PA Consulting Group

Subject **Focus on Energy Evaluation**

A Review and Update of NEBS Values for Residential Programs

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Benefit-cost (b/c) reports for Focus on Energy estimate non-energy benefits (NEBs) for an expanded test of the program portfolio's effectiveness (Goldberg et al., 2007; Goldberg et al, 2009). NEBs represent an array of valued attributes deriving from energy efficient measures that are in addition to energy savings, such as increased property value or reduced water usage. Focus evaluation does not include employment effects or emissions reduction as NEBs, though these are factored into b/c analysis as separate categories of program effects.

For Focus evaluations, NEBs are added to the benefit side of program effects in one of two ways. NEBS typically are factored as a dollar amount per measure installed. Alternatively, they are factored as a multiplier of the first-year energy savings.[1] The estimated value of NEBs for residential programs, program-to-date as of the first half of 2009, is $35 million (PSCW, 2009).

The Focus evaluation team has examined the recent NEBs literature to identify NEBs multipliers that might be incorporated into a set of recommendations for changing NEBs values. Given the difficulty of measuring NEBs and the paucity of published findings, however, we are not recommending any changes to the current NEBs values from published sources. We do make several recommendations for fine-tuning NEBs values used in future evaluations. The NEBs recommended here will first be applied in the final CY09 semiannual report (SAR).[2]

NEBs Multipliers from Secondary Sources

A significant portion of the NEBs literature is devoted to inherent difficulties in estimating NEBs values, to the review of past findings, and to making recommendations about appropriate methodologies. For instance, there is growing consensus that willingness-to-pay (WTP)

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[1] In the NEBs literature, an alternative approach is a multiplier on the net avoided cost of energy savings.

[2] Draft will be issued at the end of March.

methods—where potential beneficiaries are asked to place a dollar value on NEBs—tend to overstate the value of NEBs, are unstable, and should be abandoned in favor of contingent valuation, conjoint, and magnitude scaling methods (Wobus et al., 2007; Skumatz and Gardner, 2006; see also Amman 2006). Of these, conjoint seems to hold a great deal of promise, though significant barriers remain related to its complex implementation.

Whatever method is used, we believe it is important that NEBs estimates be couched in dollar values, rather than as a multiplier applied to energy savings. NEBs multipliers that are widely reported in the literature are valuable as a point of comparison in this still-early era of NEBs measurement; but the very concept of NEBs is that they are not a simple function of energy savings. Thus, it is almost certain that these ratios are unstable over time, as energy and non-energy benefits change in step with different processes.[3] For Focus evaluation of residential programs, we use multipliers primarily as a means of combining NEBs values across diverse measures, such as in the case of "other" measure categories or in the case of the Apartment and Condominium Efficiency Services (ACES) program, applied to all measures. Otherwise, we apply per-unit dollar values.

There are significantly fewer published reports of actual NEBs values for residential programs than there are discussions of the associated methodology. Indeed, the literature has become a veritable echo chamber, where the few published values are repeated in subsequent reviews. And, although we found general discussion of NEBs accruing to utilities and to society at large, we did not find any published estimates of them. The primary focus has, quite understandably, been on the more difficult to quantify NEBs accruing to program participants.

Given the evolution of the measurement methodology and the goal of updating previous values, our literature review focused on values published in 2004 or later. We had hoped to obtain multiple estimates for each measure category or program so that we could assess variance across estimates relative to measurement approach, geography, and other factors. The scarcity of published data precluded any systematic application of this approach, however. In general, we can remark that, setting aside whole-house programs, most NEBs multipliers have a value less than one, with the mean among reported values we identified of 0.44 and a median of 0.34. Whole-house programs generally have higher NEBs multipliers. Table 1 shows a summary of published NEBs multipliers for residential programs. All values are for NEBs accruing to programs participants.

[3] This remark may seem at odds with the fact that NEBs values are sometimes elicited from program participants by asking how much value they received from a measure relative to their energy savings. This measurement device provides a cognitive anchor that makes it easier for people to answer the questions. It should not, however, irrevocably link the two values. The problem with applying multipliers is that energy savings fluctuate over time as for instance different technologies fall under a measure category or different measure categories are included in a program. We believe the NEBs multiplier approach invites unrecognized error to be introduced into NEBs estimates over time.

Table 1. Recently Published NEBS Multipliers in the Residential Sector, by Measure Category

Measure Category	End Use	Method	Geography	NEB Value	NEB Multiplier	Year	Source*
Clothes Washer	Appliances	Scaling	NY	-	0.54	2004	(I)
Clothes Washer	Appliances	Conjoint	NY	$83.00	0.84	2006	(III)
Dishwasher	Appliances	Scaling	NY	-	0.65	2004	(I)
Refrigerator	Appliances	Scaling	NY	-	0.29	2004	(I)
Room AC	HVAC	Scaling	NY	-	0.71	2004	(I)
CFL	Lighting	Scaling	NY	-	0.90	2004	(I)
CFL	Lighting	WTP	NY	$8.40	0.51	2006	(III)
CFL	Lighting	Conjoint	NY	$1.66	0.13	2006	(III)
Lighting Fixture	Lighting	Scaling	NY	-	0.30	2004	(I)
Double Glazing	Shell	Scaling	New Zealand	$109.00**	0.26	2007	(II)
Super Insulation	Shell	Scaling	New Zealand	$229.00**	0.37	2007	(II)
Insulation	Shell	Scaling	New Zealand	$27.00**	0.30	2007	(II)
Insulation	Shell	Scaling	New Zealand	$73.00**	0.71	2007	(II)
Water Heater Wrap	Water	Scaling	New Zealand	$18.00**	0.22	2007	(II)
Solar Water Heating	Water	Scaling	New Zealand	$27.00**	0.04	2007	(II)
Solar Design	Shell	Scaling	NY	$156.00	0.25	2007	(II)
Whole House	New Construction	Scaling	NY	-	1.00	2004	(I)
Whole House	New Construction	WTP	NY	$303.00	0.51	2006	(III)
Whole House	New Construction	Conjoint	NY	$801.00	1.34	2006	(III)
Whole House	New Construction	WTP	MA	$1,445.00	3.61	2009	(IV)

*Source:

Fuchs, Skumatz and Elefsen, 2004.
Skumatz and Stoecklein, 2007.
Barkett et al., 2006.
Tolkin et al., 2009.

** Converted from $1.00 NZ = $0.92 US.

A number of the measures in Table 1 are irrelevant to Focus evaluation because they are not currently being promoted by Focus residential programs. Of interest, however, are clothes washers, CFLs, insulation measures, and whole house measures. We note that the NEBs multipliers for these measures are not markedly consistent from one study to the next. For instance, new construction program multipliers vary by a factor of more than seven.

In principal, we believe the conjoint-based values used by Barkett et al. (2006) for whole house programs are more reliable than the others, because of the methodology used; but this, admittedly, needs further demonstration.[4] One problem with their approach is that they use the

[4] We are concerned that full documentation of the conjoint model was not provided so we cannot evaluate the fit of the model to the data. Nevertheless, conjoint methods, if well designed, offer promise of improved estimates of NEBs. The chief virtue of conjoint analysis is that it asks respondents to make a choice between alternatives, which is a more realistic cognitive task than assigning a numerical value to a benefit. With new, web-based technologies available to administer conjoint studies, some of the significant implementation difficulties are being addressed. The approach of asking for an ordinal comparison of NEBs relative to energy savings is a different way of addressing this cognitive problem;

resale value of the home to estimate the dollar value of other NEBs such as durability, comfort, and safety. This is standard conjoint modeling; however, it means they cannot include resale value itself—typically one of the highest valued NEBs—*as a NEB*.[5] In other respects, this seems a plausible result built upon good research. They include benefits for air quality, comfort, durability, noise level, and safety, estimating a lifetime NEBs value of more than $22,000 over a twenty-eight year measure lifetime and an annual value of $801.

NEBs estimates for CFLs vary from 0.13 to 0.90. To give some idea of the significance of this difference, if we applied the highest NEBs multiplier of 0.90 to the first year net avoided costs of CFLs installed through Focus residential programs in the first six months of 2009, the value of NEBs would be $2.1 million; applying the lowest multiplier of 0.13 would yields a NEBs value of $0.3 million. We have reason to doubt that even the lowest values for CFL NEBs, i.e. $1.66, are accurate. Those derive, once again, from the conjoint study of Barket et al. (2006). They estimate a lifetime value for CFL NEBs of $6.63, for the benefits *bulb lifetime* and *heat generated*, netting out non-energy costs for *turn-on delay* and *warm-up delay*. The reason for doubt is the implication that retailers could add this amount, or a portion of it, to the price of CFLs and the "average customer" would continue to purchase them. The difficulties encountered in getting people to switch from incandescents to CFLs would seem to contradict the view that CFLs are under-priced. The estimate in this study is based on a sample where half the respondents have never installed a CFL. Perhaps a better number is the NEBs value estimated for CFL users, which is lower than the value for non-users, i.e., $3.59 lifetime, or $0.90 per year. This represents a NEBs multiplier of 0.07. One significant limitation of this study is that the estimates are based on a sample of only ten CFL users. So, while we believe the methodology is appropriate and the results plausible, further substantiation would be needed before these values were adopted.

The two NEBs estimates for clothes washer NEBs are similar in value. The higher of the two, $83.00 with a multiplier of 0.84 is from the Barkett et al. (2006) conjoint study.[6] We note that among the NEBs modeled—reduced water use, reduced wear and tear, reduced drying time, reduced noise—this study also included "reduced energy costs" as a NEB in their summary table, with an annual value of $48.27. If we remove this from the total, the NEBs based on scaling and conjoint approached are much more closely aligned: a multiplier in the neighborhood of 0.5. Given changes in the market for clothes washers since these NEBs were estimated, however, which have led Focus to shift from ENERGY STAR machines to promoting only tier two and tier three machines, the direct application of these values to Focus is highly questionable.

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but the task of converting relative judgments to dollar amounts introduces new methodological problems that have not been adequately addressed in the literature on NEBs.

[5] The model implies that the added resale value is the sum of the values of the other NEBs. A more typical interpretation is that the resale value NEB is the additional value to subsequent purchasers of an ENERGY STAR or similar designation. In other words, the homeowner derives benefit from comfort, healthy air, etc. and derives an additional increment of benefit from an increased resale value. The importance of resale value—its perceived benefit—to the individual would necessarily be a function of the perceived probability that the home will be sold, and when.

[6] The NEBs values in a summary table on p. 51 ($83) is not consistent with the values in the detailed discussion on p. 73 ($89; but should round to $90).

The published estimates of insulation NEBs that we found are from a single study that was conducted in New Zealand. The application to the Focus territory of NEBs values at such a distance, both culturally and economically, is problematic. Combined with the divergence in the NEBs values obtained, which reflect different programs but the same measurement approach, it does not seem prudent to apply these values to other contexts.

In sum, we do not believe the literature provides a useful basis for revising the NEBs values applied to Focus residential programs. We do not expect published values to provide a useful approach to obtaining NEBs until a substantial body of published NEBs values exists. Insofar as obtaining NEBs estimates is a priority for Focus decision makers, the emphasis should be on primary research. This is the basis for current NEBs estimates. The study currently in use for residential NEBs values was conducted in 2003 (Hall 2003), however; new primary research could update these estimates, which are beginning to age.

Health and Safety Benefits from Avoided Emissions

There is wide recognition that health and safety benefits accrue to some measures installed through energy efficiency programs. Indeed, for whole-house programs, these benefits are considered a significant inducement to participation (Knight, Lutzenheiser, and Lutzenheiser, 2004). We reviewed the energy efficiency literature for references to health and safety NEBs. These are frequently included in discussions of NEBs, but we found no reports that could directly translate into NEBs values for Focus. One approach used by Skumatz and others (Stoecklein and Skumatz, 2004; Skumatz and Gardner, 2006; Skumatz and Stoecklein, 2007), assign health NEBs as a percentage of total NEBs value for a measure or program. The values reported from one study to another are between 3 percent and 17 percent of total NEBs. This information is not directly applicable to Focus measures, however, because it assumes establishing first a total value for NEBs and apportioning this to sources; we build NEBs values up from constituents and thus lack an independent, separate value for the total.

NEBs calculation for Focus program have centered on benefits directly associated with installed measures (e.g., time savings, increased property values, and water savings). More recently there has been an increased interest in emissions, including energy efficiency as a mechanism for reducing those emissions. This has resulted in research quantifying health benefits from avoided emissions. While we have counted avoided emissions and assigned a market value to those effects, we have not assigned a value directly to the health benefits of avoided emissions. These benefits arise primarily because of reduced respiratory illnesses and deaths. To date, we have not completed the research necessary to assign these values to Focus savings. We note that the journal *Lancet* has recently published a finding, for Europe, that monetizes the health benefits of reduced emissions (Markandya et al, 2009). They put a value of $1.65 on each ton of displaced CO_2. While this model cannot be directly applied to the Focus territory, because its inputs include natural conditions of the area evaluated, such as wind patterns and insolation, it does provide some insights for further research that might allow reasonable valuation of additional benefits realized by society as a result of the avoided emissions attributed to Focus activities.

Current and Recommended NEBs Values for Focus Residential Programs

Focus residential evaluations have applied NEBs to relatively few measure categories. This has seemed prudent given the uncertainties surrounding NEBs estimates. NEBs values are based on Focus evaluation research with program participants and trade allies (Hall, 2003). Table 2 shows current NEBs values used, for instance, in the first 2009 semiannual report[7]. The column "NEBs Unit" indicates how the NEBs value is applied, either as a multiplier on energy savings (i.e., "kWh" or "therms") or on a per-measure basis (i.e., "unit" or "home"). Values in the column "NEBs Multiplier" are calculated from 2009 first-year net avoided energy costs.

Table 2. Current Annual NEBs Values

Program	Measure Category	NEBs Value	NEBs Unit	Implied NEBs Multiplier
Apartment and Condo Efficiency Services	All Measures	$0.05	kWh	0.28
ENERGY STAR® Qualified Appliances	Clothes Washers	$1.05	unit	0.05
Home Performance with ENERGY STAR	Other	$2.14	therm	1.81
Home Performance with ENERGY STAR	Air Sealing	$125.00	home	1.60
Home Performance with ENERGY STAR	Attic Insulation	$300.00	home	3.83
Home Performance with ENERGY STAR	Sidewall Insulation	$600.00	home	4.30
Wisconsin ENERGY STAR Homes	Home Certification	$97.80	home	0.92

Focus evaluation has made a distinction between NEBs having realizable monetary value, such as home resale value and NEBs that, while valued by participants, do not have realizable monetary value, such as improved home comfort. The former are termed "economic" and the latter "non-economic" NEBs. Only economic NEBs have been applied to Focus programs. Thus, nearly all of the NEBs discussed in the previous literature review would be excluded under the current approach.

Apartment and Condominium Efficiency Services

NEBs currently are attributed to the Apartment and Condominium Efficiency Services program as a multiplier of $0.05 per kWh of savings. This is based on benefits accruing to reduced maintenance costs associated with CFL installation ($280 per year, per site) and to increased property value ($153 per year, per site). It also includes reduced water consumption costs related to installation of low-flow showerheads and aerators ($19.70 per year, per site). The multiplier was derived from the ratio of NEBs to kWh savings reported in the 2003 b/c study, and has been carried forward since then.

We recommend replacing the current global NEBs multiplier with separate values for lighting and water savings. For sites where lighting measures are installed, we recommend applying the value of $280 per site. For sites where low-flow showerheads or aerators are installed, we recommend a value of $9.85 per site for low-flow showerheads and $9.85 for aerators. This will

[7] Focus Evaluation Team. *Semiannual Report (First Half of 2009).* Revised Final: October 19, 2009.

yield a NEBs value of $19.70 at sites where both measures are installed, i.e., the most common situation, and half that value where only one or the other is installed.

For the increase in property value associated with the Apartment and Condominium Efficiency Services program, the original formula was to assign eighty percent of the incremental cost of the measure, amortized over eight years with no depreciation. This formula seems reasonable as a somewhat simplified rule. We recommend adding this value to the other NEBs.

ENERGY STAR® Qualified Appliances and ENERGY STAR® Qualified Lighting

Clothes washers currently are assigned $1.05 in NEBs per year for the value of the water savings they achieve. This is based on a twenty-gallon water savings per load for an ENERGY STAR clothes washer.

We recommend changing the NEBs value to reflect changes in Focus programming. Focus no longer promotes tier one ENERGY STAR clothes washers. It now promotes only tier two and tier three machines. Tier two machines use only about 74 percent of the water used by tier one machines; and tier three machines use about 60 percent of the water used by a tier one machine (Consortium for Energy Efficiency, 2009).[8] We recommend increasing the NEB for water savings to reflect this change. Assuming that about eighty percent of program participants will choose tier two machines and twenty percent will choose tier three machines, the blended water consumption rate should be approximately 71 percent of tier one machines, a savings of about 28 gallons per load and a water savings NEBs value of $1.48 per year per unit.

Though CFLs are not included in Table 2, they require some discussion. The attribution of NEBs to CFLs distributed through the residential ENERGY STAR program has been inconsistent. The original NEBs research report (Hall 2003) estimated a NEBs value of $1.29 per lamp, per year. This was based on an assumption that a typical incandescent is replaced 1.5 time per year, requiring ten minutes to replace, at a minimum wage rate (at that time) of $5.15. This value was applied in the 2003 b/c report. For the 2007 report, it was dropped without explicit comment. It was resurrected for the 2009 b/c report as a multiplier of 0.96 times energy savings.

Our current thinking is that this resurrection was incorrect and that CFLs should not receive NEBs. The NEB identified in the 2003 research, however well conceived, does not meet the definition of economic NEBs because the value is never realized in an economic transaction. That is, the homeowner never receives his or her minimum wage rate for the activity of replacing a lamp, so never receives an economic benefit from not doing so. For b/c analysis, Focus evaluation does not include non-economic NEBs; thus, we recommend no NEBs for ESP CFLs.

[8] See Consortium for Energy Efficiency, *Super Efficient Home Appliances Initiative, Clothes Washer Qualifying Products List*, December 15, 2009, http://www.cee1.org/resid/seha/rwsh/rwsh-prod.pdf.

Home Performance with ENERGY STAR

NEBs for the Home Performance with ENERGY STAR program accrue from the increase in property value associated with improved insulation. Currently, the values $125 for air sealing, $300 for attic insulation, and $600 for sidewall insulation are applied per house. We believe these values are too high and exclude other types of insulation that currently is being installed through the program. The original logic, laid out in Hall (2003), is that one-third of the incremental cost of insulation should be added to the property value. There is no mention in the memo of amortizing this NEB but this clearly should be done.

We recommend applying a NEBs value of one-third of the incremental cost of all building shell measures, divided by the number of years over which the benefit is realized. The benefit for increased property value is realized when a property is sold. Census data indicates the average duration of residence in owner-occupied housing is approximately eight years (Hansen, 1998). If we make a further assumption that the average homeowner is halfway through their tenure in the home, the average remaining tenure is four years. Thus, we recommend dividing the total NEBs value by four to arrive at an annual value.

The NEB value for the measure category "Other," i.e., $2.14 per therm savings, applies only to chimney liners. This is equivalent to one-third of the estimated incremental cost of the measure, which is based on therm savings. We recommend converting this NEB value to the same calculation used for other building shell measures.

Wisconsin ENERGY STAR Homes

For Wisconsin ENERGY STAR Homes, the "Home Certification" measure category is attributed $2,445 in NEBs for an increase in property value due to certification. This is an average of the responses from interviews with Wisconsin ENERGY STAR Homes builders in 2001, who estimated the difference in cost between a Wisconsin ENERGY STAR Homes home and non-Wisconsin ENERGY STAR Homes home to be between $150 and $9,000. This value is spread across 25 years to obtain an annualized NEBs value of $97.80.

We recommend changing the apportionment of increased property value from 25 years to 8 years, reflecting the logic outlined for Home Performance with ENERGY STAR, that increased property value is realized when a home is sold. Thus, the NEBs value would be $305.63 per home, per year. Netted out over eight years at a 5 percent discount rate, this represents a present value of $1975.35 in the program year.

Summary of Recommendations

Table 3 shows the values we recommend using for NEBs attributed to residential programs.

Table 3. Recommended Annual NEBs Values

Program	Measure Category	NEBs Value	NEBs Unit
Apartment and Condominium Efficiency Services	All Measures	0.80	incremental cost / 8
Apartment and Condominium Efficiency Services	Lighting	$280.00	building
Apartment and Condominium Efficiency Services	Shower Heads	$9.85	building
Apartment and Condominium Efficiency Services	Faucet Aerators	$9.85	building
ENERGY STAR Qualified Appliances and Lighting	Clothes Washers	$1.48	unit
Home Performance with ENERGY STAR	Building Shell	0.33	incremental cost / 4
Home Performance with ENERGY STAR	Other	0.33	incremental cost / 4
Wisconsin ENERGY STAR Homes	Home Certification	$305.63	home

We believe the decision to limit NEBs attributed to Focus residential programs to only the category of economic NEBs does tend to under-represent the full value of NEBs. If a decision were made to invest further resources into updating NEBs values with primary research this decision would have to be re-evaluated. The current published literature on NEBs, however, does not at this time provide an adequate basis for incorporating non-economic NEBs.

Table 4 shows the application of NEBS values to the first six months of CY09. This is the period covered by the most recent SAR. In this table, for comparison with the prior SAR value, we show the total NEBs value over the life of the measure. The calculation for NEBs is simply the "NEBs Value" multiplied by the "Total Units."

Table 4. NEBs values for First Six Months of CY09

Program	Measure Category	NEBs Value	NEBs Unit	Total Units	Total NEBS	Prior Value
Apartment and Condominium Efficiency Services	All measures	0.80	Incremental cost	$1,083,878	$357,680	$336,392
Apartment and Condominium Efficiency Services	Lighting	$280.00	Building	368	$103,040	NA
Apartment and Condominium Efficiency Services	Shower heads	$9.85	Building	229	$2,256	NA
Apartment and Condominium Efficiency Services	Faucet aerators	$9.85	Building	444	$4,373	NA
ENERGY STAR Qualified Appliances and Lighting	Clothes washers	$1.48	Unit	2	$3	$2
Home Performance with ENERGY STAR	Building shell	0.33	Incremental cost	$1,083,878	$357,680	$575,300
Home Performance with ENERGY STAR	Other	0.33	Incremental cost	$364,275	$120,211	$132,430
Wisconsin ENERGY STAR Homes	Home certification	$1975.35	Home	544	$1,074,590	$1,342,305
Total					**$2,019,833**	**$2,386,429**

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