

Integrating Enhanced Building Operations into Municipal GHG Programs

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acknowledgements

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Context

- NYC adopting Carbon Reduction goal
 - “30 by 30” from 2005 level
- Similar to many municipalities
 - ICLEI tools for GHG Inventory
- City leadership by funding mandate for its own properties
 - 10% of annual energy expense
 - Recognition of “retro-commissioning”
 - Programming to be defined.

Define dimensions of benefit from EBO as an increment to a Capital Projects Program

- *Capture of low-cost, low-hanging fruit*
- *Better realization of projected energy savings from system upgrades*
- *Stronger persistence of savings as a result of on-going data feedback and operator attention*
- *Early action and results*

Quantify Savings from EBO as an increment to a Capital Projects Program

- Create a spreadsheet to project savings
- Transparent, easy-to-adjust variables

| INPUT VARIABLES | | \$ x 10(3) |
|---------------------------------------|-------|-------------------|
| NYC Annual Energy Budget, 2007 | | 800,000 |
| Annual Allocation to EE | 10% | 80,000 |
| Annual Svgs at paybck, in years = | 8.0 | 10,000 |
| | | |
| Initial Annual Allocation to EBO | 20% | 16,000 |
| Ann Svgs from EBO at pybk, yrs = | 1.5 | 10,667 |
| | | |
| Cap Savings Realization | 90% | 9,000 |
| Cap Savings Realization w/ EBO | 98% | 9,800 |
| | | |
| Annual Svgs degradation (persistence) | 0.50% | |
| Annual Svgs degradation w/ EBO | 0.01% | |

Spreadsheet

Years (to 2030)

Run under scenarios with and without EBO

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | TOTALS | | |
|---|--------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | | | |
| SCENARIO 1 - Capital Projects Only | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) budg alloc | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 1,840,000 | |
| (2) Annual Cap Proj invest | 0 | 10,000 | 50,000 | 150,000 | 190,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 1,840,000 |
| (3) cumulative invest | 0 | 10,000 | 60,000 | 210,000 | 400,000 | 480,000 | 560,000 | 640,000 | 720,000 | 800,000 | 880,000 | 960,000 | 1,040,000 | 1,120,000 | 1,200,000 | 1,280,000 | 1,360,000 | 1,440,000 | 1,520,000 | 1,600,000 | 1,680,000 | 1,760,000 | 1,840,000 | 1,840,000 | 1,840,000 | |
| (4) annual savings, realized | 0 | 0 | 0 | 0 | 45,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 207,000 |
| (5) savings depreciation (loss of persistence) | 0 | 0 | 0 | 0 | 0 | 225 | 208 | 313 | 356 | 399 | 442 | 485 | 528 | 570 | 612 | 654 | 696 | 737 | 779 | 820 | 861 | 901 | 942 | 981 | 10,587 | |
| (6) cumulative savings | 0 | 0 | 0 | 0 | 45,000 | 53,775 | 62,500 | 71,194 | 79,838 | 88,438 | 96,996 | 105,511 | 113,984 | 122,414 | 130,802 | 139,148 | 147,452 | 155,715 | 163,936 | 172,116 | 180,256 | 188,355 | 196,413 | 196,413 | 196,413 | |
| SCENARIO 2 - with Enhanced Building Operations (EBO) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (8) cap invest | 0 | 10,000 | 32,000 | 118,000 | 160,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 1,616,000 |
| (9) cumulative invest | 0 | 10,000 | 42,000 | 160,000 | 320,000 | 392,000 | 464,000 | 536,000 | 608,000 | 680,000 | 752,000 | 824,000 | 896,000 | 968,000 | 1,040,000 | 1,112,000 | 1,184,000 | 1,256,000 | 1,328,000 | 1,400,000 | 1,472,000 | 1,544,000 | 1,616,000 | 1,616,000 | 1,616,000 | |
| (10) EBO alloc | 16,000 | 16,000 | 16,000 | 16,000 | 16,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 224,000 |
| (11) EBO invest | 8,000 | 16,000 | 24,000 | 16,000 | 16,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 224,000 |
| (12) cumul EBO invest | 8,000 | 24,000 | 48,000 | 64,000 | 80,000 | 88,000 | 96,000 | 104,000 | 112,000 | 120,000 | 128,000 | 136,000 | 144,000 | 152,000 | 160,000 | 168,000 | 176,000 | 184,000 | 192,000 | 200,000 | 208,000 | 216,000 | 224,000 | 224,000 | 224,000 | |
| (13) EBO savings | 5,333 | 10,667 | 16,000 | 10,667 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 114,667 |
| (14) Cap savings | 0 | 0 | 0 | 0 | 36,000 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 181,800 |
| (15) Realization incrom from EBO | 0 | 0 | 0 | 0 | 3,200 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 16,160 |
| (16) Persistence incrom from EBO | 27 | 80 | 161 | 215 | 465 | 538 | 612 | 685 | 760 | 834 | 898 | 968 | 1,020 | 1,082 | 1,145 | 1,208 | 1,272 | 1,336 | 1,400 | 1,464 | 1,529 | 1,594 | 1,658 | 1,721 | 1,784 | 19,291 |
| (17) total ann svgs | 5,333 | 10,693 | 16,080 | 10,827 | 50,081 | 14,618 | 14,692 | 14,765 | 14,839 | 14,913 | 14,913 | 12,321 | 12,382 | 12,444 | 12,507 | 12,569 | 12,632 | 12,695 | 12,759 | 12,822 | 12,887 | 12,951 | 13,016 | 13,081 | 13,146 | 331,908 |
| (18) cumulative savings | 5,333 | 16,027 | 32,107 | 42,934 | 93,015 | 107,634 | 122,325 | 137,090 | 151,929 | 166,842 | 179,163 | 191,545 | 203,990 | 216,496 | 229,065 | 241,697 | 254,393 | 267,151 | 279,974 | 292,860 | 305,811 | 318,827 | 331,908 | 331,908 | 331,908 | |

Kept simple:

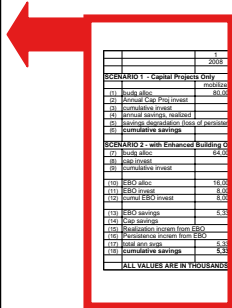
All in constant dollars (2008)

No inflation, no discounting

Spreadsheet - scenario lines

SCENARIO 1 - Capital Projects Only

- (1) budg alloc
- (2) Annual Cap Proj invest
- (3) cumulative invest
- (4) annual savings, realized
- (5) savings degradation (loss of persi
- (6) **cumulative savings**



| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | TOTALS |
|--|--------|--------|--------|--------|--------|--------|---------|---------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| SCENARIO 1 - Capital Projects Only | | | | | | | | | | | | | | | | | | | |
| (1) budg alloc | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 1,600,000 |
| (2) Annual Cap Proj invest | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 200,000 |
| (3) cumulative invest | 10,000 | 20,000 | 30,000 | 40,000 | 50,000 | 60,000 | 70,000 | 80,000 | 90,000 | 1,000,000 | 1,100,000 | 1,200,000 | 1,300,000 | 1,400,000 | 1,500,000 | 1,600,000 | 1,700,000 | 1,800,000 | 1,850,000 |
| (4) annual savings, realized | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 400,000 |
| (5) savings degradation (loss of persi | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (6) cumulative savings | 0 | 0 | 20,000 | 40,000 | 60,000 | 80,000 | 100,000 | 120,000 | 140,000 | 160,000 | 180,000 | 200,000 | 220,000 | 240,000 | 260,000 | 280,000 | 300,000 | 320,000 | 330,000 |
| SCENARIO 2 - with Enhanced Building | | | | | | | | | | | | | | | | | | | |
| (7) budg alloc | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 1,716,000 |
| (8) cap invest | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 200,000 |
| (9) cumulative invest | 10,000 | 20,000 | 30,000 | 40,000 | 50,000 | 60,000 | 70,000 | 80,000 | 90,000 | 1,000,000 | 1,100,000 | 1,200,000 | 1,300,000 | 1,400,000 | 1,500,000 | 1,600,000 | 1,700,000 | 1,800,000 | 1,850,000 |
| (10) EBO alloc | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 200,000 |
| (11) EBO invest | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 200,000 |
| (12) cumul EBO invest | 10,000 | 20,000 | 30,000 | 40,000 | 50,000 | 60,000 | 70,000 | 80,000 | 90,000 | 1,000,000 | 1,100,000 | 1,200,000 | 1,300,000 | 1,400,000 | 1,500,000 | 1,600,000 | 1,700,000 | 1,800,000 | 1,850,000 |
| (13) EBO savings | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 200,000 |
| (14) Cap savings | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (15) Realization increm from EBO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (16) Persistence increm from EBO | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (17) total ann svgs | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 | 200,000 |
| (18) cumulative savings | 0 | 0 | 10,000 | 20,000 | 30,000 | 40,000 | 50,000 | 60,000 | 70,000 | 80,000 | 90,000 | 1,000,000 | 1,100,000 | 1,200,000 | 1,300,000 | 1,400,000 | 1,500,000 | 1,600,000 | 1,650,000 |

SCENARIO 2 - with EBO (Enhanced B

- (7) budg alloc
- (8) cap invest
- (9) cumulative invest
- (10) EBO alloc
- (11) EBO invest
- (12) cumul EBO invest
- (13) EBO savings
- (14) Cap savings
- (15) Realization increm from EBO
- (16) Persistence increm from EBO
- (17) total ann svgs
- (18) **cumulative savings**

Spreadsheet

Adjustments for EBO limitations:

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | TOTALS | | | |
|---|-----------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | | | | |
| SCENARIO 1 - Capital Projects Only | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 1,840,000 | |
| (2) | 10,000 | 10,000 | 50,000 | 150,000 | 190,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 1,840,000 |
| (3) | 10,000 | 60,000 | 60,000 | 210,000 | 400,000 | 480,000 | 560,000 | 640,000 | 720,000 | 800,000 | 880,000 | 960,000 | 1,040,000 | 1,120,000 | 1,200,000 | 1,280,000 | 1,360,000 | 1,440,000 | 1,520,000 | 1,600,000 | 1,680,000 | 1,760,000 | 1,840,000 | 1,840,000 | 1,840,000 | 1,840,000 | |
| (4) | 0 | 0 | 0 | 0 | 45,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 9,000 | 207,000 | |
| (5) | 0 | 0 | 0 | 0 | 225 | 269 | 313 | 356 | 399 | 442 | 485 | 528 | 570 | 612 | 654 | 696 | 737 | 779 | 820 | 861 | 901 | 942 | 981 | 10,587 | 10,587 | 10,587 | |
| (6) | 0 | 0 | 0 | 0 | 45,000 | 53,775 | 62,506 | 71,194 | 79,838 | 88,438 | 96,996 | 105,511 | 113,984 | 122,414 | 130,802 | 139,148 | 147,452 | 155,715 | 163,936 | 172,116 | 180,256 | 188,355 | 196,413 | 196,413 | 196,413 | 196,413 | |
| SCENARIO 2 - with Enhanced Building Operations (EBO) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (7) | 64,000 | 64,000 | 64,000 | 64,000 | 64,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 1,616,000 | |
| (8) | 10,000 | 32,000 | 118,000 | 160,000 | 160,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 72,000 | 1,616,000 |
| (9) | 10,000 | 42,000 | 160,000 | 320,000 | 320,000 | 392,000 | 464,000 | 536,000 | 608,000 | 680,000 | 752,000 | 824,000 | 896,000 | 968,000 | 1,040,000 | 1,112,000 | 1,184,000 | 1,256,000 | 1,328,000 | 1,400,000 | 1,472,000 | 1,544,000 | 1,616,000 | 1,616,000 | 1,616,000 | 1,616,000 | |
| (10) | 16,000 | 16,000 | 16,000 | 16,000 | 16,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 224,000 |
| (11) | 8,000 | 16,000 | 24,000 | 16,000 | 16,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 224,000 |
| (12) | 8,000 | 24,000 | 48,000 | 64,000 | 80,000 | 88,000 | 96,000 | 104,000 | 112,000 | 120,000 | 128,000 | 136,000 | 144,000 | 152,000 | 160,000 | 168,000 | 176,000 | 184,000 | 192,000 | 200,000 | 208,000 | 216,000 | 224,000 | 224,000 | 224,000 | 224,000 | |
| (13) | 5,333 | 10,667 | 16,000 | 10,667 | 10,667 | 5,333 | 5,333 | 5,333 | 5,333 | 5,333 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 2,667 | 114,667 |
| (14) | Cap savings | 0 | 0 | 0 | 36,000 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 8,100 | 181,800 |
| (15) | Realization incrom from EBO | 0 | 0 | 0 | 3,200 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 720 | 18,160 |
| (16) | Persistence incrom from EBO | 27 | 80 | 161 | 215 | 465 | 538 | 612 | 685 | 760 | 834 | 896 | 958 | 1,020 | 1,082 | 1,145 | 1,208 | 1,272 | 1,336 | 1,400 | 1,464 | 1,529 | 1,594 | 1,659 | 1,724 | 19,281 | |
| (17) | total ann svgs | 5,333 | 10,693 | 16,080 | 10,827 | 50,081 | 14,618 | 14,692 | 14,913 | 14,913 | 12,321 | 12,382 | 12,444 | 12,507 | 12,569 | 12,632 | 12,695 | 12,759 | 12,822 | 12,887 | 12,951 | 13,016 | 13,081 | 13,146 | 13,211 | 331,908 | |
| (18) | cumulative savings | 5,333 | 16,027 | 32,107 | 42,934 | 93,015 | 107,634 | 122,325 | 137,090 | 151,929 | 166,842 | 179,163 | 191,545 | 203,990 | 216,496 | 229,065 | 241,677 | 254,393 | 267,151 | 279,974 | 292,860 | 305,811 | 318,827 | 331,908 | 331,908 | 331,908 | |
| ALL VALUES ARE IN THOUSAND OF DOLLARS (2008) | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Cost of EBO measures doubled after year 5

Savings from EBO halved after year 10

QUESTION FOR THE COMMUNITY: Is it reasonable to continue new EBO savings out to the end of the program period?

Spreadsheet Cumulative Results

| | | Cumulative to 2030 |
|---|---------------------------------|---------------------------|
| SCENARIO 1 - Capital Projects Only | | |
| (1) | budget allocation | \$ 1,840,000 |
| (2) | Annual Cap Proj investment | \$ 1,840,000 |
| (3) | cumulative investment | \$ 1,840,000 |
| (4) | annual savings, realized | \$ 207,000 |
| (5) | savings degradation (loss of | \$ 10,587 |
| (6) | cumulative savings | \$ 196,413 |
| SCENARIO 2 - with EBO | | |
| (7) | budget allocation | \$ 1,616,000 |
| (8) | capital invested | \$ 1,616,000 |
| (9) | cumulative investment | \$ 1,616,000 |
| (10) | EBO allocation | \$ 224,000 |
| (11) | EBO investment | \$ 224,000 |
| (12) | cumul EBO invest | \$ 224,000 |
| (13) | EBO savings | \$ 114,667 |
| (14) | Capital Projects savings | \$ 181,800 |
| (15) | Realization increm from EBO | \$ 16,160 |
| (16) | Persistence increm from EBO | \$ 19,281 |
| (17) | total ann svgs | \$ 331,908 |
| (18) | cumulative savings | \$ 331,908 |
| | | (\$ x 10 ⁽³⁾) |

- 50% greater savings for same total investment
- Capital Projects alone do not achieve 30% target reduction
- Shows savings attributable to separate EBO components
- Easy sensitivity analysis

Early Action Results - differential impacts in first 5 years

| | | 1 | 2 | 3 | 4 | 5 |
|---|---|--------------|---------------|---------------|---------------|---------------|
| | | 2008 | 2009 | 2010 | 2011 | 2012 |
| SCENARIO 1 - Capital Projects Only | | | | | | |
| | | mobilize | audits | design | const | on-line |
| (1) | budg alloc | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| (2) | Annual Cap Proj invest | 0 | 10,000 | 50,000 | 150,000 | 190,000 |
| (3) | cumulative invest | 0 | 10,000 | 60,000 | 210,000 | 400,000 |
| (4) | annual savings, realized | 0 | 0 | 0 | 0 | 45,000 |
| (5) | savings degradation (loss of persistence) | | | 0 | 0 | 0 |
| (6) | cumulative savings | 0 | 0 | 0 | 0 | 45,000 |
| SCENARIO 2 - with Enhanced Building Operations (EBO) | | | | | | |
| (7) | budg alloc | 64,000 | 64,000 | 64,000 | 64,000 | 64,000 |
| (8) | cap invest | 0 | 10,000 | 32,000 | 118,000 | 160,000 |
| (9) | cumulative invest | | 10,000 | 42,000 | 160,000 | 320,000 |
| (10) | EBO alloc | 16,000 | 16,000 | 16,000 | 16,000 | 16,000 |
| (11) | EBO invest | 8,000 | 16,000 | 24,000 | 16,000 | 16,000 |
| (12) | cumul EBO invest | 8,000 | 24,000 | 48,000 | 64,000 | 80,000 |
| (13) | EBO savings | 5,333 | 10,667 | 16,000 | 10,667 | 10,667 |
| (14) | Cap savings | 0 | 0 | 0 | 0 | 36,000 |
| (15) | Realization increm from EBO | | 0 | 0 | 0 | 3,200 |
| (16) | Persistence increm from EBO | | 27 | 80 | 161 | 215 |
| (17) | total ann svgs | 5,333 | 10,693 | 16,080 | 10,827 | 50,081 |
| (18) | cumulative savings | 5,333 | 16,027 | 32,107 | 42,934 | 93,015 |
| ALL VALUES ARE IN THOUSANDS OF DOLLARS (2008) | | | | | | |

- Importance of faster mobilization
 - Value when discounted
 - Political value

So if EBO is so great....

... why doesn't economics drive it to be part of all our projects?

Disjunction between EBO and the way Construction & Engineering is practiced

The Business Model Issue

- Construction & engineering based on capital project expense
- EBO-RCx labor rather than capital intensive
- EBO-RCx requires special data, acquisition skills, longer timeframe for study
- Will be pushed out of projects if not structured in
- Becomes more expensive when not built into projects and project teams from the outset

Using The Municipal Program To Craft Solutions For The Market

1. Model contract provisions
2. Template instrumentation specs for specific types of installations, for monitoring and reporting
3. **Training:** consultants, property managers, service mechanics, **operating engineers**, technical students
4. Teaming arrangements for specialized skills
5. Energy audit procedures
6. Program rules - credit in-house labor as match
7. Reporting requirements with financial incentives for documented persistence of savings