Green Building and Sustainable Development in the Commercial Real Estate Industry:

Critical Issues Series

SPONSORED BY

SUSTAINABLE REAL ESTATE MANAGER™

SUSTAINABLE OPTIONS
green building consultants

The Formidable Challenge of Building Energy Performance Benchmarking

Anthony J. Buonicore, P.E.
Managing Director
Buonicore Partners, LLC

White Paper No. 10-001
Published in Building Energy Performance News
April 5, 2010

Building Energy Performance News™

This white paper is published by the author through Building Energy Performance News, an operating company of Buonicore Partners, LLC. Direct all inquiries to Buonicore Partners, LLC, Suite 101, 440 Wheelers Farms Road, Milford, CT 06461, 800-238-1841.

The Formidable Challenge of Building Energy Performance Benchmarking

By Anthony J. Buonicore, P.E.

Background

Benchmarking the energy consumption of a building against that of "comparable" buildings to produce a rating which can then be viewed by third parties is now mandatory in a number of jurisdictions across the U.S. and spreading rapidly. In 2005, Michigan became one of the first states to require energy performance assessment and benchmarking when the governor issued an Executive Order that was applicable to state buildings.(1) In January 2007, the governor of Ohio followed with a similar Executive Order.(2) In October of that year, California passed the first law applicable to the collection by utilities of energy use data at virtually all commercial buildings in the state and further added a benchmarking and disclosure requirement when the building was part of a real estate transaction associated with its sale, lease or financing.(3) Benchmarking laws in one form or another have since been adopted in Denver, Colorado,(4) West Chester, Pennsylvania,(5) Washington, D.C.,(6) Washington,(7) Hawaii,(8) Austin, Texas,(9) New York City,(10) and Seattle, Washington.(11) Although there are efforts underway at the national level(12) to address building energy performance disclosure, this issue is essentially in the domain of local regulatory authorities, such as planning commissions and building departments. Over $3 billion of federal stimulus funding has been allocated to the State Energy Office program which requires that local building energy codes be updated to improve energy efficiency. On the international front, the European Union, under its Energy Performance of Buildings Directive,(13) required Member States to develop building energy performance laws with an effective date no later than 2009. In Australia, for example, the law that was passed applies to existing commercial buildings as small as 21,500 SF. In the UK, the law that passed applies to existing commercial buildings as small as 10,760 SF.

> It is evident from this growing body of legislative and regulatory activity at the local, state, national and international levels that building energy performance benchmarking will rapidly become mainstream in the management, acquisition and operation of commercial real estate.

In addition to regulatory pressures for building energy performance benchmarking, labeling and disclosure, the commercial real estate industry is also concerned about what this may mean in the marketplace and how it may ultimately impact the value of real estate portfolios, given the nexus of energy consumption, net operating income and asset valuation. Laws that make disclosure mandatory serve to put considerable public pressure on building owners. For example, it is likely that less energy efficient buildings may become less competitive and require rent discounting to attract prospective tenants. Since prospective tenants today often enter into triple-net leases where they are required to pay their allocated share of utility costs, poor building energy performance may reduce the prospective tenant pool. Also, buildings with poor energy performance may be viewed as less valuable. There is no question that if a building is deemed to have relatively poor energy performance as compared to its peers, it can negatively impact the building and its financial performance. This is one of the principal reasons why lenders who finance building purchases are becoming more concerned about a building's energy performance in their due diligence. Tenants ultimately are looking for the "fully-loaded" occupancy cost that combines the base rent with operating expenses, of which energy cost is a major component.

> In view of its growing importance and potential business impact, building energy performance benchmarking must be accomplished on a technically sound, consistent, practical and reasonable basis.

This is critical because there is a lot at stake for property owners. Fortunately, the collection of building energy performance data is currently being standardized at the national level by ASTM.(14) Unfortunately, development of a technically sound, statistically representative building energy performance database for use in benchmarking which has adequate coverage for all major building categories and subcategories associated with commercial real estate transactions still leaves much to be desired. This is a serious shortcoming as it is a critical underpinning at the very heart of building energy performance benchmarking. The "peers" or "comps" for a building must truly be its "peers" or "comps."

CBECS Database

The U.S. Department of Energy's (DOE) Commercial Building Energy Consumption Survey (CBECS) database currently is the only publicly available national database containing commercial building characteristics and energy use information and is the most widely used today in benchmarking models (such as EPA's ENERGY STAR). Unfortunately, as a database against which to benchmark, its building type coverage still leaves much to be desired. Energy consumption data in CBECS is collected every four years for a very small sample of commercial building stock.(15) The most recent data available (released in December 2008) are from 2003 and include actual data from a surveyed population of 5,215 buildings chosen to represent the entire U.S. stock of approximately 5 million commercial buildings (see Table 1).

Building Type Classification

Building type classification is a key issue in energy benchmarking. There must be a statistically acceptable number of "peers" or "comps" for a particular building to be compared against. In the CBECS database, commercial buildings are categorized into 12 major "principal building activities" or PBAs (excluding the "vacant" and "other" categories). Unfortunately, there is no standardized way to classify non-residential, commercial buildings. In CBECS, for a building to be considered commercial at least 50% of its floor space must be used for purposes other than residential, manufacturing/industrial or agricultural. Mixed

TABLE 1.		
CBECS Database (2003)		
Parameter	%	No. Buildings
Total No. Buildings Surveyed	100.0	5215
Floor Area (SF)		
• < 5,000	23.4	1222
• 5,001 – 10,000	10.8	562
• 10,001 – 25,000	19.0	988
• 25,001 – 50,000	12.6	657
• 50,001 – 100,000	12.5	653
• > 100,000	21.7	1133
Date of Construction		
• 1959 and before	26.3	1373
• 1960 – 1989	46.7	2438
• 1990 – 1999	19.1	994
• 2000 – 2003	7.9	410
Location		
• Northeast	17.1	892
• Mid-West	26.5	1381
• South	37.7	1969
• West	18.7	973
Principal Building Activity		
• Office	18.7	976
• Retail(i)	28.5	1487
• Warehouse(ii)	9.5	493
• Lodging	5.0	260
• Education	12.5	649
• Health Care	8.3	434
• Public Assembly(iii)	5.3	279
• Public Order & Safety(iv)	1.6	85
• Religious Worship	6.0	311
• Laboratory	0.8	43
• Vacant	2.6	134
• Other	1.2	64

(i) Including malls, strip centers, single retail stores such as dry cleaners, barber shops, beauty parlors, gas stations, post offices, food markets, grocery stores, restaurants, fast food, convenience stores, etc.

(ii) Refrigerated and non-refrigerated

(iii) Such as libraries, convention centers, sports arenas, theaters, museums, etc.

(iv) Such as police and fire stations, jails and penitentiaries

use buildings are assigned to the PBA occupying the most floor space. In cases where there is not a single activity accounting for more than 75% of the total floor area, CBECS requires buildings to identify the top three activities and the percent of total floor area for each. Interestingly, of the 5,215 buildings included in CBECS, only 301, or 5.8%, indicated that there was not a single activity accounting for more than 75% of the total space.

The most common complaint about building benchmarking based on the CBECS database is its inability to account for all the important (from an energy consumption viewpoint) differences between buildings. Virtually every building is unique in its use, occupancy, operations, maintenance and systems. The CBECS survey was designed to be representative of commercial buildings nationally, rather than designed to meet the myriad of needs associated with a benchmarking database. Unquestionably, there is a trade-off between having a significant sample size of "peer" buildings to compare against, and the true similarity of those buildings to each other. The question is where the balance must lie to be acceptable and truly useful for market participation.

A general investigation of building categories and subcategories that can have a noticeable impact on energy consumption suggests considerably more building sub-categories are needed in CBECS compared to what currently exists. Two good examples demonstrate this. The first is the "office" category and the second is the "lodging" category. The number of buildings in the CBECS database for these two categories is summarized in Table 2. Average site energy use intensities (EUIs) are summarized in Table 3. Site EUI, expressed in annual kBTU/SF, is the most commonly used metric for building energy consumption. It represents total energy consumption on-site at the building, including electricity use, on-site fuel use and delivered energy from district systems (steam, hot water and cooling water). It is what the building owner actually pays for. For office buildings in the CBECS database, the

TABLE 2.				
CBECS Database (2003) for Office and Lodging PBAs				
	Office		Lodging	
Parameter	Number	Percent	Number	Percent
Total Number Buildings Surveyed	976	100.0	260	100.0
Floor Area (SF)				
• < 5,000	207	21.2	25	9.6
• 5,001 – 10,000	106	10.9	26	10.0
• 10,001 – 25,000	145	14.9	59	22.7
• 25,001 – 50,000	123	12.6	48	18.5
• 50,001 – 100,000	103	10.5	41	15.8
• > 100,000	292	29.9	61	23.4
Date of Construction				
• 1959 and before	244	25.0	46	17.7
• 1960 – 1989	519	53.2	142	54.6
• 1990 – 1999	152	15.6	48	18.5
• 2000 – 2003	61	6.2	24	9.2
Location				
• Northeast	201	20.6	40	15.4
• Mid-West	257	26.3	63	24.2
• South	317	32.5	104	40.0
• West	201	20.6	53	20.4

TABLE 3. CBECS Database (2003) EUIs for Office and Lodging PBAs (in kBTU/SF)		
Parameter	Office	Lodging
All Buildings Surveyed in PBA	92.9	100.0
Floor Area (SF)		
• 1,001 – 10,000	73.5	111.0
• 10,001 – 100,000	89.5	91.2
• > 100,000	104.2	106.7
Date of Construction		
• 1959 and before	93.6	N/A
• 1960 – 1989	94.4	111.7
• 1990 – 2003	88.0	88.1
Location		
• Northeast	101.2	N/A
• Mid-West	108.8	109.0
• South	87.0	96.9
• West	72.1	103.7
Climate Zone		
• Zone 1	93	133
• Zone 2	95	92
• Zone 3	80	96
• Zone 4	72	115
• Zone 5	68	102

**For all major fuel consumed at the site, including electricity, fuel oil, natural gas, district steam and district hot water.*

EUI ranges between approximately 60 – 300 kBTU/SF per year, with a national average for the category of 92.9 kBTU/SF per year. For lodging facilities, the range is between approximately 85 – 330 kBTU/SF per year, with a national average for the category of 100 kBTU/SF per year. The large EUI range suggests that CBECS building category coverage may be much too broad in that there may still be significant differences (from an energy use impact viewpoint) in the buildings included in a particular category. This may not have been the case if the category was defined much more narrowly (to reflect these differences). It is evident from Tables 4 and 5 there are many building characteristics that can potentially impact a building's EUI. The CBECS database only factors into the EUI analysis the building's location (in order to take weather into consideration) and size (for square footage normalization). If the CBECS database is used in the benchmarking model for lodging facilities, for example, a tall luxury hotel with conference, restaurant and swimming pool facilities and an on-site laundry should only be compared against similar hotels. As an alternative, there should be some kind of normalization built into the models to account for the various amenity differences. It is most important that the EUIs of these hotels not be "mixed in" with those of hotels not having these luxuries and amenities. To do so can result in misleading EUI conclusions and potentially lead to erroneous EUI goals. Unfortunately, while some of these differences can be normalized for (as ENERGY STAR ratings do if sufficient data exist to allow this), there is simply not enough building characteristics data in CBECS to allow all of these differences to be statistically analyzed with confidence.

Interestingly, California developed its own building energy benchmarking database because they felt it would be more representative of properties in the state. The CBECS database includes only 973 buildings in the entire western part of the country. The California End Use Survey (CEUS) was used to develop a peer-group benchmarking database by surveying 2,750 non-residential premises across California, using stratified random sampling across four utility districts, seven major climate zones, 12 general building types and 62 sub-types, and variable building sizes. The CEUS data are more detailed than CBECS and are more representative of California buildings, enabling a higher level of granularity in benchmarking.

Another inherent limitation in the CBECS database is its bias towards smaller-sized and older buildings. More than one-third the buildings in the database have less than 10,000 square feet (refer to Table 1). Almost three-quarters of the buildings are more than 20 years old and more than a quarter more than 50 years old. This bias was purposeful because the CBECS survey was designed to be representative of commercial buildings nationally, where the number of smaller-sized and older buildings is relatively large. Unfortunately, this puts a building owner with a newer, larger building at a disadvantage with respect to the number of "similar" buildings available for benchmarking in the database.

Floor Area Confusion

There has also been an issue related to how well respondents to the CBECS interview really understood the definition of building "gross floor area," particularly since it was not verified and yet could substantially impact the EUI calculation. Sharp[19] found it to be frequently misreported and a major source of error in EUI calculations. Complicating the issue is the fact that there are many different ways of defining "floor area" in the commercial real estate industry. Terms such as gross and net floor area, gross and net usable floor area, and gross and net leasable (or rentable) floor area are commonly used in the industry, but have different meanings. One problem, for example, is that gross floor area in the CBECS database includes indoor parking areas. Many in the commercial real estate industry do not include these areas in the gross floor area calculation. It is also not unusual to get back the leasable area or usable area when asking for the gross floor area. There is no question that such inconsistency and confusion can have a significant impact on the EUI calculation. The CBECS database further compounds the error by rounding off the area, which in and of itself reportedly can produce errors in EUI estimates of 5-10%, or for smaller buildings, as much as 14-25%.[20]

Extraordinary Conditions Limitation

Finally, the CBECS database does not differentiate in the EUI calculation any extraordinary conditions that may have existed in a building during the time frame covered by the survey. For example, the data used to determine the building's EUI may not reflect the fact that the vacancy rate for a period of time was unusually high, perhaps due to current market conditions, or that a portion of the building was out of use because of construction or mechanical problems. Not being able to factor such conditions into the EUI analysis can also lead to erroneous results and conclusions.

Energy Star And CBECS

Despite the inherent shortcomings associated with the CBECS database, it is the "best available" and EPA relies on this database for its underlying ENERGY STAR benchmarking system. The benchmarking system allows building owners and managers to enter data about the energy consumption of their buildings, hours of operation, number of occupants, location and other building characteristics. The system then compares each building's energy performance with the performance of "similar" buildings across the country. Each building receives an ENERGY STAR rating from 1 to 100 based on one year's energy consumption data. ENERGY STAR utilizes the CBECS database to benchmark buildings, adjusting (normalizing) for weather variations and basic operating conditions. For example, annual energy consumption in buildings can vary up to 30% depending on local weather. ENERGY STAR removes the impact of weather on the energy use intensity by normalizing against 30-year average normal air temperatures using linear regression. Similar linear regression modeling is conducted on other building characteristics collected in CBECS to determine the most significant drivers of energy consumption.

Only a select number of building characteristics are input into ENERGY STAR. In the office category, for example, ENERGY STAR considers building location (for weather normalization), size (for gross floor area normalization), weekly hours of operation, number of employees working on the main shift, number of computers, and the percent of floor area that is heated and air conditioned. Table 4 suggests that ENERGY STAR may not be taking into consideration other office building characteristics that can impact EUI, such as, for example, whether or not the building is a stand-alone, or attached on one, two or even three sides. Also, in the analysis of office buildings, EPA found that small office buildings do not behave the same way as larger office buildings, i.e. large buildings use more energy than small building (see Table 3). As such, to remove the lower EUI bias, EPA excluded these small buildings from the CBECS data set and actually uses only 498 office buildings for benchmarking in ENERGY STAR. Assuming that such a small sample of office buildings can be representative of all office buildings in the country is the subject of considerable debate. For lodging facilities, as another example, ENERGY STAR takes building location (for weather normalization), size (for gross floor area normalization), number of rooms, number of employees working on the main shift, number of commercial refrigeration/freezer units, the presence of cooking facilities, and the percent of floor area that is heated and air conditioned into consideration. Unfortunately, just as with office buildings, Table 5 for lodging facilities suggests that ENERGY STAR may again not be considering other building characteristics that can impact EUI.

TABLE 4.
Building Characteristics Within the Office Building PBA That Can Impact Energy Consumption for Benchmarking
Location (weather conditions)
Size (gross floor area)
Occupancy
Hours of Operation
Age
Surroundings
• Stand-alone (unattached)
• Attached to another building on one side
• Attached to another building on two sides
• Attached to another building on three sides
Parking
• Attached indoor parking garage
• Attached outdoor parking garage
• Unattached parking garage
Height of the Building
• Short
• Tall
Building Footprint
• Outside wall exposure
Tenant PBA
• 100% office (with/without a data center)
• Mixed Use
• With retail space
• With residential space
• With hotel space
Backup Power Supply

The way that ENERGY STAR determines its ratings from the modeled CBECS data is by determining the energy efficiency ratio, defined as the actual building source EUI divided by the "predicted" source EUI. Source EUI accounts for both on-site building energy consumption and off-site losses (or inefficiencies) in bringing delivered energy (such as electricity from the local utility and steam, hot water and cooling water from district systems) to the building. There remains debate in the industry as to whether site EUI or source EUI should be used for benchmarking. Advocates for site EUI make the strong point that this is the actual energy consumed on-site and what the building pays for. EPA uses source EUI because it is considered to be more directly representative of the environmental impacts of energy use and is more reflective of total energy use. According to EPA, site EUI can fail to recognize highly

TABLE 5.

Building Characteristics Within the Lodging PBA That Can Impact Energy Consumption for Benchmarking

Type
• Standard hotel rooms
• Suites
• Combination
• On-site laundry facilities
Amenities
• Conference facilities
• Restaurant/kitchen facilities
• Swimming pool facilities
• Health club/spa facilities
• Atrium and public lobbies
Location (weather conditions)
Size (gross floor area)
Occupancy
Age
Surroundings
• Stand-alone (unattached)
• Attached to another building on one side
• Attached to another building on two sides
• Attached to another building on three sides
Parking
• Attached indoor parking garage
• Attached outdoor parking garage
• Unattached parking garage
Height of the Building
• Short
• Tall
Building Footprint
• Outside wall exposure
Tenant PBA
• 100% lodging
• Mixed Use
• With retail space
• With residential space
• With office space
Backup Power Supply

efficient energy systems and may improperly reward inefficient systems. For example, site energy comparison suggests that electric resistance heating (where nearly 100% of the energy is converted to heat) is more efficient than an on-site natural gas-fired boiler system (where approximately 85% of the energy is converted to heat). In actuality, however, one unit of electric energy delivered to a building comes at a cost of approximately three units of energy consumed at the power plant (since electrical generation and distribution is accomplished at an overall efficiency of approximately 30%). So that no building will be credited (or penalized) for the relative efficiency of its utility provider, EPA uses national source/site ratios rather than using the efficiency data associated with the local utility power plant providing the energy. Site EUI advocates would suggest that a building using electric heat would be penalized on the cost side of the equation.

For EPA's energy efficiency ratio, actual source EUI is divided by the "predicted" EUI. The "predicted" source EUI is the "expected" energy use for the building based upon the regression equation developed for the specific building type normalizing for weather and some very basic operating conditions. Using this equation, the "predicted" source EUI effectively is the average source EUI plus a series of adjustments based upon how much the building's basic operating characteristics differ from the CBECS population mean. In EPA's model, if the building rating is 75, it means that the building performed better than 75% of its "peers" nationwide. Buildings with ratings of 75 or greater are eligible to receive an ENERGY STAR label that can be displayed in the building. The ENERGY STAR rating is available for 13 major commercial building types based upon principal building activity (PBA). These building types are similar, but not exactly the same as the CBECS categories and subcategories. For mixed use buildings, the PBA is determined by what category has 50% or more of the gross floor area. To use ENERGY STAR, more than 50% of a building's gross floor area must be defined by one of ENERGY STAR's 13 space types, and the combined floor area of any space classified as "other" cannot exceed 10% of the total gross floor area (excluding parking). By the middle of last year more than 7,500 buildings had received the ENERGY STAR label (see Table 6). This number grew to more than 8,700 buildings by the end of the year.

A licensed professional engineer must verify that the data collected for ENERGY STAR is accurate and that the building adheres to current industry standards for thermal comfort, outside air ventilation, control of indoor air pollutants, and illumination, as specified by American National Standards Institute and the Illuminating Engineering Society of North America.

As of the end of 2009, approximately 110,000 eligible buildings have been voluntarily entered into EPA's ENERGY STAR Portfolio Manager System by building owners and operators to derive a rating on their building(s). This represents another area of frequent misunderstanding in the commercial real estate market where the user often assumes when a building is entered into ENERGY STAR that these 110,000 buildings are directly used as part of the benchmarking database. However, the basis for the EPA ENERGY STAR rating system is still only the 5,215 buildings in the 2003 CBECS database and does not include the growing number of buildings voluntarily entered in Portfolio Manager. Notwithstanding, while the buildings in Portfolio Manager are not included as part of the sample analyzed to develop EPA's rating models, it should be noted that EPA's models for each building type are routinely tested against the buildings of that type in Portfolio Manager. Although ENERGY STAR is widely utilized for building energy performance benchmarking, its underlying value contribution has been subject to industry scrutiny principally due to its reliance on the CBECS database for benchmarking.

Building Performance Rating Systems And CBECS

While the CBECS database is the database used by EPA for benchmarking in ENERGY STAR, other building rating systems also rely on it. For example, the ASHRAE BuildingEQ rating relies on national source EUIs from the CBECS database for different types of properties.[16] The U.S. Green Building Council (USGBC) uses the EPA ENERGY STAR energy performance rating to award LEED energy points in its rating system.[17] The Green Building Underwriting Standard developed by the Capital Markets Partnership (CMP) uses the EPA ENERGY STAR energy performance rating to award energy points in its Green Value Score rating system.[18]

TABLE 6.

Cumulative Number of Buildings Rated in ENERGY STAR Portfolio Manager (through June 30, 2009)

Property Type	Number	Percent	Gross Floor Area (Million SF)
All	97,316*	100.0	13,281
Office			
- Professional	26,087	26.8	5,472
- Medical	1,661	1.7	126
- Banks/Financial Institutions	6,995	7.2	299
- Courthouses	655	0.7	103
Subtotal	35,398	36.4	6,000
Lodging			
- Hotels/Motels	4,723	4.9	986
- Residence Halls/ Dormitories	1,320	1.3	111
Subtotal	6,043	6.2	1,097
Retail			
- Retail Stores	17,007	17.5	1,399
- Supermarkets/ Grocery Stores	9,504	9.8	366
Subtotal	26,511	27.3	1,765
Warehouses	1,371	1.4	273
Schools	25,353	26.0	2,703
Hospitals	2,640	2.7	1,443

**Of which 7,476 (approximately 8%) have been awarded the ENERGY STAR label; as of December 2009, the unofficial total number of eligible buildings that have used Portfolio Manager is approximately 110,000, with 8,741 buildings earning the ENERGY STAR label.*

Conclusion

Federal and state governments, and DOE and EPA in particular, are to be commended for their leadership in priming the building energy performance benchmarking marketplace.

However, the challenge now rests with the commercial real estate industry, which has much at stake and is more intimately familiar with market needs and nuances of the process, to take the government's lead and further develop and improve commercial building energy benchmarking methodology.

Building energy performance benchmarking can be challenging to implement across diverse real estate assets; however, it is an essential step toward development of a plan to capture the significant opportunities related to improved energy efficiency across existing building stock. Notwithstanding, building energy benchmarking cannot be considered satisfactory without statistically representative coverage for all major sub-categories within each major building classification category. A serious shortcoming with relying solely on the CBECS database for benchmarking is that building categories/subcategories are still much too general and there are simply too few truly "peer" buildings to achieve a high confidence level in the benchmarking analysis. The best way to resolve this deficiency is to build a larger database with more buildings in each subcategory associated with each major category to better account for the differences between buildings that can significantly impact energy consumption.

As an industry that can be financially impacted by building benchmarking and energy performance disclosure, every effort must be made to encourage expansion of the building energy consumption database to include more buildings and more building sub-categories. The commercial real estate industry would likely be much more receptive to a benchmarking database having a sufficient number of buildings in each sub-category to be statistically representative with a 90% confidence level. Such a database would likely be widely accepted as "best practice" and invaluable for assisting the industry in assessing the risks and opportunities associated with building energy performance.

Both DOE and EPA can also contribute significantly to this effort. DOE, for example, may want to consider expanding the 2011 CBECS, perhaps to as many as 20,000 plus buildings, and publish the results in an expedited manner. EPA needs to do even more to encourage building owners to enter their properties into Portfolio Manager so that nuances might be better factored into their benchmarking models. The industry could also benefit from greater transparency by these agencies as benchmarking models are continually refined.

There is too much at stake in the highly competitive commercial real estate industry to accept anything less that what is needed to provide truly good "comps" for building energy performance benchmarking. Until a database that can facilitate an industry best practice with statistically adequate coverage to represent true "comps" in each building category/subcategory is developed, there will be those in the industry who will be skeptical to adopt this emerging and important practice as part of its standard operating procedure.

As with any new and emerging market, it will ultimately be those from within the industry that is impacted who usually respond and coalesce around a new challenge to further drive evolution and innovation. It will be no different for the challenge of building energy performance benchmarking in the commercial real estate industry.

REFERENCES

(1) State of Michigan, Executive Order 2005-4, April 2005.

(2) State of Ohio, Executive Order 2007-02, January 2007.

(3) California Assembly Bill (AB) 1103, October 2007, modified in October 2009 by AB 531.

(4) Denver, Colorado Executive Order 123, October 2007.

(5) West Chester, Pennsylvania Borough Ordinance, March 2008.

(6) Clean and Affordable Energy Act of 2008, Washington, D.C., Law No. L17-0250, October 2008.

(7) Washington Bill SB 5854, May 2009.

(8) State of Hawaii, HB 1464, June 2009.

(9) Austin, Texas City Council Energy Conservation Audit and Disclosure Ordinance, Rule No. R161-09.35, September 2009.

(10) New York City Council Bill 476-A, December 2009.

(11) Seattle, Washington Building Energy Disclosure Council Bill (CB) 116731, January 2010.

(12) Waxman-Markey House Bill HR 2454, American Clean Energy and Security Act of 2009, June 2009.

(13) European Union Energy Performance of Buildings Directive 2002/91/EC, adopted by the European Parliament on December 16, 2002, effective January 4, 2003.

(14) ASTM Task Group WK24707 on Building Energy Performance Assessment and Disclosure, formed in 2009.

(15) For more information, go to http://www.eia.doe.gov/emeu/cbecs/.

(16) For more information on the ASHRAE BuildingEQ rating system, go to http://www.buildingEQ.com.

(17) For more information on LEED, go to http://www.usgbc.org/.

(18) For more information on the CMP Capital Markets Partnership rating system, go to http://www.capitalmarketspartnership.com.

(19) Sharp, T., "Energy Benchmarking in Commercial Office Buildings," Proceedings of the ACEEE 1996 Summer Study on Energy Efficiency in Buildings (4): 321-329, 1996.

(20) Sharp, T., "Benchmarking Energy Use in Schools," Proceedings of the ACEEE 1998 Summer Study on Energy Efficiency in Buildings (3): 305-316, 1998.

Mr. Buonicore is Managing Director at Buonicore Partners, LLC, a firm specializing in building energy performance. He writes a blog on Building Energy Performance News that may be accessed at www.bepinfo.com. Mr. Buonicore can be reached at 800-238-1841 or at his email address: ajb@bepinfo.com.

BIOGRAPHY

ANTHONY J. BUONICORE, P.E.

Anthony Buonicore is a past president and Fellow Member of the Air & Waste Management Association, a Diplomat in the American Academy of Environmental Engineers, a Qualified Environmental Professional and a licensed professional engineer. He is a member of the ASTM Property Environmental Due Diligence committee, former chairman of its ASTM Phase I Task Group, and currently chairs the ASTM Task Group that developed the U.S. standard for vapor intrusion screening for properties involved in real estate transactions. In addition, Mr. Buonicore is chairman of the ASTM Task Group responsible for developing the new Building Energy Performance Assessment and Disclosure Standard.

Mr. Buonicore has been a leader in the energy-environmental industry since the early 1970s, serving as General Chairman of the American Institute of Chemical Engineers' First National Conference on Energy and the Environment in 1973 and as founder and first chairman of the Air Pollution Control Association's Energy-Environmental Interactions Technical Committee in 1974. He pioneered the use of refuse-derived fuel pellets (a bio-fuel) mixed with coal in stoker-fired boilers and has written extensively on energy and environmental issues.

As a Managing Director of Buonicore Partners, LLC, Mr. Buonicore is responsible for management of the firm's commercial real estate holdings and all due diligence activities associated with property acquisition. He holds both a bachelor's and a master's degree in chemical engineering.

Please share your comments on this white paper at Anthony Buonicore's blog, found at: http://blog.bepinfo.com/