Measurement and Verification

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The Problem

With buildings accounting for 36 percent of the energy used in the U.S. and 65 percent of the electricity used, it has become imperative for owners to start implementing system upgrades and retrofits; not only would these improvements save money in the long run, they would also help companies meet the ever evolving standards set by the government for emissions. However, when asked, 76 percent of construction firms cite initial cost as being the biggest obstacle for owners when project planning. In response to this need, Energy Service Companies began offering a service called energy performance contracting. This is a turnkey service that not only designs and plans a project implementation, but it also provides complete financing, lifting the initial cost burden from owners. With a large investment such as this, a way to verify energy savings is necessary. This verification comes from another service called measurement and verification. These services combined make it possible for owners to make the needed upgrades to their systems.

The Project

This project aimed to develop a standardized Excel template to perform measurement and verification analysis. Once the program was completed, it would allow for the inputted data to be more easily analyzed and would provide building owners with concrete savings values, confirming that the energy conservation measure that they implemented is yielding the savings agreed upon and running more efficiently. The program was created using the International Performance Measurement and Verification Protocol (IPMVP) and American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Guideline 14 for Measurement and Energy Demand Savings. The general approach process can be seen in Figure 1.

M&V General Process

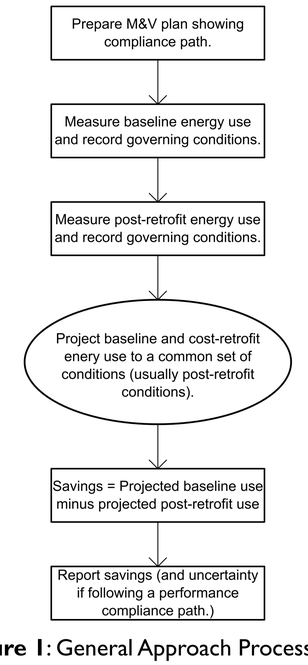

Figure 1: General Approach Process Guide

Cost Savings

Date	Cost ($)	Projected Cost ($)	Energy Cost Avoidance ($)
Mar-11	$ 8,250.19	$ 12,909.35	$ (4,659.17)
Apr-11	$ 3,721.27	$ 6,216.45	$ (2,495.18)
May-11	$ 1,137.52	$ 2,359.82	$ (1,222.30)
Jun-11	$ 4,117.21	$ 6,437.13	$ (2,319.92)
Jul-11	$ 6,842.69	$ 10,680.70	$ (3,838.01)
Aug-11	$ 6,418.69	$ 10,235.20	$ (3,816.52)
Sep-11	$ 2,386.93	$ 3,888.94	$ (1,502.01)
Oct-11	$ 3,165.40	$ 5,564.53	$ (2,399.13)
Nov-11	$ 8,500.69	$ 13,281.75	$ (4,781.07)
Dec-11	$ 13,278.45	$ 20,347.29	$ (7,068.84)
Jan-12	$ 15,122.96	$ 23,361.42	$ (8,238.46)
Feb-12	$ 11,509.27	$ 17,623.01	$ (6,113.74)
Mar-12	$ 8,414.86	$ 13,652.09	$ (5,237.23)
Apr-12	$ 3,845.40	$ 6,788.56	$ (2,943.16)
May-12	$ 1,136.69	$ 2,355.79	$ (1,219.09)
Jun-12	$ 4,145.35	$ 6,563.59	$ (2,418.24)
Jul-12	$ 6,812.90	$ 10,547.26	$ (3,734.36)
Aug-12	$ 6,390.55	$ 10,108.42	$ (3,717.87)
Sep-12	$ 2,367.90	$ 3,802.71	$ (1,434.81)
Oct-12	$ 2,977.56	$ 4,705.77	$ (1,728.21)
Nov-12	$ 8,557.78	$ 13,538.31	$ (4,980.53)
Dec-12	$ 13,490.29	$ 21,296.27	$ (7,805.98)
Jan-13	$ 15,255.36	$ 23,954.74	$ (8,699.38)
Feb-13	$ 11,693.53	$ 18,475.57	$ (6,775.98)
Total	$ 169,545.50	$ 268,570.98	$ (99,025.48)

Figure 3: Cost Savings Calculated Using Program

Energy Inputs

Monthly Energy Data	Independent Variables		Totals		Projected Energy	Avoided Energy
	Degree Days	Occupancy	Energy	Cost	(MMBtu)	(MMBtu)
Month/Year	(Days)	(Person)	(MMBtu)	($)		
Mar-09	518	200	270.45	$ 15,372	N/A	N/A
Apr-09	228	250	131.92	$ 7,942	N/A	N/A
May-09	64	251	49.08	$ 3,492	N/A	N/A
Jun-09	261	100	138.61	$ 7,792	N/A	N/A
Jul-09	431	156	228.27	$ 12,804	N/A	N/A
Aug-09	400	234	217.80	$ 12,506	N/A	N/A
Sep-09	150	123	84.02	$ 4,936	N/A	N/A
Oct-09	189	321	116.93	$ 7,378	N/A	N/A
Nov-09	534	198	283.14	$ 15,897	N/A	N/A
Dec-09	840	144	434.23	$ 23,837	N/A	N/A
Jan-10	952	245	497.58	$ 27,587	N/A	N/A
Feb-10	729	120	376.52	$ 20,653	N/A	N/A
...	....	...	...	...	...	...
TOTALS BEFORE ECM	10592	5456	5713.39	$ 325,883	N/A	N/A
Mar-11	513	200	174.10	$ 8,250	272.42	98.32
Apr-11	223	250	77.38	$ 3,721	129.28	51.89
May-11	59	251	22.40	$ 1,138	46.49	24.08
Jun-11	256	100	86.88	$ 4,117	135.84	48.96
Jul-11	426	156	144.47	$ 6,843	225.50	81.03
Aug-11	395	234	134.89	$ 6,419	215.10	80.21
Sep-11	145	123	49.90	$ 2,387	81.31	31.40
Oct-11	184	321	65.05	$ 3,165	114.36	49.31
Nov-11	529	198	179.45	$ 8,501	280.37	100.93
Dec-11	835	144	281.48	$ 13,278	431.33	149.85
Jan-12	947	240	320.04	$ 15,123	494.39	174.35
Feb-12	724	120	244.01	$ 11,509	373.63	129.62
...	....	...	...	...	...	...
TOTALS AFTER ECM	10472	5451	3568.31	$ 169,545	5652.44	2084.12

Figure 2: Scaled Chart of One Year of Data Collection

Energy Savings

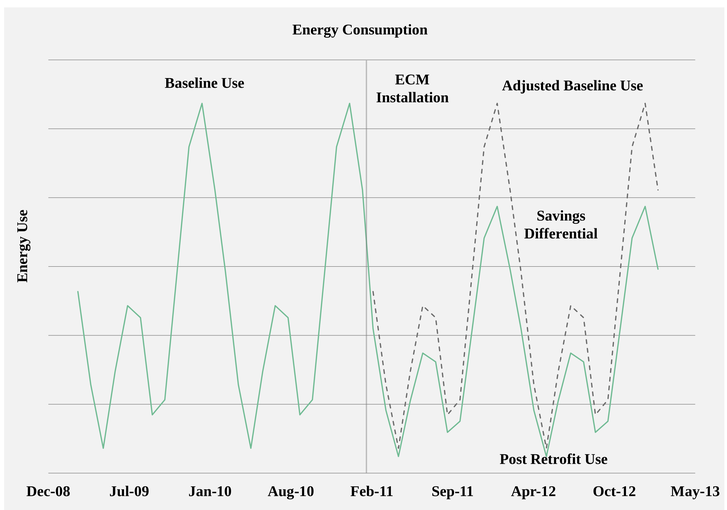

Figure 4: Cost Savings Calculated Using Program

Domains of Sustainability

Built
- Reduce building emissions
- Retrofit existing buildings that would otherwise be torn down due to building system quality
- Provides attainable and affordable means for retrofitting buildings

Natural
- Reduce building emissions, therefore, increase air quality
- Reduces the amount of resources required to operate a building or industrial process

Social
- Increases environmental awareness among company owners and employees
- Promotes healthy business practices as well as healthy lifestyle practices among company

Closing Remarks

Since no project was commissioned at the time of this project, controlled data was used for all calculations. However, the process of data collection and data analysis still proved to be an invaluable experience for a young engineer striving towards energy engineering. This project not only gave me the opportunity to work in the energy engineering field, but it also gave me a better understanding of the importance and process in achieving energy conservation. I was introduced to the realistic process of energy engineering by beginning this project from scratch and delving into the protocols and standards in order to create a compliant program. Buildings are not going to cease consuming energy, therefore, it is imperative that measures such as M&V are utilized in order to make the most of each system and source.

This poster was prepared in partial fulfillment of SUST 4103 Sustainability Capstone