

The Chicago Green Bungalow Project

The Chicago bungalow has been around for a century. A Green Team is working to make sure these houses last for another hundred years.



by Paul Knight

The Chicago bungalow has played a defining role in the history of many Chicago neighborhoods. Between 1900 and 1940, this middle-class home, with its solid exterior and comparatively spacious rooms, served developing communities as Chicago spread out from its industrial and commercial core. More than 80,000 bungalows were built. Often entire blocks were developed in the Chicago bungalow style, and they continue to stand—housing current residents while connecting communities to their past.

The Chicago bungalow has been defined as a blend of the Prairie School architectural style, developed in the work of Louis Sullivan and Frank Lloyd Wright, and the Arts and Crafts

movement. Like Prairie School homes, the Chicago bungalow has low pitched roofs, wide eave overhangs, long horizontal lines, massive masonry supports, and earth-toned or contrasting colors. The Arts and Crafts movement promoted homes as private and individualized retreats from the hectic pace of city life. Following this principle, each bungalow has unique features that personalize the residence. As a result, one can look at a block of Chicago bungalows and quickly see both the common features and the individual differences between them.

To preserve these unique homes, the City of Chicago sponsored the Green Bungalow Initiative (see “Green Bungalow Initiative”). This initiative builds on the connection to the environment that was important to the Prairie School and

the Arts and Crafts style by examining how sustainable products could be used in the renovation and landscaping of Chicago bungalows. Sustainable product choices included recycled insulating materials, low volatile organic compound (VOC) paints, and water-conserving landscape features.

In addition to choosing sustainable products for renovation and maintenance, the Chicago Green Bungalow Initiative made energy efficiency a priority. Energy efficiency reduces the operating costs of these homes and will enable moderate-income families to afford them for another century. Energy efficiency is also a proven strategy for pollution prevention. Another goal of the Green Bungalow Initiative was to demonstrate different approaches to energy efficiency.

For example, one bungalow had a hydronic heating system already installed. We chose to maintain it and use a high-efficiency boiler. A geothermal combination space- and water-heating system and a high-efficiency gas-fired furnace were

guide the renovation process with respect to architecture, design, sustainability, energy efficiency, landscaping, and urban design. The 6400 block of South Fairfield was selected by the partners as a model block for the

sive was to gather and exchange ideas on creating adaptable, energy-efficient, and green Chicago bungalows. Groups were formed, and each group was given a type of bungalow type on which to focus. The results of each group were presented to the participants. After some general discussion, these results were summarized. Results for each type were then given to the architect for incorporation into the design of one of the four bungalows.

The four types of bungalow that grew out of this process were

- wheelchair accessible;
- home office;
- young professionals; and
- classic restoration.

Rehab work scopes and construction documents were prepared for each bungalow. An energy-efficient strategy was designed for each bungalow in keeping with the rehab work scope. Appropriate sustainable materials were then chosen for each design. Rehab work began in the fall of 2001 and was completed a year later. The bungalows were purchased and occupied in November 2002.

Heating bills for the 2002–03 heating season were acquired in the spring of 2003 to determine energy savings. After doing energy ratings for each bungalow before renovation, we estimated the savings that would result from a typical rehab and from an energy-efficient rehab, and compared our actual space-heating consumption to the estimated consumption of the typical rehab. Three of the homes were tested with a blower door. Time constraints did not allow us to perform a blower door test at 6425.

**6421 South Fairfield—
Wheelchair Accessible**

This home was rehabbed with accessibility in mind (see Table 1). A 500 ft² addition to the back of the home includes an 11.5 ft x 10 ft (gross) master bedroom. A laundry room, a wheelchair lift that provides access to the ground floor and basement, and a wide corridor leading to the new rear deck are part of the addition. The addition was built over a conditioned crawlspace. The total floor area in the renovated home is 1,400 ft². The existing kitchen and bathroom were demolished and rebuilt to accommodate a wheelchair. The two existing bedrooms, living room, and dining room were refin-



More than 80,000 bungalows were built in Chicago neighborhoods between 1900 and 1940. These middle-class homes served the expansion of Chicago beyond its industrial and commercial core.

**Table 1. Actual Costs Over Typical Rehab Costs—
6421 S. Fairfield (1,400 ft²)**

Energy Measure	Typical Rehab	Actual Rehab	Additional Cost	Unit Cost
Attic Insulation	R-30	R-43	\$ 230	\$0.17/ft ²
Wall Insulation (existing walls)	None	R-4 (injected foam)	\$ 900	\$0.82/ft ²
Wall Insulation (addition)	R-13 batts	R-13 batts + 1-in insulated foam board	\$ 400	\$0.68/ft ²
Basement/Crawl Space Wall Insulation	None	R-10 blanket & R-15 in crawl space	\$ 1,200	\$1.00/ft ²
Windows	New double glazed	New double glazed with low-e coating	\$ 370	\$2.00/ft ²
Furnace	Standard 80%			
Water Heater	Standard natural draft	Ground source heat pump	\$10,000	

Total rehab cost: \$192,958 (\$137.82/ft²)
 Total additional energy cost: \$13,100 (\$9.36/ft²)
 Percent increase: 6.8%

other choices for space heating. A tankless water heater provides hot water in one home. And all the refrigerators, clothes washers, and dishwashers installed in all of the homes are Energy Star.

6400 Block of South Fairfield

A project architect was hired and a Green Team was assembled to help

Chicago Green Bungalow Initiative. Four abandoned bungalows were acquired by the Neighborhood Housing Services. A theme, or type, was chosen for each bungalow, on which the rehab work would be based.

A group of bungalow homeowners and professionals gathered for a half-day workshop in April 2001 to begin the design process. The purpose of the inten-

ished. Existing walls and mechanicals in the conditioned basement were removed.

The existing building was in fairly good shape. The plaster and lath required only patching and painting. New windows were installed. New plumbing, new electrical, and a new heating system were part of the rehab work scope. Blower door testing after the rehab showed a CFM₅₀ of 2,000.

The following energy and indoor air quality (IAQ) measures were included in the rehab work scope:

- R-4 foam insulation injected between the plaster and brick on the exterior walls;
- R-18 sidewall insulation in the addition;
- R-43 attic insulation;
- R-10 basement and crawlspace foundation wall insulation;
- new double-glazed low-e windows with a U-value of 0.34 and a solar heat gain coefficient (SHGC) of 0.31 (old pulley wells were filled with foam insulation);
- ground source heat pump with electric backup for space heating and domestic hot water;
- bathroom and kitchen exhaust fans vented to the outside; and
- all ducts in conditioned space, duct joints, bypasses, and obvious penetrations through the building shell air sealed.

The green materials used in the rehab were low-VOC paints used throughout; a cork floor in the master bedroom; linoleum in the hallway and kitchen; ceramic tile in the bathroom; recycled-content gypsum board used throughout; cement board siding used on the garage; and copper-treated lumber used for the rear deck. (This lumber was treated with chromated copper arsenate, or CCA.)

6423 South Fairfield— Home Office

The interior of this home was in poor condition that warranted a gut rehab (see Table 2). Plaster and lath were removed from all the walls, exposing the interior studs and the masonry exterior walls. A 262 ft² space that can be used as a home office was added to the back of the home over a slab-on-grade. The home office area has a separate entrance and is connected to a kitchenette and bathroom in the

Energy Measure	Typical Rehab	Actual Rehab	Additional Cost	Unit Cost
Attic Insulation	R-30	R-43	\$ 180	\$0.17/ft ²
Wall Insulation (existing walls)	R-9	R-15 (blown rock wool)	\$1,060	\$1.02/ft ²
Wall Insulation (addition)	R-13	R-13 + 1-in insulated foam board	\$ 500	\$0.82/ft ²
Basement Insulation	None	R-13 batts	\$ 400	\$0.50/ft ²
Slab insulation	R-10 perimeter	R-10 full slab	\$ 400	\$1.54/ft ²
Windows	New double glazed	New double glazed with low-e coating	\$ 640	\$2.00/ft ²
Furnace	Standard 80%	Combination heating system	\$2,000	
Water Heater	Standard natural draft			
Total rehab cost: \$220,425 (\$169.64/ft ²) Total additional energy cost: \$5,180 (\$3.98/ft ²) Percent increase: 2.4%				

Energy Measure	Typical Rehab	Actual Rehab	Additional Cost	Unit Cost
Attic Insulation	R-30	R-43	\$ 100	\$0.17/ft ²
Wall Insulation (existing walls)	R-9	R-15 (blown rock wool)	\$1,300	\$1.35/ft ²
Batt Insulation	Knee walls: R-11 Rafter cavity: R-19	Knee walls: R-18 Rafter cavity: R-21	\$1,100	\$0.95/ft ²
Basement Insulation	None	R-10 blanket	\$1,000	\$1.00/ft ²
Windows	New double glazed	New double glazed with low-e coating	\$ 475	\$2.00/ft ²
Furnace	Standard 80%	94% efficient	\$ 600	
Total rehab cost: \$175,200 (\$106.57/ft ²) Total additional energy cost: \$4,575 (\$2.78/ft ²) Percent increase: 2.6%				

partially finished basement. The finished total floor area is 1,300 ft². Blower door testing showed a CFM₅₀ of 1,530.

A gut rehab offers many opportunities to include energy-efficient building measures. The energy features of this bungalow included

- R-15 blown rock wool insulation in 2 x 4 exterior wall framing;
- R-18 wall insulation in addition (R-5 rigid foam between brick and

block with interior 2 x 4 framing and R-13 batts);

- R-43 attic insulation;
- R-13 basement wall insulation;
- R-10 full slab-on-grade insulation;
- new double-glazed low-e windows with a U-value of 0.34 and an SHGC of 0.31 (old pulley wells were packed with insulation);
- air sealed bypasses and obvious penetrations;



The rigid foam insulation between brick and block in this addition at 6423, combined with R-13 batts in the wood-framed interior walls, results in an R-18 wall.

**Table 4. Actual Costs Over Typical Rehab Costs—
6448 S. Fairfield (1,268 ft²)**

Energy Measure	Typical Rehab	Actual Rehab	Additional Cost	Unit Cost
Attic Insulation	R-30	R-43	\$ 120	\$0.17/ft ²
Wall Insulation	None	None	\$ 0	\$0
Knee Walls	R-13	R-13 denim insulation	\$ 125	\$0.25/ft ²
Basement Insulation	None	R-10 foam board	\$1,445	\$1.50/ft ²
Windows	Typical tripletrack storms	Low-e storm	\$ 700	\$2.00/ft ²
Boiler	Standard 80%	88% efficient	\$1,000	
Total rehab cost: \$131,153 (\$103.43/ft ²)				
Total additional energy cost: \$3,390 (\$2.67/ft ²)				
Percent increase: 2.6%				

- radiant floor heating in the home office;
- direct-vent sealed-combustion combination space and water heating furnace (88% combined seasonal heating efficiency);
- Lennox A/C unit with a seasonal energy efficiency ratio (SEER) of 14; and
- bathroom and kitchen exhaust fans vented to the outside.

The green materials included natural slate tiles in the home office; linoleum in the kitchen; recycled content gypsum board; low-VOC paints and stains; rubber flooring in the finished part of the basement; and cement board siding used on the garage.

**6425 South Fairfield—
Young Professionals**

The interior of this home was in poor condition and, like the home at 6423, required a gut rehab (see Table 3).

A section of the roof was raised and a master bedroom suite was added to the second floor. The ceiling over the living room was removed and the roof was finished as a cathedral ceiling. The basement was finished as living space. The final total floor area is 1,644 ft². The estimated blower door results for this house was a CFM₅₀ of 1,930.

The A/C unit at 6425 has a SEER of 11. The only place to locate the unit at 6425 was under the back porch. A low profile unit was required and we were only able to get a SEER of 11.00. But a wide range of energy measures were included as part of the gut rehab, resulting in significant energy savings. These energy and IAQ features included

- R-15 blown rock wool insulation in 2 x 4 exterior wall framing on the first floor;
- R-43 attic insulation;
- R-10 basement wall insulation;
- R-18 insulation in the knee walls and R-21 in the rafter cavity on the second floor;
- new double-glazed low-e windows with a U-value of 0.34 and an SHGC of 0.31 (old pulley wells were packed with insulation);
- air sealing;
- direct-vent sealed-combustion furnace (94% annual fuel utilization efficiency, or AFUE);
- a 2.4 kW PV system on the roof; and
- bathroom and kitchen exhaust fans vented to the outside.

Among the green materials used in the rehab were recycled-plastic-content carpet; recycled-content gypsum board; low-VOC paints and stains; cement board siding used on the garage; and plantings on the garage roof (to create a green roof).

**6448 South Fairfield—
Classic Restoration**

This home was in fairly good shape (see Table 4). A number of historic features, such as doors, windows, and trim, were preserved and restored as part of the rehab. The as-yet unheated attic was framed and insulated with denim insulation and can be finished as living space at some future point. The total floor area is 1,268 ft². The blower door results for this house showed a CFM₅₀ of 3,780.



PAUL KNIGHT

Three of the bungalows were tested with a blower door. The results were 2,000 CFM₅₀ for 6421; 1,530 CFM₅₀ for 6423; and 3,780 CFM₅₀ for 6448, which, as a classic restoration, offered less opportunity to include energy efficiency measures than the other rehabs. We estimated a CFM₅₀ of 1,930 for 6425.



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(left) The renovation at 6423 South Fairfield included the installation of a 90% efficient, direct-vent, sealed-combustion combination space- and water-heating furnace. (right) The renovation also included an addition that can serve as a home office. The walls of the addition include R-5 rigid foam between brick and block.

	Estimated Energy Savings	Actual Energy Savings
6421 S. Fairfield	68%	56%
6423 S. Fairfield	51%	61%
6425 S. Fairfield	72%	69%
6448 S. Fairfield	38%	47%



PAUL KNIGHT

Despite limited opportunities for including energy measures, significant energy savings were achieved. Foundation insulation, attic insulation, a new energy-efficient boiler, an instantaneous water heater, and limited air sealing were installed. Sidewalls were not insulated, nor were the windows replaced. These homes are masonry construction with plaster and lath installed over furring strips. There is a 1/2-inch air cav-

ity between the brick and the back of the plaster/lath. This cavity was foamed at 6421 because the plaster needed patching and the windows were being replaced. The plaster at 6448 was in very good shape and required very little patching. Furthermore, the windows were not being replaced. We didn't want to incur the added cost of patching the plaster, risking blowout of the plaster, or filling the pulley wells.

The energy and IAQ features in this rehab included

- R-43 attic insulation;
- R-10 foundation wall insulation;
- R-13 denim insulation in the second-floor expansion;
- single-glazed low-e storm windows (added over existing windows);
- sealed combustion boiler (88% AFUE);

Green Bungalow Initiative

The Chicago Green Bungalow Initiative was a pilot program sponsored by the City of Chicago. The goals of the initiative were to

- demonstrate creative methods of rehabbing bungalows that appeal to contemporary homeowners while preserving the historic character of the homes;
- demonstrate innovative energy-efficient and environmentally sustainable techniques;

- encourage homeownership in the Chicago Lawn/Gage Park neighborhoods through visible neighborhood revitalization;
- strengthen the cohesiveness of the neighborhood through a variety of streetscape improvements; and
- promote the results of the Chicago Green Bungalow Initiative to bungalow owners and design professionals.

Many groups worked together to help guide the Chicago Green Bungalow Initia-

tive. These groups, representing a wide range of housing stakeholders, include the city of Chicago Department of Environment, the city of Chicago Department of Housing, HUD, Neighborhood Housing Services Redevelopment Corporation, Southwest Home Equity Assurance Program, Greater Southwest Development Corporation, the Chicago chapter of the American Institute of Architects, and the Historic Chicago Bungalow Association.

Table 6. Cost Effectiveness

	Annual Savings	Payback	Life Cycle
6421 S. Fairfield	\$1,073	12.2 years	1.12
6423 S. Fairfield	\$ 709	7.3 years	2.08
6425 S. Fairfield	\$ 849	5.4 years	2.82
6448 S. Fairfield	\$ 574	5.9 years	2.57



(left) The payback period for the four unique bungalow renovations ranged from approximately 5 years to just over 12 years. (above) The as-yet unheated attic at 6448 was framed and insulated with denim insulation and can be finished as a living space in the future.

- instantaneous water heater (68% energy factor, or EF);
- new high-velocity central air conditioning; and
- bathroom and kitchen exhaust fans vented to the outside.

The green materials included recycled-content gypsum board; low-VOC paints and stains; restored and repaired stained glass windows, bookcase, fireplace mantel, light fixtures, and door hardware; and cement board siding used on the garage.

Energy Savings and Cost Effectiveness

The actual energy cost savings were greater than the estimated savings in the 6423 and 6448 bungalows, and less than estimated for the 6421 and 6425 bungalows (see Table 5). All four homes were occupied during the period in which fuel bills were analyzed. We had some operational problems with the geothermal system at 6421, and we were off only by 3% at 6425.

Cost differences between the typical rehab and the energy-efficient

rehab were obtained for each of the four bungalows. Energy savings for each bungalow were compared to the additional costs for the energy measures to determine cost effectiveness. Cost effectiveness is figured in different ways: payback, life cycle, and cash flow.

Payback is the number of years it takes for the energy savings to pay for the energy measures—the lower the payback, the greater the cost effectiveness. Payback is determined by dividing first-year energy savings into the cost of the energy measures. It does not account for inflation or increased cost of energy. Paybacks for the four bungalows ranged from 5.4 to 12.2 years (see Table 6).

Life cycle accounts for the increased cost of energy over time. Life cycle indicates how many times over an energy measure pays for itself over 20 years—the higher the life cycle, the more cost-effective. An energy measure with a life cycle of 1 will pay for itself once over 20 years. Any measure with a life cycle greater than 1 is cost-effective; any measure with a life cycle of less than 1 is not

cost-effective, as it will not pay for itself in 20 years or less. Life cycles for the four bungalows ranged from 2.82 to 1.12 (see Table 6).

The cost to finance the energy work is subtracted from the monthly energy savings to determine cash flow. If the monthly energy savings are greater than the monthly financing costs, there is a positive cash flow. That is, the owner uses the energy savings to pay the monthly finance charges and still has money remaining. The more money remaining, the greater the cash flow. If the monthly finance charges exceed the monthly energy savings, there is a negative cash flow.

Cash flow for the four bungalows was determined for two financing scenarios. First, it was assumed that money to pay for the energy measures was borrowed over 30 years at 6.5% interest (see Table 7). Under these terms, the monthly finance charge is \$6.32 for every \$1,000 borrowed. In a second scenario, we assumed that the money was borrowed over 15 years at 5.5% interest. Under these terms, the monthly finance charge is \$8.17 for every \$1,000 borrowed.



(left) The Arts and Crafts movement promoted homes as private and individualized retreats from the hectic pace of city life. Each bungalow has unique features. (right) With HERS scores in the 80s, the residents of the renovated Chicago bungalows should enjoy cost-effective and energy-efficient comfort for years to come.

Table 7. Cash Flow for 30-Year Financing

	Additional Cost for Energy Measures	Monthly Savings	Monthly Cost to Finance	Net Cash Flow
6421	\$13,100	\$89	\$82.79	+ \$ 6.21
6423	\$ 5,180	\$59	\$32.74	+ \$26.26
6425	\$ 4,575	\$71	\$28.91	+ \$42.09
6448	\$ 3,390	\$48	\$21.42	+ \$26.58

Table 8. HERS Rating


	Rehab Type	Typical Rehab	Actual Rehab
6421 (accessible)	moderate	63.1	81.2
6423 (home office)	"gut"	59.4	85.1
6425 (young professional)	"gut"	64.4	86.5
6448 (classic)	patch & paint	68.0	80.9

Home Energy Ratings

Home energy ratings (HERS) were done for each bungalow. HERS measure the home's energy characteristics, including insulation levels; window efficiency; and the heating, cooling, and water-heating system efficiency on a scale from 0 to 100. A rating of 80 indicates that the home meets the International Energy Conservation Code (IECC). Each one-point increase in the rating represents approximately a

5% improvement in the efficiency of the home. A rating of 86 or above meets the EPA Energy Star Home criterion of being 30% better than standard construction.

Each bungalow received two ratings (see Table 8). The first rating was based on a typical rehab for each bungalow. The second rating was based on the actual rehab that includes the energy-efficient measures. With the energy-efficient measures included, the home at 6425 South Fairfield reached Energy Star status, and the home at

6423 fell slightly below. Both of these homes received a gut rehab. Both 6421 and 6446 received moderate rehabs and these homes were able to meet the IECC. 

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