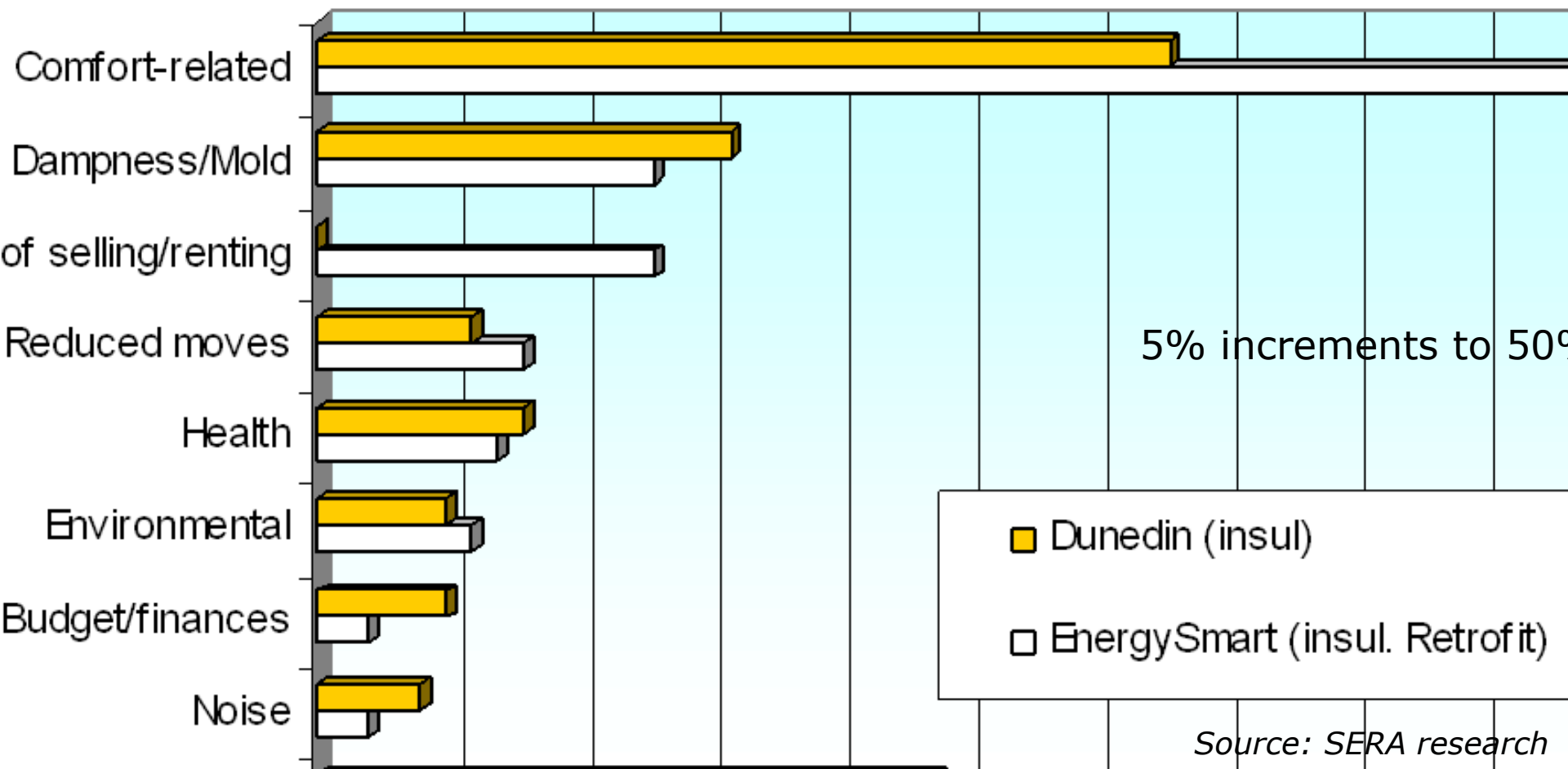
(Source: Skumatz /SERA
ECEEE 2007, ACEEE 2006)

WHICH PARTICIPANT NEBS ARE HIGH VALUE?

□ Example Participant NEBs breakdown

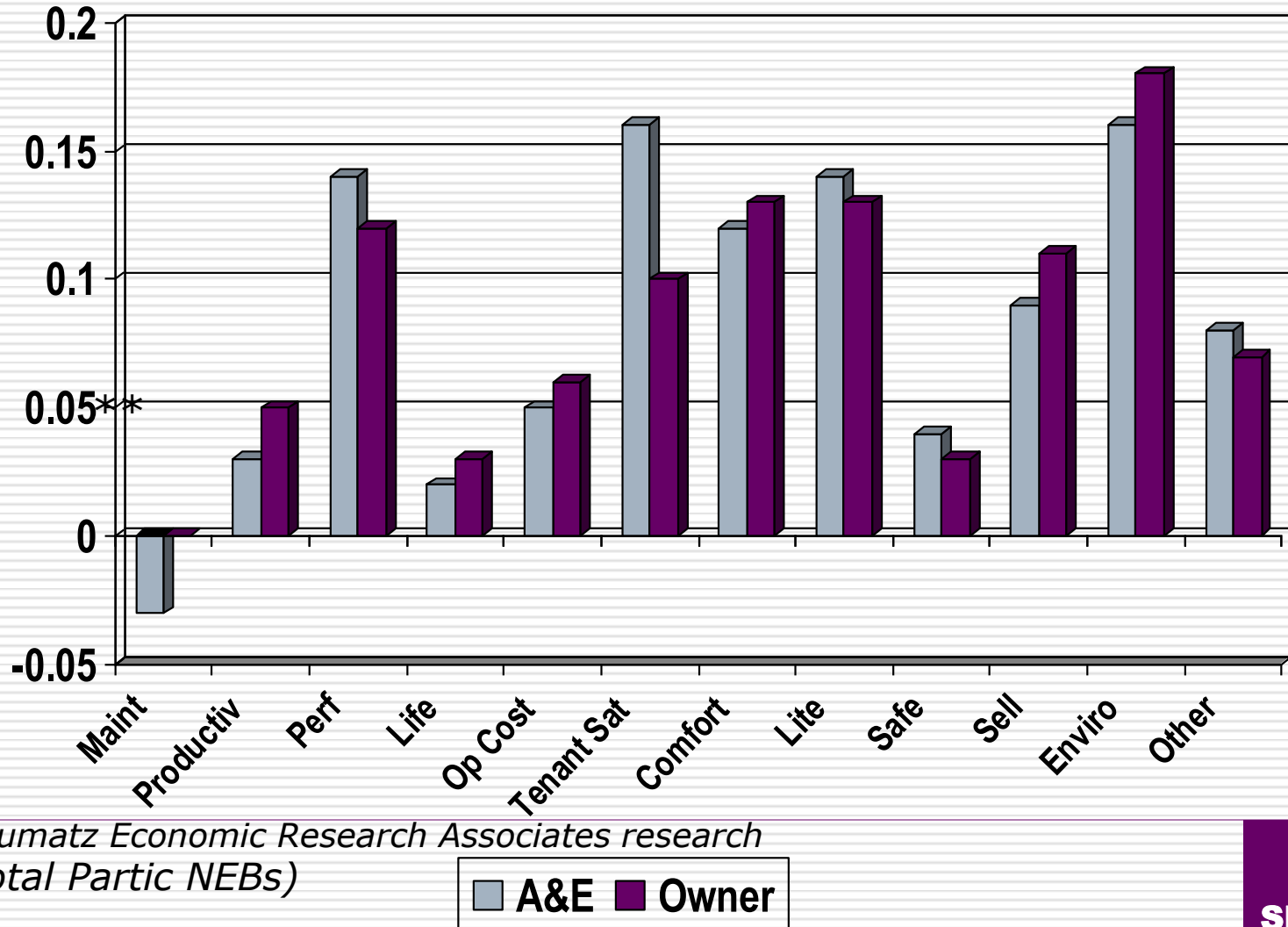


INSULATION RESULTS (DUNEDIN & ENERGY SMART)



*IMPLICATIONS: Maintenance as a barrier -- \$ amount to get to "neutral", not just score (\$ and distribution)
 Owners had higher NEB total, and would have taken higher investment in new technology (education vs. fear of losing bid)*

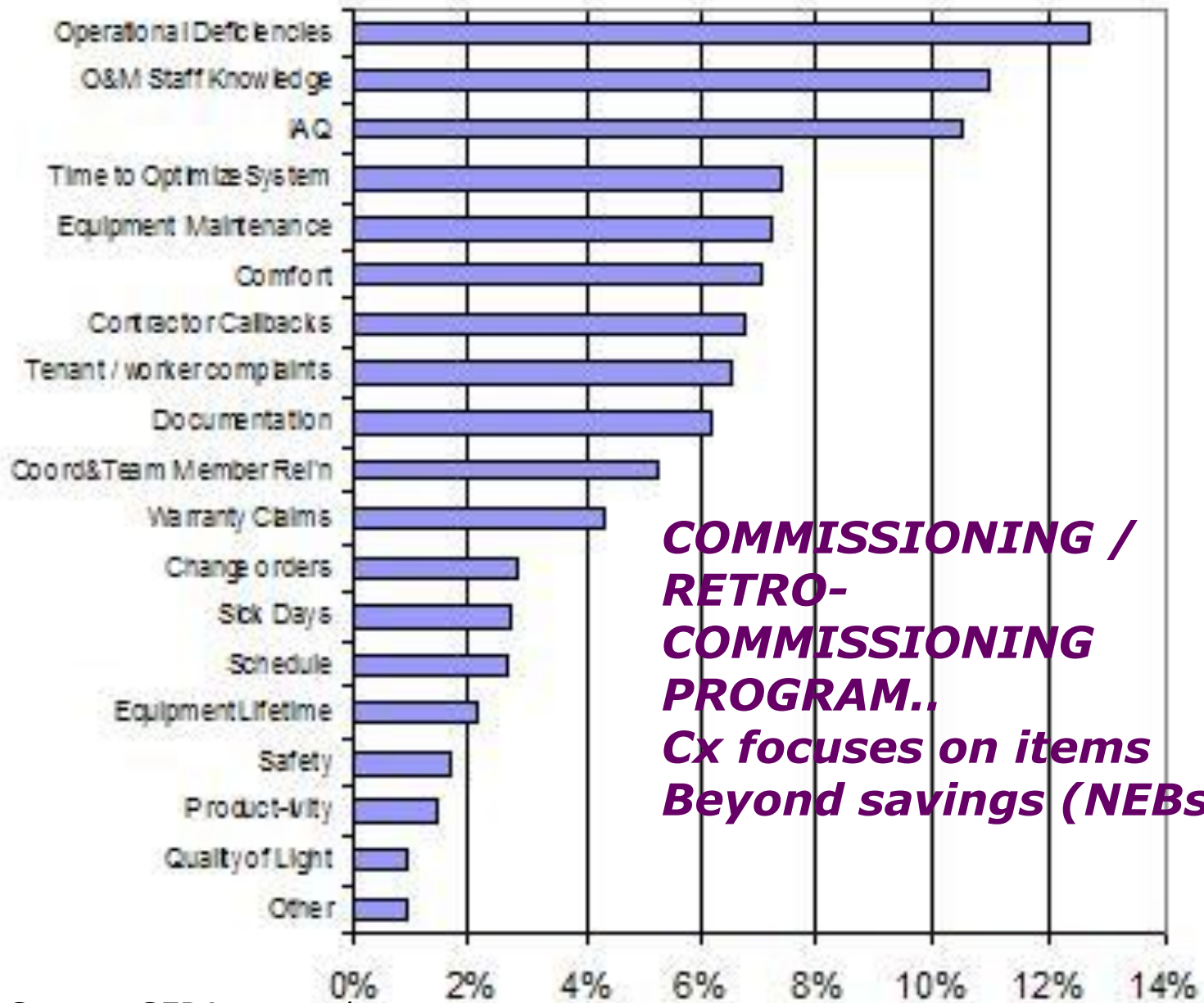
C&I NEW CONSTRUCTION



Source: Skumatz Economic Research Associates research
 (Pct of Total Partic NEBs)

■ A&E ■ Owner





**COMMISSIONING /
RETRO-
COMMISSIONING
PROGRAM..**
*Cx focuses on items
Beyond savings (NEBs)*

Source: SERA research

EXPRESSING NEBS VALUE – Cx

Yellow is highest per category	NEB Value per \$1 of gross Cx cost	NEB Value per \$1 Cx rebate provided	Benefit per "net" Cx cost (\$1)	Benefit per building square foot	Imptc of Cx compared to construct & O&M cost (0-100)
Overall	\$1.00	\$2.30	\$3.10	\$0.50	70.5
Respondent Role					
Facility Mgrs	\$1.20	\$2.80	\$4.30	\$0.70	79.1
Construction related	\$0.90	\$1.20	\$2.00	\$0.40	68.8
A&E	\$0.60	\$2.90	\$0.80	\$0.80	62.5
Facil / maint	\$0.50	\$1.20	\$1.10	\$0.20	46.7
Building Type					
Office	\$2.00	\$4.90	\$3.40	\$1.00	91.3
University	\$0.90	\$2.00	\$4.90	\$0.60	70.5
Prison (small sample)	-\$0.40	-\$0.80	-\$0.60		50.0
Other	\$0.90	\$2.00	\$1.70	\$0.50	58.0
Business Type					
Gov't / University	\$1.10 / \$0.80	\$2.60 / \$1.80	\$3.90 / \$1.70	\$0.60 / \$0.40	67.5 / 75.0
Systems Commissioned					
HVAC only / More	\$1.40 / \$0.90	\$3.00 / \$2.20	\$10.50 / \$1.80	\$1.20 / \$0.40	79.0 / 67.7
Type of Commissioning					
New / Retrofit	\$0.70 / \$1.90	\$1.60 / \$4.70	\$2.90 / \$3.70	\$0.50 / \$0.70	62.1 / 90.0

Strong value from RetroCx

Source: Skumatz Economic Research Associates research

SERA

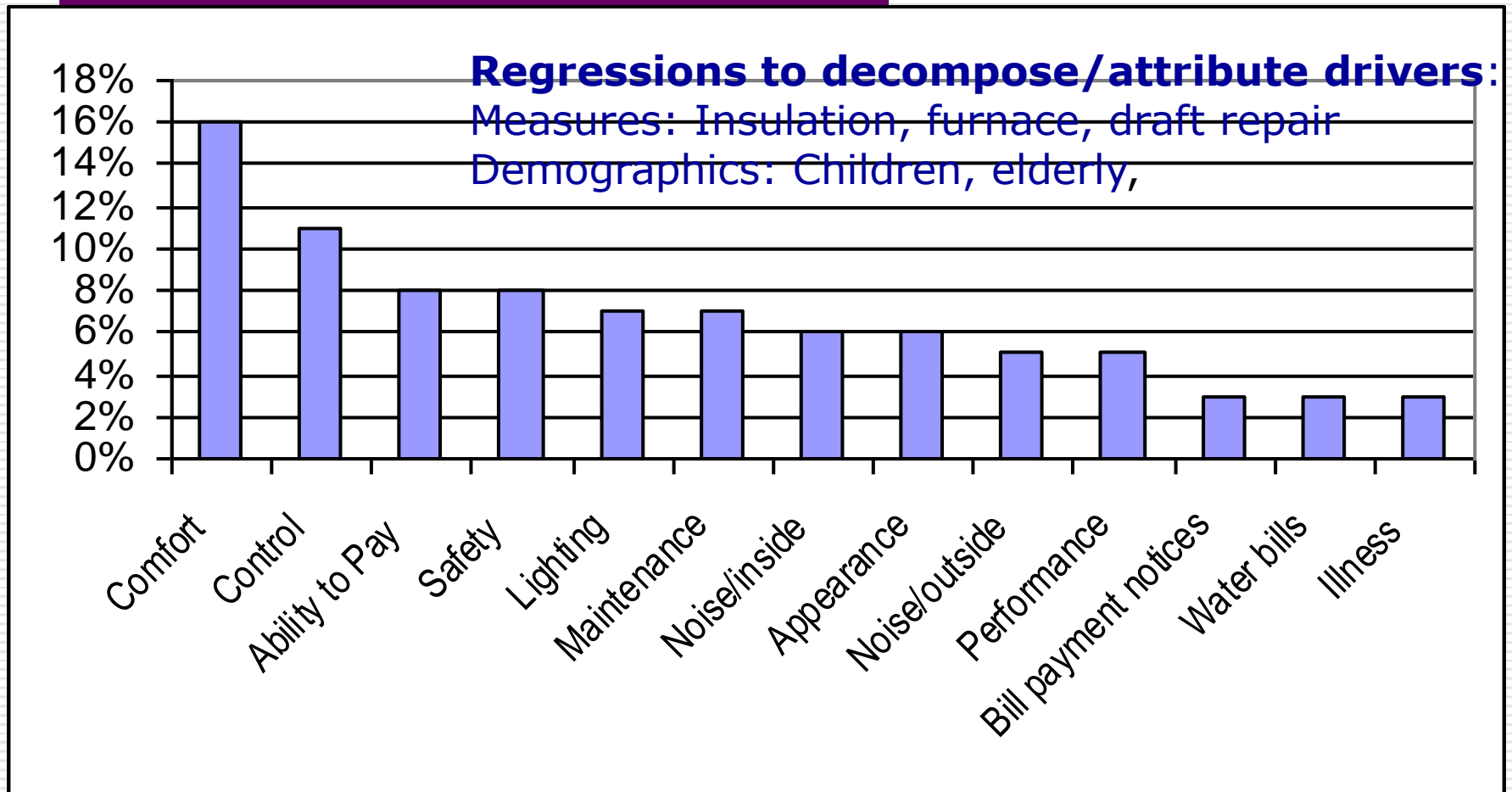
NZ-ZALEH: VALUE-OR PERCEIVED COST-OF BARRIERS

Negative NEB values / cost of barrier	Solar Water Heat NZ\$ / Euros	Solar Design NZ\$ / Euros
Appearance (NZ\$ / Euros)	-14 / -7	- 3 / -2
Maintenance (NZ\$ / Euros)	-9 / -5	- 5 / -3
Other (NZ\$ / Euros)	-	- 3 / -2
Total value of Negative NEBs for Measure (and share of energy savings)	-23 / -12 (0.79)	-11 / -6 (.06)

Implications: **Negatives / barriers**
 Can be very real & important.
 Can address with redesign, or,
 presumably, rebates. Perhaps warranties...

TOP NEBS FOR WX PROGRAM

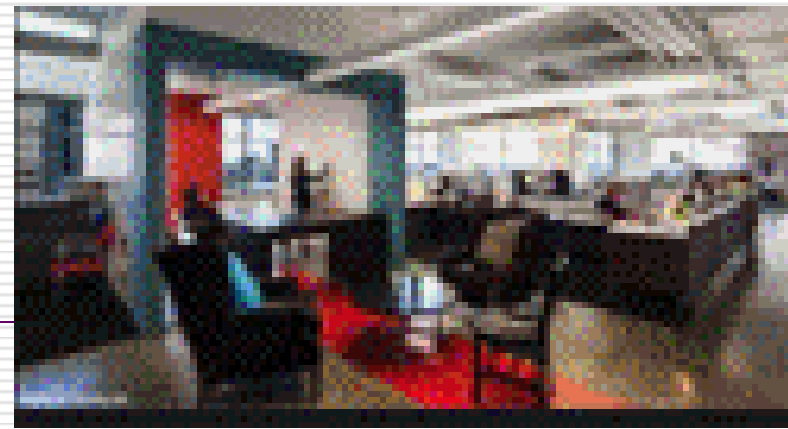
(Percent of total survey-based participant NEBs)



RESULTS FROM C&I PROGRAMS

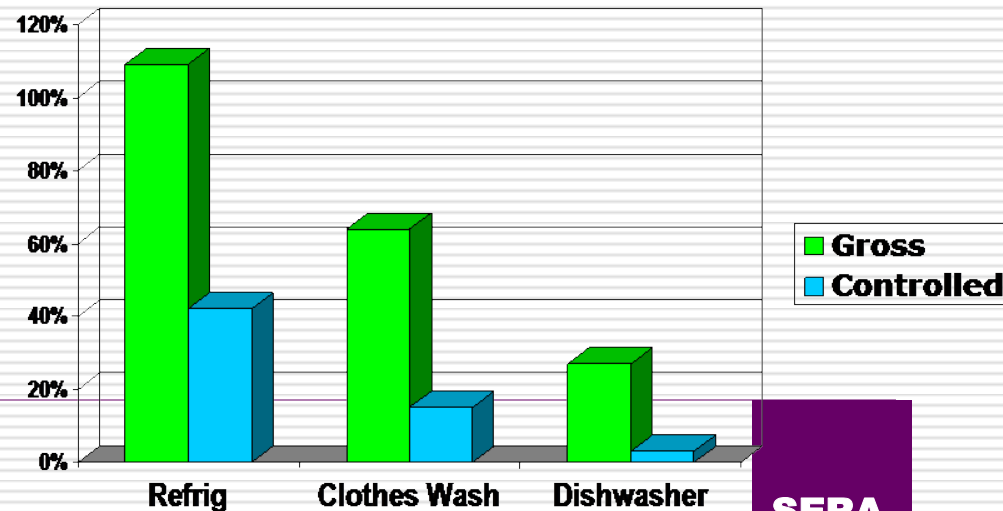
	Lighting	High performance New construction	New Construction	Tech assistance	Boilers
NEB\$	75-90%	About 100%	90-110%	75-90%	110%
Top NEBs	Enviro, other op costs, perf, lighting, comfort, safety	Comfort, quality of light, tenant satisf, eqpt perf, product- ivity, enviro, sell/lease	Enviro, Tenant satisf, performance, comfort, lite	Enviro, other op costs, perf, lighting, comfort, safety	Features/con trolfootprint, performance, tenants, noise
Neg	Maint, labor, light (not net negative)	Cost, maintenance	Maintenance	Maint, labor, light (not net negative)	Lifetime
Actor info	A&E higher value than owners	A&E less positive than owners	A&E >owners, Part > NP	A&E higher value than owners	Vendors strong, Participants much higher

OTHER PROGRAMS*



- Motors
 - Footprint
- Commercial program negatives: maintenance
- Real time pricing
- Various appliances (revealed analysis)
 - Features, noise,
 - O&M
- Student & retail
 - Daylighting
- Low income
 - Hardship
- Etc, etc.

Source: SERA research



SERA

NEBS MEASURED IN SURVEYS: CHANGES IN...

- Comfort
- Aesthetics / appearance
- Lighting quality / quantity
- Noise
- Safety
- Property value(*)
- Moves
- Control over bill / knowledge / concern / notices, etc.
- Doing good for environment
- Equipment lifetime*
- Equipment maintenance*
- Illness / lost days / visits / cost
- Other bills*
- Business productivity
- Other
- Valuation metrics vary for valuing these impact changes
 - Some directly valued from survey responses (depending on method)
 - Others "valued" (e.g. calls times length times value of time)

Some can be derived other ways, checked

Some should be explored as financial calculations instead (*)

PROGRESS IN APPLICATIONS OF NEBS

APPLICATIONS*

- Market/target–improve participation, uptake
 - Sell features users want to buy/variations... **Tide®**
 - Target audience refinements
 - Incentive-setting info; measure include / exclude
- Evaluation, policy, barriers – program guidance
 - Negative effects give clues for program interventions, remediation, measures
 - \$ investment needed; better than standard process evaluation; researchable questions
- Disconnects between actors-lost potential
- Cost-effectiveness; regulatory B/C tests
 - Cautious until accumulation of literature /comfort



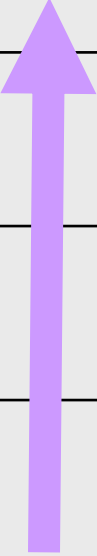
NEBS USES / APPLICATIONS

	Utility	Participant	Societal
Portfolio dev'p	Yes	Yes	Yes
Program refinem't	Yes	Yes	Yes
Marketing		Yes	*
B/C internal cust		Yes	*
B/C Tests	Yes	Yes	Yes

(*) these reflected in participant indirectly
Multiple actor interviews provide robust inferences

Source: Skumatz 2010 **SERA**

METHODS TO INCLUDE NEBS IN REGULATORY TESTS

	Maximize DSM opportunities & feedback	Minimize Regulatory Risk	Minimize Evaluation Cost
Adder			
Readily Measurable			
Hybrid			
All NEBs			

STATE / REGULATORY TREATMENT OF NEBS*

Pgm Marketing	Ont, Manitoba, Quebec (TRC), many others
Project screen	WI (caveats)
Pgm screen – not req'd	MT, GA, SC, AR, other
Test / Pgm screen – adder	VT (15%; +15% LI); CO (20/5 LI) , NH (15%); DC (10%); NY (\$15 adder for carbon); NW (15%); for low income or <1 (CA*, ID, OR, WA*, UT, WY)
Test / Pgm screen – readily measured	MA (NEBs must be “reliable & with real economic value”; utility, prop, H&S, comfort; LI); CA (Low income), VT (maint, eqpt replacement); CO (measurable with current mkt values); NH (as adder; LI); BCHydro (maint, GHG, life-time, product loss, productivity, floorspace); OR (esp C&I; carbon value on societal test, PV deferred plant extension, water/ sewer savings; laundry soap); CT (LI); RI (LI; quantify util, H&S, prop, comfort); (broader DC,MA,RI,VT)**
Test / Pgm screen scenario	NYSERDA, (DPS adder+many NEBs for scenario; programs must pass without NEBs)
Test / Pgm screen-Broad	MA order / decision - becoming broader – count in res & ICI / demonstratable incl. survey...(not yet econ / conflicting)



**More
Aggres-
sive
use**

NEBS & THE REGULATORY TEST (B/C) ISSUE*

- Internal consistency – if costs included, should include benefits (measured NEBs). Goals link. Bias leads to underinvestment
- Societal test → include utility, participant & societal NEBs
- TRC → include participant & utility & at least environmental effects
- Environmental NEBs should be included in the Societal Cost test, the TRC, and the PAC test.
- Tests for Low income programs should include NEBs – reflect policy (policy & utility) – considered LIPPT
- If Utility not willing to change test, DISPLAY the results in percents.

ADJUSTED PAYBACKS – ADDING ONLY PARTICIPANT EFFECTS

- Gross payback: 5.6 yrs → 2.5
- Net payback excl. FR: 9.0 yrs → 4.0
- B/C incl all partic NEBs: 0.9 → 1.9
- B/C adj for FR: 0.55 → 1.2



PROGRESS & GAPS IN NEBs*

- Greatest progress – beyond “lists”
 - Utility: coll’n; some T&D, subsidies
 - Societal: Climate change – models; Economic development (net)
 - Participant: water/sewer, payment-related; property value, some illness, moves, “soft” in total (not assoc. with measures); some O&M & performance
- Needs more work / gaps
 - Utility: T&D, kW, capacity, health and safety, insurance, substation infra, power quality
 - Society: Water infrastructure, hardship; kW/capacity; H&S, neighborhood improvement; (wildlife; national security, tax)
 - Participant: Limited progress on hardship indicators (LI); com’l performance/prod; fire/safety/gas; chronic health/H&S / IAQ
 - Overall: persistence pattern (& underlying EULs weak); transferability, policymakers, B/C

DIRECTIONS & LEFTOVERS*

- Feedback to design
- Perception they are inaccurate – Risk, accuracy
 - Level needed for decisions? Need reliability for important uses - False accuracy / spreadsheets & forecasting
- Perception that NEBs are costly
 - Next steps: CT - Incorporating NEBs into all process evaluations; incremental set of question on surveys
- Retention: follow measure? EULs reliable? 25 yr tech change
- Consequences of omission
 - Bias in EE investment; getting max for same budget/same for less
 - Incomplete understanding of participation,
 - Ineffective marketing / targeting campaigns,
 - Under-capture in market;
 - Inefficient / ineffective / suboptimal programs & portfolios...

THANK YOU!!



Questions?



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