

NON-ENERGY BENEFITS IN THE C&I SECTOR:

What Matters Most To Your Customers

*Omitted Program Effects and Guidance for Program
Improvements*

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TOPICS

- NEBs, rationale, context
- Measurement methods
- Results for C&I programs
 - Focus on participant perspective
- Uses and Summary

BACKGROUND AND RATIONALE

□ What are NEBs?

- Wide range of program impacts / outcomes not directly energy savings / truer program assessment

□ Literature / concepts

- Evolution from hypothetical lists to consistent evaluation & structure, and well-researched methods
- Why analyzed? Get past assumption of zero if not included... explicitly address –
 - Level of precision needed?
 - Myriad useful program applications

PROGRAMS AND PROGRESS

- Discussion reflects work for
 - Numerous projects – wide application
 - 31 projects, 25 utilities and clients
 - More than 50 programs -- >30 residential programs, >25 commercial / industrial programs, and other specialty programs (renewables, real-time pricing, commissioning, others)
 - Full scale projects for some clients (WI, CA, NE, Internat'l...), partial for others (NYSERDA, NU...)
 - Adopted in varying degrees by regulators
 - >20 publications by author

RESIDENTIAL PROGRAMS “NEBBED” USING SERA’S “NEB-It”[©] MODEL

- SF New construction
- SF Retrofit
- Air Conditioners
- Weatherization
- Eqpt. Rebate
- Direct install
- Lighting / CFL
- MF New construction
- MF retrofit
- Metering
- PV
- Low income
- Energy Star[®]
- Real time pricing
- Sustainability
- Financing / loan
- Education / Marketing
- Other
- Thousands of surveys, results
 - By measures
 - By program types
 - By sectors
 - By stakeholders
 - By geography
- Variety of end uses

C&I PROGRAMS “NEBBED” USING SERA’S “NEB-It”[©] MODEL

- New construction
- Lighting
- Motors
- Audit
- Eqpt. rebate
- Commissioning
- Technical assistance
- Training / outreach
- PV
- Retail renewable
- SPC
- DG / CHP
- HVAC
- Equipment rebate
- Other
- Thousands of surveys, results
 - By measures
 - By program types
 - By sectors
 - By stakeholders
 - By geography
- Variety of end uses

ENHANCEMENTS TO THE LITERATURE -- STRUCTURE

- Three clear perspectives / distinction

- Utility

Utility/Ratepayer

- Societal

Societal

- Participant

Participant

- Duplication? Similar, but different perspectives / beneficiaries, appropriate valuations, uses

- Expanding to other perspectives

- Documentation / sources

- Well documented, peer-reviewed computations / extensive literature (400+ publications) review to support

- Consistent units

ENHANCEMENTS TO THE NEB LITERATURE -- MEASUREMENT

- Program-attributable NEBs – NET approach
 - Need to make 3 adjustments to assure you are measuring only “attributable” NEBs
- Multiple interviewees for “perspective”, robustness, numerous evaluation applications
- Point and range estimates, scenarios (B/C, portfolio assessment, risk)

ENHANCEMENTS -- MEASUREMENT

- Estimation / modeling - Approach depends on category
 - Primary and secondary data
 - Tailored program and utility data
 - Computational method for many NEBs: baseline value * pgm impact * valuation
- Hard To Measure (HTM) / Participant
 - Some secondary, program data
 - Most categories survey-based – first to tackle
 - Demonstrated relatively low expense; add-on

CATEGORIES OF NEBs

NEBS CATEGORIES DERIVE FROM...

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

More than 60 categories... subsets as Needed / important to purpose of project

UTILITY BENEFITS

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

Societal Benefits – changes in...

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

- Economic benefits – direct and indirect multipliers
- Emissions / environmental (trading values and/or health / hazard benefits)
- Health and safety equipment
- Water and waste water treatment or supply plants
- Other

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) •NEGATIVES include: Production disruption during installation. Others are included above (e.g. troublesome maintenance, etc.) |
|---|---|

PARTICIPANT BENEFITS – RESIDENTIAL

Residential Participants – changes in...

...Valued at household marginals.

- 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

- Control over bill
- Understanding / knowledge
- “Care” (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)

- NEGATIVES include: Installation hassles / mess, negative values from items above.

MEASURING NEBS

MEASURING UTILITY & SOCIETAL NEBs

- Utility
 - Computational method: baseline value * pgm impact * valuation
- Societal
 - Economic: Input/output model multipliers – tailored by region, scope, program type -- NET
 - Enviro: emissions variations by generation type, local / selected valuations
 - Water: built up
 - Other: Program or impact-specific
- Largely routinized in “NEB-It”[©] model...
- Participant – most survey-based

SELECTING NEBs TO BE INCLUDED IN MODEL

NEB Estimates and Proxies for the Selected Program

Selected State: *MA*
 Program Year: *1999*
 Program Name: *WRAP Weatherization Program*

Present Value of NEBs
 over Evaluation Period
 (uses # participants and
 number of years)

Annual NEBs Per
 Avg. Participant
 computed from
 worksheets 7A through 9

| Select NEBs to Include | Worksheet Reference Number | Non-Energy Benefit Category | Enter # of Years this Benefit should Last | Total Program Horizon from Assumptions above | NEBs Over Program Life / Evaluation Period (adjusted)-- TO B/C CALCS | Subtotals | NEB Value Per participant HH per Year (Calculated on detailed worksheets) |
|---|----------------------------|--|---|--|--|-----------|---|
| UTILITY-RELATED BENEFITS: BENEFITS VALUED AT UTILITY COSTS AND SAVINGS | | | | | | | |
| <input checked="" type="checkbox"/> | 7A | Reduced Carrying Cost on Arrearages (interest) | 10 | 10 | \$18,021 | | \$1.71 |
| <input checked="" type="checkbox"/> | 7B | Lower Bad Debt Written Off | 10 | 10 | \$38,117 | | \$3.62 |
| <input checked="" type="checkbox"/> | 7C | Fewer Shutoffs | 10 | 10 | \$0 | | \$0.00 |
| <input checked="" type="checkbox"/> | 7D | Fewer Reconnects | 10 | 10 | \$0 | | \$0.00 |
| <input checked="" type="checkbox"/> | 7E | Fewer Notices | 10 | 10 | \$16,706 | | \$1.59 |
| <input checked="" type="checkbox"/> | 7F | Fewer Customer Calls | 10 | 10 | \$6,214 | | \$0.59 |
| <input checked="" type="checkbox"/> | 7G | Lower Collection Costs | 10 | 10 | \$0 | | \$0.00 |
| <input checked="" type="checkbox"/> | 7H | Red'n in emergency gas service calls | 10 | 10 | \$4,206 | | \$0.40 |
| <input checked="" type="checkbox"/> | 7I | Utility Health & Safety - Insurance savings only | 10 | 10 | \$0 | | \$0.00 |
| <input checked="" type="checkbox"/> | 7J | Transmission and/or distribution savings (distribution only) | 10 | 10 | \$17,887 | | \$1.70 |
| <input checked="" type="checkbox"/> | 7K | Utility Rate Subsidy Avoided (CARE) payments | 10 | 10 | \$382,581 | | \$36.38 |

Source: Skumatz Economic Research Associates, Inc., 2001

KEY SETTINGS FOR NEB COMPUTATIONS IN MODEL

Reduced Carrying Costs on Arrearages -- Utility Perspective

User Selects only one value. Check the blue box

| Item | Selected Utility | Computation Description | Source | Research Study Options for Values for Item 2: | | |
|--------|------------------|---|--|---|-------|--|
| | | | | USER Select ONLY one | Value | Source |
| Item 1 | CT \$79.40 | Average Arrearage per Low Income Customer | California Utility Data Sheet | <input checked="" type="checkbox"/> | 28% | Average |
| Item 2 | 32% | Times Estimated Program-Induced Percentage Reduction in Arrearages | Selected Research Value (see Yellow table for value and alternates) | <input type="checkbox"/> | 16% | Median |
| Item 3 | 8.10% | Times Appropriate Utility Interest Rate for Carrying Charges | California Utility Data Sheet | <input type="checkbox"/> | 0% | Minimum |
| Item 4 | \$2.03 | Equals Proxy for NEB: Reduced Carrying Cost on Arrearages -- in Annual Terms | Computed (Item1*Item2*Item3) | <input type="checkbox"/> | 90% | Maximum |
| Item 5 | 10 | Input: Assumed Years for the Benefit | Assumptions Table | <input type="checkbox"/> | 0% | Hagler, 1993, Wisconsin Gas |
| Item 6 | 1.0 | Item 4 Multiplied by Adjustment Factor for Appropriate Horizon | Derived from horizon and discount assumptions from Program Assumptions Table | <input type="checkbox"/> | 2% | Quaid and Pigg, 1991, WA Yakima Valley (YVESP) |
| Item 7 | \$2.03 | Equals Proxy for NEB: Reduced Carrying Cost on Arrearages in Dollars per participant per year | Computed -- annualized dollars per average participating household per year | <input type="checkbox"/> | 3% | Quaid and Pigg, 1991, WA Yakima Valley (YVESP) |

Source: Skumatz Economic Research Associates, Inc., 2001

CONSIDERABLE WORK ON SOCIETAL BENEFITS (as a result)

□ Environmental benefits

- Emission computations vary by generation source
- Multiple options for valuations by emission
- Updated with add'l options, tailoring

□ Economic benefits / multipliers

- Economic impacts – vary by type of program
- Job creation benefits
- SERA input-output analysis; corrected flaw in key literature on “net” impacts

□ Extensive work on health benefits

- Surveys and secondary values for multiple clients

MEASURING PARTICIPANT BENEFITS

WTP and beyond... how developed

MEASURING PARTICIPANT BENEFITS

- Important, yet ignored by literature as HTM. SERA pioneered CV & beyond
- 7 main approaches (+ many variations) used / developed / adapted / tested by SERA
 - Administered via phone, mail, clipboard, web, fax, other over the years

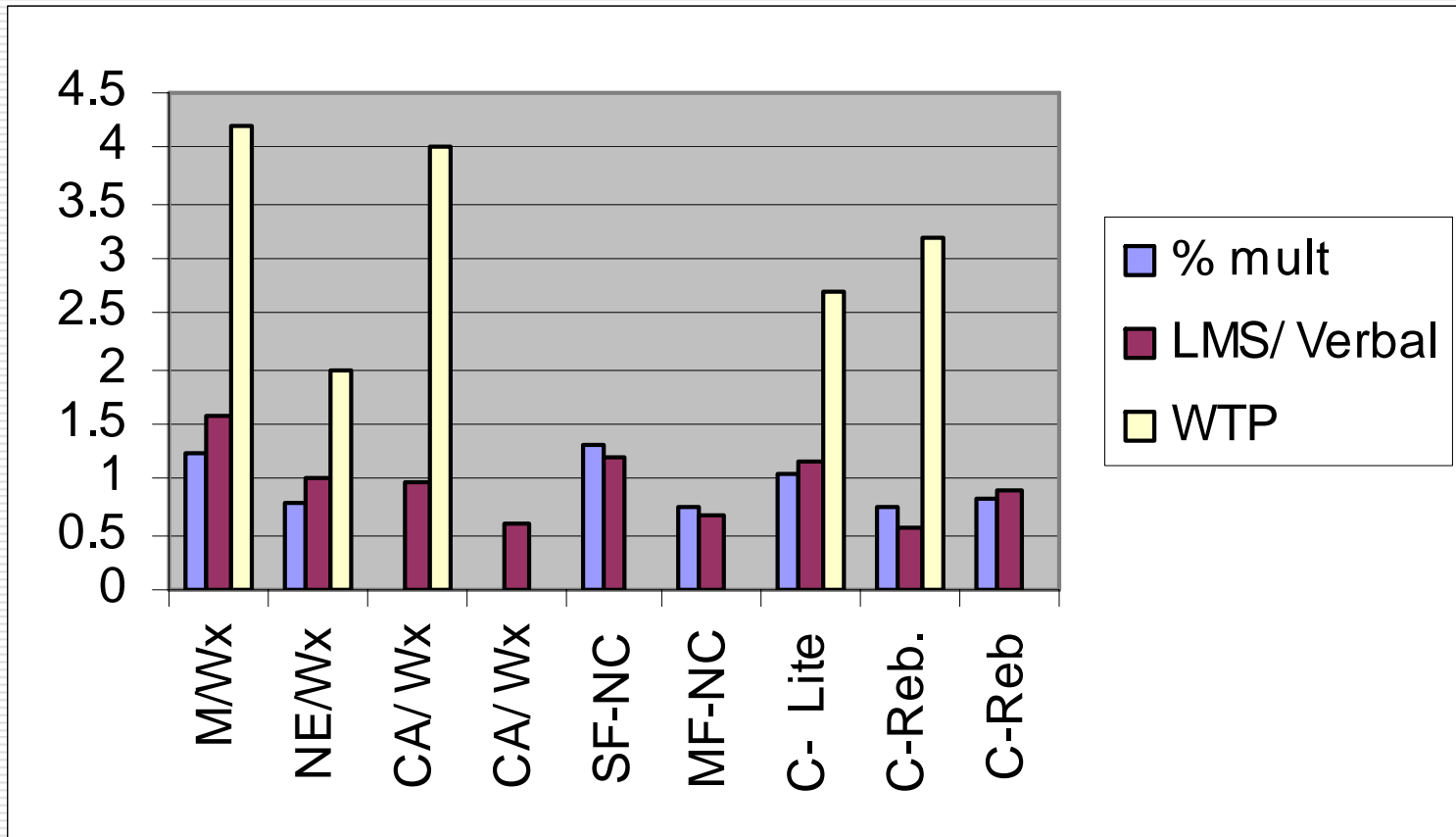
PARTICIPANT FOCUS / MEASUREMENT

- Basic pros / cons. Looking for consistent, reasonable practical, unbiased method.
- Assessed / compared on bias, theory, field performance
 - Demonstrated in literature * Response ease
 - Reliability / volatility * Conservative /
 - Clarity / computation, etc. consistent
- Problems with direct: rarely available so missing observations problem
 - Survey approach
 - Perception... what are you trying to measure?

PARTICIPANT FOCUS / MEASUREMENT

- ❑ Suitability varies by: sector, time, budget, program. other
- ❑ Individual categories and overall values
- ❑ Examples from numerous programs / papers (2000-current)

COMPARISON OF MEASUREMENT METHODS



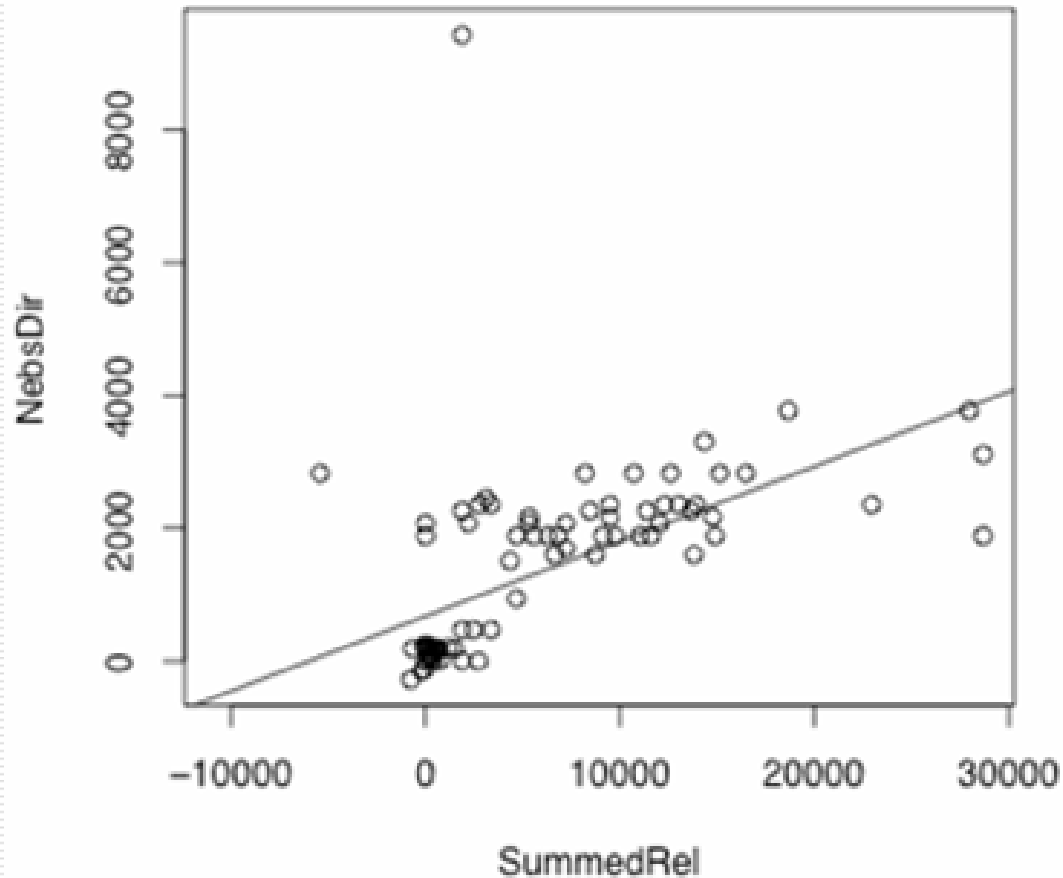
PARTICIPANT MEASUREMENT APPROACHES – RESULTS INDICATE

- LMS / % similar
 - LMS a little higher usually; LMS faster; categories
- WTA volatile, usually higher value (depends where placed in survey)
- Basic WTP volatile – higher, huge delay / uncertainty; bargaining bias
 - Refined WTP approaches closer to other results... but slower; depend on values selected...
- → Most consistent / fast / practical – LMS; refined multipliers from >4,000 surveys

INDIVIDUAL CATEGORIES VALUED USING SEVERAL METHODS

- Methods used to indicate value or importance (can use same methods)
 - Comparative percent
 - LMS
 - Positive / negative
 - Highest 3
- LMS most fruitful / fastest
- Results vary by program

MAPPING SUMMED INDIVIDUAL VS. TOTAL NEBS – COMM'L LIGHTING



INDIVIDUAL CATEGORIES VALUED USING SEVERAL METHODS

- Sum > total
 - Average multiple 2-4 times (2.9 and 3.6 in paper)
 - Reasons: overlap, revise scale, verbal list, etc.
- Approaches
 - “Normalize” results; maintain relative importance
 - ASK about overlap and revise lists and reporting
 - Other / investigating

PARTICIPANT MEASUREMENT APPROACHES

- Currently running small scale test of 7 leading approaches previously mentioned; investigating bias, speed, results
 - Promising results from several, particularly in commercial and more complicated programs
 - Looking for opportunity to test further / larger scale
- Difficulty – obtaining external / outside / independent measurement
 - Price encompasses efficiency, NEBs, etc.
 - Experiments...
 - What trying to measure?

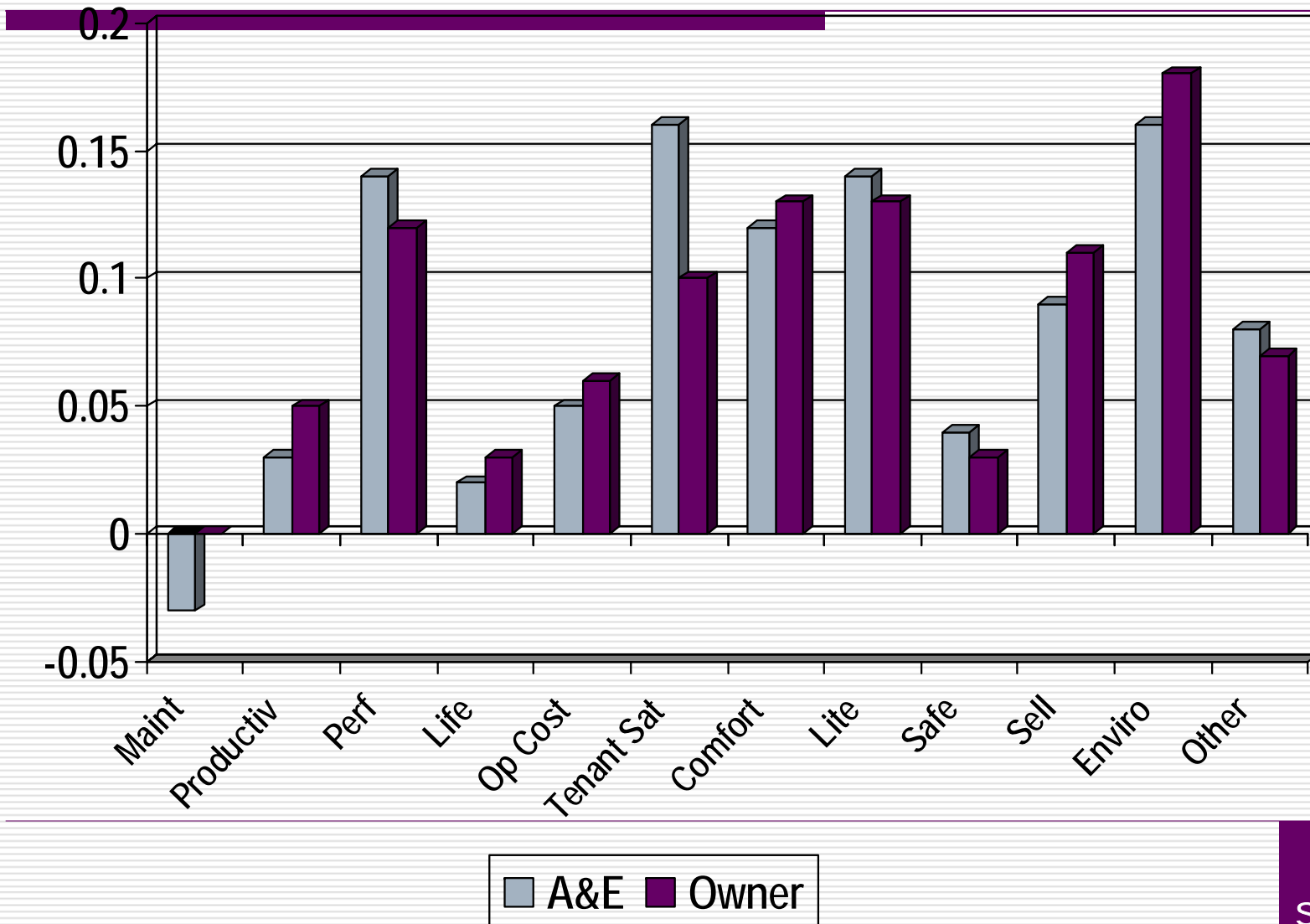
RESULTS FOR SAMPLE OF C&I PROGRAMS

Individual and Total NEBs

C&I PROGRAMS “NEBBED”

- New construction
- Lighting
- Motors
- Audit
- Eqpt. rebate
- Commissioning
- Technical assistance
- Training / outreach
- PV
- Retail renewable
- SPC
- DG / CHP
- HVAC
- Equipment rebate
- Other
- Thousands of surveys, results
 - By measures
 - By program types
 - By sectors
 - By geography

NEW CONSTRUCTION



NEB RESULTS FROM C&I PROGRAMS

- Sample results and results presented for individual programs (contact author for more detailed results)

RESULTS ALSO VARY BY MEASURES (and sector)

Lighting

- better lighting
- safety/security
- lower maintenance
- work environment
- aesthetics
- glare, eyestrain
- productivity
- control, other

Refrigeration

- maintenance/lifetime
- noise, control
- product life/losses
- reduced water use
- aesthetics

HVAC

- maintenance/life
- comfort
- air, airflow, quality
- productivity
- tenant satisfaction
- aesthetics
- control
- environmental

Water

Motors

Etc.

ESTIMATE WORTH BY MEASURE,
BUILDING TYPE, END USE, ETC.

COMM'L RESULTS BY MEASURE TYPE

- Sample results by measure type
- Sample results by end use
- Sample results by business type
- Results from several thousand surveys provide useful information for "peer to peer" (e.g. hospitals to hospitals)

ARE NEBS USED IN MARKET
/ DECISIONS?

USE OF NEBS BY MARKET ACTORS IN EE MEASURES DISCUSSIONS

| | MF Meter (.44-1) | Rebate (new) (.65) | TA (.75-- .90) | Rebate (0.90) | HVAC (.9- 1.3) | Cx (1.8) | Lite (.62-.78) |
|--------------------------|---|---|--|----------------------------|----------------------|-----------------|--|
| Used/ owner report | 37% | 45% | 35% | 40% | 82% | 81% | 80% (54% Pgm 2) |
| Contractor report | 56% | 74% | 56% | | | | |
| Most important | Bill control, usage/load, enviro, cost, maint. | Maint, comfort, lighting, prod, IAQ | Maint, safety, product ivity, enviro | Maint, lite, control | | | Light quality, Op costs, aesth, prod, maint |

NP Lighting Distributors cited enviro

USES, SUMMARY, & IMPLICATIONS

STEPS

- Utility and societal NEB estimation / modeling
- Participant combination of surveys & direct
 - Steps in gathering data, estimating NEBs
 - Interpretation / implications
- Apply to program portfolio, B/C, program decision-making, outreach...

NEBS SIGNIFICANT OMITTED PROGRAM EFFECTS

| | NEB Values Relative to the Value of the Program Energy Savings (easily converted to currency values) |
|------------------------------------|--|
| Perspective | Non-residential Programs |
| Utility | Varies for commercial but tends to be relatively low unless power quality is an important factor. Varies with inclusion of gas measures or not, program design and targets. |
| Societal | 100%-300% of energy savings typical, depending on aggressiveness of environmental and economic valuations |
| Non-residential Participant | Equipment programs, 35-50% of measure savings New construction programs about equal to value of energy savings; Commissioning, about equal to the value of the work conducted; Other variations by program type. Depending on program type, these may need to be discounted additionally for free ridership. |
| Total NEBs | Total - 35% to 300% / 400% of energy savings |

SUMMARY & CONCLUSIONS

- NEBs strong benefits – to participants and others
 - Well past conceptual – important / large / measureable
 - 0.4 – 1.5 times energy savings; more with utility & societal
- Strongest individual categories depend on program, utility's design, targets... evaluation implications...
- Cost-effective add-on to evaluations –
 - 2 levels: primary data coll'n or tailored default values

APPLICATIONS / USES

- Benefit cost, enhanced with scenarios
 - Uses in B/C ratios / enhanced B/C; more programs “pass”
 - Assess portfolio & mix, scenarios...
 - “Adders”, enhanced regulatory tests – (accepted to varying degrees), etc.
- Program design
 - Program / benefits maximization & optimization
- Program marketing / outreach / targeting
 - Speak in participant value terms in mktg
 - Sell what people want to buy-past EE
 - Tide example

APPLICATIONS / USES

- Program evaluation
 - Meaningful barriers analysis
 - Market progress in barriers – useful implications of \$ value of barrier and remediation costs
 - Tracking market progress in perceptions
 - “Disconnects” between decision-makers and implications
 - Tracking success in education/training/info
 - Refine training to address
- Working with ESCOs, etc.
- Other

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