

GHG Emission Reduction Record

Artists for Humanity
Boston, Massachusetts, U.S.A.
October 1, 2004 – September 30, 2005

Created March 2006
by **ICBE**
Gainesville, Florida, U.S.A.

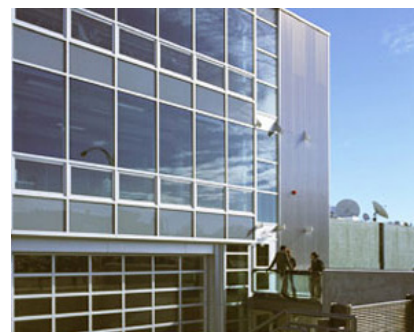
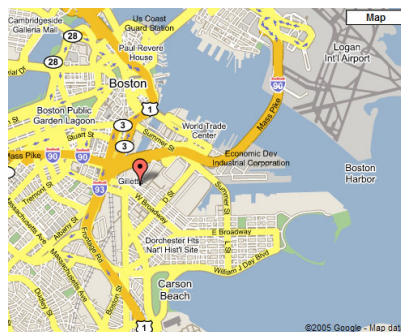
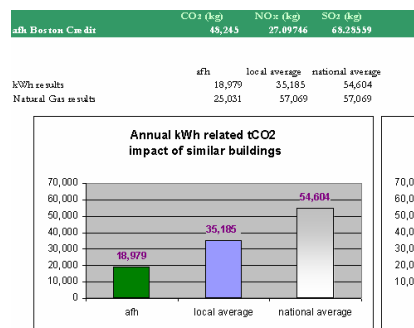


Photo by: Richard Mandelkorn

Summary

In April 2005, Artists for Humanity—a non-profit educational group in Boston, MA—commissioned ICBE to create a greenhouse gas (GHG) reduction record based on the energy performance characteristics of their main building located at 100 West Second Street in South Boston's Waterfront.

The 23,500 square foot structure—named EpiCenter—is a high-performance, industrial-style, glass and steel building, incorporating a variety of sustainable designs, such as walls that provide passive heating and cooling, super insulation, maximum utilization of daylight, and a 48 kW DC rooftop photovoltaic array. Construction was completed in the summer of 2004, and Artists moved in September 2004.

Based on utility records for gas, electricity and water consumption, the study found that during Year One of occupancy, EpiCenter consumed about half the electricity and natural gas compared to a group of comparable buildings, and in spite of various water conserving features, consumed nearly three times the baseline amount of water. The reduction in gas and electricity consumption resulted in nearly 50 tCO₂ savings.

Method of Analysis

To create the GHG record, a comparison was drawn between the target building on 100 West Second Street and a pool of similar conventional buildings in the same geographic area. The study's original aim was to create a baseline of thirty buildings located in the Boston area with comparable size and occupational patterns. To accomplish this, the Boston Department of Neighborhood Development (DND) created a master list of the 325 commercial buildings that occupy between ten thousand and forty thousand square feet (sf) from the city's Tax Records. This list was then screened for owners who had local Boston addresses, and who appeared, purely from the impression of owner names, easily approachable in case direct contact was necessary. Buildings owned by Hertz Corporation and XYZ Realty in NY were thus eliminated. Without any further qualification, the working list was reduced to ten buildings larger than thirty thousand sf; ten buildings smaller than twenty thousand sf; and ten buildings with exactly or nearly exactly 23,500 sf.

Due to a variety of issues, in only a limited number of instances were the water, electric, and gas records easily available for the selection of thirty addresses, so the sample pool grew smaller. In addition, upon examination of the water records, it became clear that a number of addresses were occasionally unoccupied and were therefore dropped from the list. Collecting utility records using a given specific address was not always successful. A single location can exist under various aliases in different database systems because: the location is large enough to have multiple addresses; the building was once several buildings reconstructed into a single building; or the billing address is different from the address of the service location. After consultation with contact persons at the various utilities, it was also determined that several buildings (especially in the old Boston downtown) which had been fitted with piping, conduits and points of telemetry when services were first introduced, were deemed to have service footprints

inconsistent with the square footage listed in their tax profiles. Thus, as the original list of thirty was not a useful baseline for comparison, it was discarded, and a new approach was devised.

Based on the experiences gained during the first approach, the working list was reassessed using *Google Earth*'s high resolution Boston search feature. One by one, addresses were pulled up, eliminating: buildings in or close to downtown; buildings attached to other buildings; buildings with fewer than two stories; and buildings with multiple tenants in which the taxable square footage was not equal to the buildings' physical square footage. The first ten buildings surviving these criteria became the new baseline group, which was resubmitted to the relevant utilities. The search returned six electric records, four of which showed gas use. Of the same six electric addresses, three water records were returned. The water records were made available in cubic feet per month; natural gas records in one hundred cubic feet per month; and due to privacy issues, electric data was restricted to demand in kilo watt, as opposed to the more desirable consumption figures in kilo watt hours. All the data were reduced to consumption per square foot, with special attention paid to differences in winter and summer patterns.

The new baseline group showed consistent consumption results when viewed annually and when broken down in summer and winter blocks. As anticipated, addresses served by gas and electric showed high use of gas and lower use of electric in the winter due to heating needs, and the reverse in the summer because of cooling needs. The baseline group used about three times more gas in the winter than in the summer; whereas the winter upswing in gas use in the target building was more tempered, likely due to passive warming and effective insulation characteristics. When the number of baseline buildings was reduced to the four that use gas for heating, the winter electric consumption on a per square foot basis was very similar to each other and to the target building. Summer electric consumption, on the other hand, was less by about two-thirds, due to EpiCenter's alternative cooling techniques.

GHG Factors

Electricity - emission rates associated with kWh consumption from the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Database (eGRID) were applied and reflect the emissions generated in the power control area (PCA) of the baseline and target buildings' locations. The database lags a few years in publication, and for CY 2005, year 2000 emission rates were applied. No discounting was factored in to account for distribution and transmission losses, which nominally stand at a bit over 10% for the New England ISO.

Natural Gas - emission values for Natural Gas were sourced from Argonne National Laboratories' Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model, commonly known as GREET. The values applied reflect the consumption of the fuel itself, not the energies expended during recovery, processing, and transportation.

Water - emission rates associated with water consumption were not factored in, but an attempt to estimate those will be made during further refinement of the baseline in Year Two.

Conclusion

To attain a higher level of confidence in assessing the true greenhouse gas reduction aspect of the target building at 100 West Second Street, the baseline needs to be refined. Though results found to date are generally consistent with expectations expressed in documentation of the architects and in paperwork generated for the LEED Certification for Sustainable Design at the Platinum Level, the lower than desired number of qualified comparable buildings in the baseline pool, along with a lack of updated readings of the grid-related emissions factors prevailing in CY2005, forces the greenhouse gas reduction profile to build in a 20% probability of error.

Additionally, building occupants require a few seasons to become fully accustomed to the workings of their building, to optimize the various systems available to them, and to settle into a management routine. Therefore, Year Two and Year Three may be much more representative of the long term energy consumption and the resulting emissions trend.

ICBE will address these issues in collaboration with the various utilities in preparation for Year Two of the GHG Emissions Reduction Record. The greenhouse gas emissions profile for EpiCenter, which we can calculate with certainty, as opposed to its greenhouse gas *reduction* profile which needs more definition, comes in at about 35% less than the national average. This is due to the high presence of hydro, biomass and nuclear resources in New England's electric generation resource mix. It also shows that the given parameters of energy consumption per square foot, solar availability, and grid carbon intensity—the design and systems employed in EpiCenter—in similar climatic conditions elsewhere in the U.S., could lead to around 800 tCO₂ reductions per decade, or roughly 4000 tCO₂ over the 50 year design life of the building.

For ICBE:

Mark van Soestbergen

March 3, 2006

Gainesville, Florida, U.S.A



Acknowledgements/References

This report was made possible through the contribution of many hours, phone calls, data sets, emails, anecdotes and corrections of individuals directly and peripherally involved in the EpiCenter project. Below is a short list of the people who volunteered knowledge, help and guidance necessary in assessing the various building related processes.

Artists for Humanity, for proposing this groundbreaking study.

Robert Gehret, bgehret.dnd@ci.boston.ma.us

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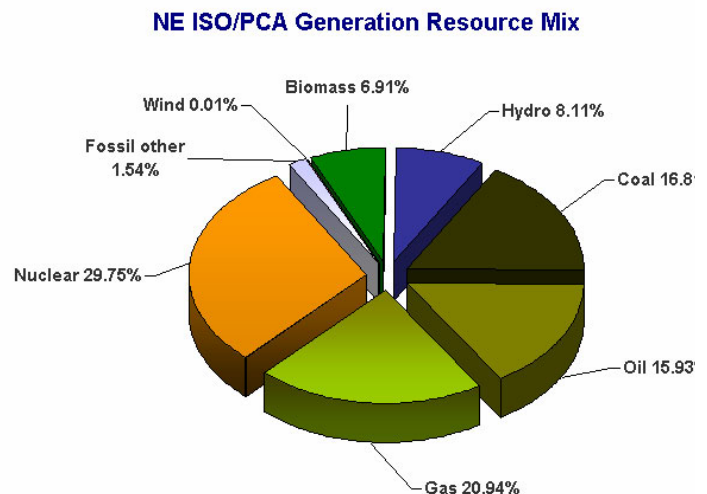
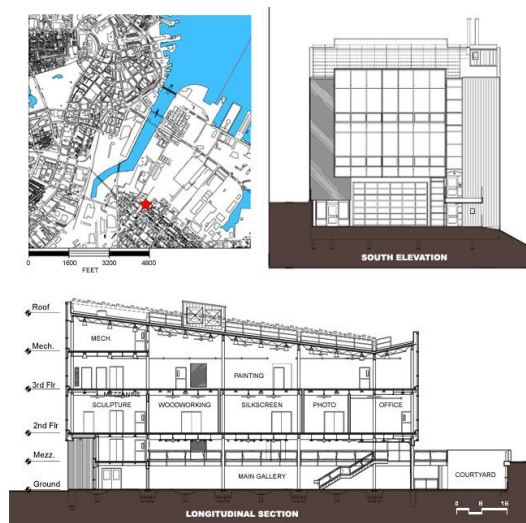
References

Kelley, Mark E., Cornelison, Patricia. 2005. Artists for Humanity Epicenter: A Successful Model for the Sustainable Design Process. *Orlando: 2005 Solar World Congress*

Born, Kathleen. 2004. Artists for Humanity EpiCenter Opens in South Boston

United States Green Building Council. 2005. *LEED Certified Project Case Study*. Artists for Humanity EpiCenter. Washington: www.usgbc.org

Key figures



Total project cost: \$4,900,000
Cost per square foot: \$208

Grid emission rate: 407 kg CO₂ per MWh
Grid emissions: 51,864,054 tCO₂/yr

Accreditation formula for a Boston, Massachusetts, LEED certified Industrial / Educational building, using New England PCA as a baseline. October, 2004 ~ September, 2005, applying known electric and natural gas values. Style: Emissions Avoidance

*Technically, these types of reductions are named Emission Avoidance Units or EAU's. They are characterized by the fact that they adversely influence the load and emissions results

National emissions per kWh												
1	CO2 (kg)	NOX (kg)	SO2 (kg)	CO (kg)	NMVOCS (kg)	CH4 (kg)	N2O (kg)	SF6 (kg)	HG (kg)			
	0.63151	0.00135	0.00274	0.00015	0.00002	0.00001	0.00001	0.00000	0.00000			

of the utility products that the project would have otherwise had to rely on under conventional circumstances.

NE ISO emissions per kWh							HG (kg)
1	CO2 (kg)	NOX (kg)	SO2 (kg)				0.00000
	0.40692	0.00068	0.00171				

NE PCA baseline kWh										
86,466	35,185	58.83	148.25	kWh	53.94%	1.85				
									</	

NE baseline CCF						
10,260	57,069	NG	43.86%	2.28		

National kWh												
86,466	54,604	116.37	237.05	CO2 (kg)	NOX (kg)	SO2 (kg)	CO (kg)	NMVOCS (kg)	CH4 (kg)	N2O (kg)	SF6 (kg)	HG (kg)

kWh from grid										
46,640	18,979	31.73	79.97							0.00021

kWh from PV										
48,685	0									
NG in CCF										
4,500	25,031									
Residual oil in gals										
0	0									

Quick sheet for U.S. National Average 2000

grams/lbs	lbs/MWh	grams/kWh	Emission
453.59237	1,392.24	631.50853	CO2
	6.044	2.7415123	SO2
	2.967	1.3458086	NOx
	0.0263	1.193E-05	Hg

<http://www.epa.gov/airmarkets/egrid/>

http://bioenergy.ornl.gov/papers/misc/energy_conv.html

LPG in gals										
0	0									
Gasoline in gals										
0	0									
Diesel in gals										
0	0									

Quick sheet for New England ISO and PCA 2000

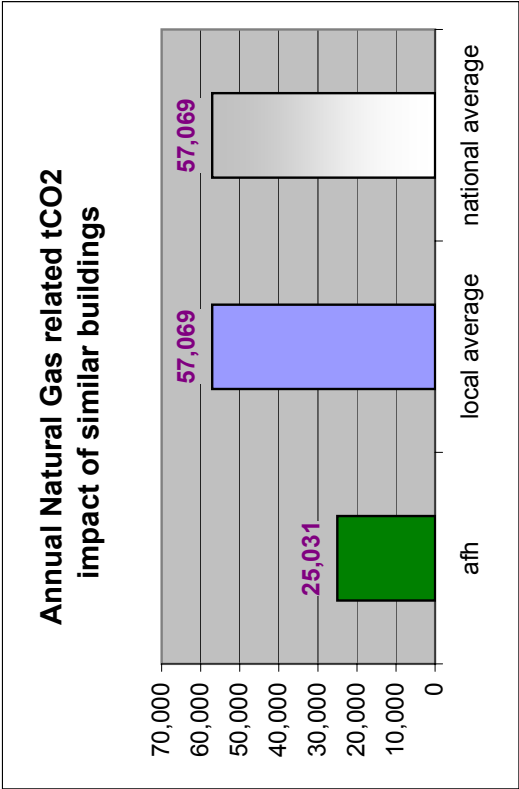
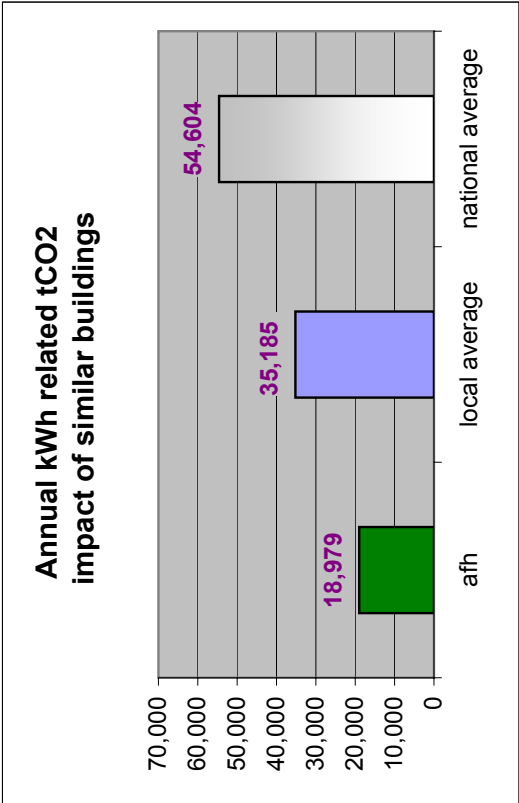
grams/lbs	lbs/MWh	grams/kWh	Emission
453.59237	897.11	406.92225	CO2
	3.78	1.7145792	SO2
	1.5	0.6803886	NOx
	0.0097	4.4E-06	Hg

NStar is an integral part of the New England ISO & PCA

<http://www.iso-ne.com/>

afh Boston	CO2 (kg)	44,009	NOX (kg)	31.73	SO2 (kg)	79.97	CO (kg)	NMVOCS (kg)	CH4 (kg)	N2O (kg)	SF6 (kg)	HG (kg)
												0.00021
afh Baseline	CO2 (kg)	92,254	NOX (kg)	58.83	SO2 (kg)	148.25	CO (kg)	NMVOCS (kg)	CH4 (kg)	N2O (kg)	SF6 (kg)	HG (kg)
												0.00038
afh Boston Credit	CO2 (kg)	48,245	NOx (kg)	27.09746	SO2 (kg)	68.28559						Hg (kg)
												0.0001752

kWh results	afh	local average	national average
Natural Gas results			
	18,979	35,185	54,604
	25,031	57,069	57,069



ERC % project holder	70%	ICBE	5%	Discount	20%	Insurance	5%
ERC's (t)							100%
	33.84	2.42	9.67	2.42			
Total							48.340233

GHG rate in kgCO2/ft2/yr	1.87
GHG sink rate in tCO2/yr	48,245
Total Avoided Emissions	48,340

Electric demand in KW (Kilowatt or 1000 watt), afh's grid demand is a bit over half the baseline average

ST_NUM	ST_NAME	ST_SUF	STATE	ZIP_CODE	GROSS AREA	KW Win 2006	KW Sum 2005	KW Win 2005	KW Sum 2004	KW Win 2004	KW Sum 2003	KW Win 2003
	ARLINGTON	ST	MA	02116	16738	12.8	13.2	20.0	12.0	12.0	meter not read	11.4
	BOSTON	ST	MA	02125	20000	28.8	58.4	32.4	54.8	32.4	46.8	31.2
	BRADSTON	ST	MA	02118	22932	170.4	86.4	172.8	57.6	144.0	57.6	177.6
	BROOKLINE	AV	MA	02215	22878	54.0	68.0	54.2	69.0	58.0	76.0	49.0
	HARCOURT	ST	MA	02116	10665	21.6	54.0	22.8	49.2	28.0	50.0	24.0
	WALNUT	ST	MA	02108	13248	28.0	50.8	23.9	40.6	23.7	50.5	26.4

gross sf total
106,461
average sf per building
17,744
average DMD in KW
average DMD per sf per season
0.0030
average DMD per sf all buildings over 3 years
0.0030

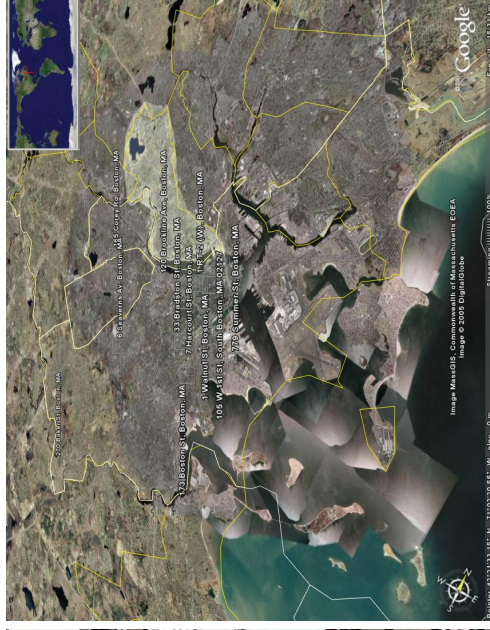
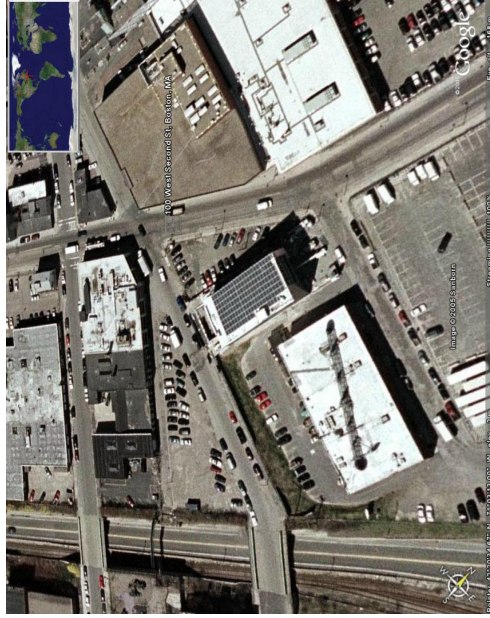
target building
target building
DMD in KW
average DMD per sf per season
average DMD per sf over 3 seasons
target building DMD relative to baseline
53.94%

52.6
0.0030
55.1
0.0031
54.4
0.0031
49.6
0.0021

47.2
0.0027
49.7
0.0028
56.2
0.0032
53.3
0.0030

100 West Second Street

23,500



About the afh building
More about the afh building

DMD (demand) is read every time the meter is read, usually once a month. DMD is continuously recalculated as a rolling average of 15 minute increments. In this baseline, Summer demand is based on the August readings and Winter demand on February readings. A more accurate representation of electrical use would employ kWh totals, the goal for Baseline Year 2.

The target building is a LEED certified, 23,500 square foot multi functional 4 story building, used primarily M-F, 9 to 5pm. The comparison baseline buildings are mainly commercial buildings such as banks, insurance offices etc, with similar occupational patterns.

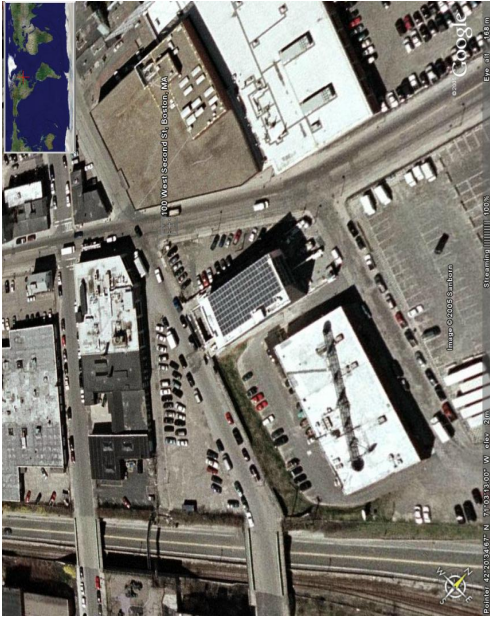
Natural Gas usage in 100 Cubic Feet (1 CCF = 748.05 gallon), afh uses less than half the baseline average

ST_NUM	ST_NAME	ST_NAME_SUF	STATE	ZIP_CODE	GROSS AREA	NG Sum 2005	NG Win 2005	NG Total 12 months
ARLINGTON	ST		MA	02116	16738	996	7,291	8,287
BRADSTON	ST		MA	02118	22932	275	438	713
BROOKLINE	AV		MA	02215	22878	2,116	8,479	10,595
HARCOURT	ST		MA	02116	10665	4,518	7,851	12,369

gross sf total	73,213
average sf per building	18,303
average usage in CCF	1,976
average usage in CCF per sf per season	0.1080
baseline annual CCF usage per sf	0.44

target building	1,253
target building	0.0533
average usage in CCF	3,247
average usage in CCF per sf per season	0.1382
target building CCF usage per sf	4,500
target building CCF usage relative to baseline	0.1915
	43.86%

100 West Second Street



About the afh building
More about the afh building

The target building is a LEED certified, 23,500 square foot multi functional 4 story building, used primarily M-F, 9 to 5pm. The comparison baseline buildings are mainly commercial buildings such as banks, insurance offices etc, with similar occupational patterns.

Water usage in Cubic Feet (1 CF =7.48 gallon), afh uses more than twice the baseline average

ST_NUM	ST_NAME	ST_NAME_SUF	STATE	ZIP_CODE	GROSS AREA	Water 2005
ARLINGTON	ST		MA	02116	16738	5,989
BRADSTON	ST		MA	02118	22932	10,340
WALNUT	ST		MA	02108	13248	12,977

gross sf total
average sf per building
average usage in CF
average usage in CF per sf per year

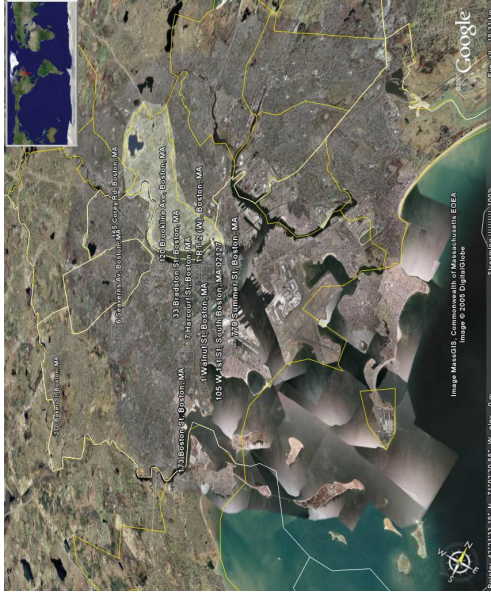
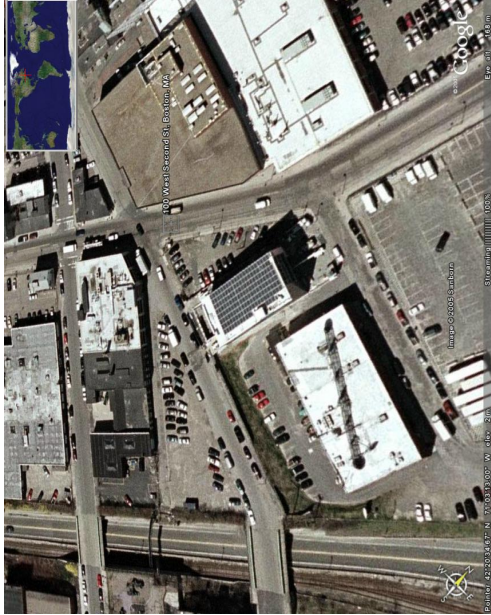
52,918
17,639
9,769
0.5538

target building
target building
average usage in CF
average usage in CF per sf per year
baseline annual CF usage per sf
target building CF usage per sf
target building CF usage relative to baseline

32,350
1.3766
0.5538
1.38
248.57%

100 West Second

Street



About the afh building
[More about the afh building](#)

The target building is a LEED certified, 23,500 square foot multi functional 4 story building, used primarily M-F, 9 to 5pm. The comparison baseline buildings are mainly commercial buildings such as banks, insurance offices etc, with similar occupational patterns.

Emission Reduction Certificate

Style: Emission Avoidance

Grid-connected LEED certified industrial/educational building
48,245 tonnes CO₂



2004 Industrial Assembly Style
4-story Grid Connected Building

Production: Oct 1, 2004 to Sep 30, 2005
Location: Boston, Massachusetts
Country: United States

Carbon Sink:

Sink Type: On-grid Industrial Building
Sink Variant: Steel & Glass, 23,500ft²
Sink GHG Rate: 1.87 kg/ft²/yr
Sink Reduction Rate: 48.25 tCO₂/yr

Emission Reductions Created by:

Artists for Humanity
100 West Second Street
Boston, MA 02127, US
andrewmotta@afhboston.com



31,000 MW of Mixed Generating Supply


Reduction: Oct 1, 2004 to Sep 30, 2005
Location: New England ISO / PCA
Country: United States

Carbon Source:

Source Type: Standard Utility Grid
Coal 16.78%, Oil 15.95%, Gas 20.90%
Nuclear 29.74%, other fossil 1.54%
Biomass 6.90%, Hydro 8.15%
Source Output: 51,864,054 tCO₂/yr
Source Emission Rate: .406 tCO₂/MWh

Emission Reductions Certified by:

ICBE, Inc.
6651 NW 23rd Avenue
Gainesville, FL 32606-8400, US
mark@icbe.com


Treasurer of the International Carbon Bank and Exchange®

US CERTIFICATION # 000000177

This certificate represents the reduction of 48,245 tonnes of Carbon Dioxide (CO₂), and the creation and assignment of all the emission reduction rights associated with the reduction activities to the project holder. The certificate represents reductions achieved by the project holder in the New England ISO/PCA, Massachusetts, U.S.A., through various reduction activities. A record of this issuance can be found on www.icbe.com.