GREENING EXISTING HOMES WITH HOME PERFORMANCE

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In response to AB 549 requirements, the California Energy Commission published a report on "Options for Energy Efficiency in Existing Buildings" in December 2005, which described recommended strategies to increase energy efficiency in existing buildings. The report identified Integrated Whole Building Diagnostic Testing and Repair as a residential strategy for energy efficiency. The report stated, "Whole building diagnostic testing is a process to systematically detect flaws in building construction or operation, diagnose their causes, and facilitate, enable and verify their correction, leading to energy savings as well as increased comfort, health, and safety benefits. Cost-effectiveness criteria should appropriately account for the non-energy benefits realized. No legislative action is needed".

Home Performance: Home Performance follows a Whole House Approach and includes whole building diagnostic testing. Consider a home to be a system with three major parts: (1) the structure (building envelope/enclosure), (2) the equipment (HVAC, etc), (3) lighting and appliances. These three parts and all components of these parts work together in a home. For a home to be comfortable and provide the residents with a healthy and conducive living environment, while using the least amount of energy, it is important that the system with all its parts and components be well balanced. The Whole House approach focuses on fixing the trouble spots in the home and increasing its overall energy efficiency, with added considerations for equipment/appliance safety, health and indoor air quality. The Home Performance with Energy Star program, a national program from the U.S. EPA and U.S. DOE, offers a comprehensive, whole-house approach to improving energy efficiency and comfort at home, while helping to protect the environment.

Typical Home Problems reported by homeowners, and addressed through Home Performance, are:

- High Energy Bills
- Hot or Cold Rooms
- Drafty Rooms
- Mold, Mildew or Musty Odors
- Damp Basement
- Cold Floors in Winter
- Dust
- Moisture on Windows
- Peeling Paint
- Dry Indoor Air in Winter

According to the U.S. EPA, "A drafty home, rooms that are too hot or too cold, and high energy bills are all common issues for homeowners. Installing a new heating or air conditioning system, buying replacement windows, or adding more insulation may fix part of the problem. But the way to better results is through an integrated 'whole-house' approach that looks at your house as a system."

The Home Performance Process starts with a homeowner interview to understand the primary issues of concern to the homeowner and the homeowner's assessment of the comfort level in his/her home. An evaluation of the utility bills (gas, electricity) for the past 12 months is then carried out for base and peak loads, followed by a walk through the house and reviewing the problem areas. Diagnostic testing is carried out using a variety of tools, such as blower door, duct blaster, carbon monoxide tester, gas leakage tester, infrared camera, etc. Testing includes: Measurement of enclosure air leakage and duct leakage, pressurization and depressurization tests as needed, combustion safety tests for combustion equipment and appliances, checking attic and crawl space ventilation, exposed insulation installation quality check, insulation and air barrier inspection, HVAC system and thermostats check, temperature stratification tests, hot water heater check, lighting and other electrical loads assessment, thermal imaging, etc. A comprehensive report of the findings is subsequently presented to the homeowner along with recommendations for improvements. A Test-Out is suggested following implementation of the recommendations by the homeowner.

Sample Home Evaluation Results are given in the Table below for three So. California houses built over a period of 35 years (between 1943 and 1978), and having a living area varying almost two-fold (between 1,568 and 3,250 square feet). The 1943 house had 3 additions over the years. The annual utility bill amounts (gas + electricity) are presented in column 3 of the Table, with the utility charges per square foot per year provided in parenthesis under the annual utility charges.

Location /Year Built /(Additions)	Living Area sq. ft	Annual Utility Bill ($)/ ($/sq.ft/year)	Enclosure Leakage @50 Pascals	Duct Leakage @25 Pascals	HVAC Capacity Air conditioner (tons) Furnace (BTU)
Long Beach 1943 (3)	1,943	$2,163 ($1.01)	3,270 cfm	430 cfm	4 tons 100,000 BTU
Pasadena 1952 (0)	1,568	$2,188 ($1.47)	5,245 cfm (2,863*)	555 cfm (12*)	4 tons 100,000 BTU
Anaheim 1978 (0)	3,250	$3,250 ($1.00)	3,550 cfm	810 cfm	5 tons 100,000 BTU

* Test-Out Leakage Data (cfm)

The above Table shows some interesting results. Regardless of the age and size of the houses, the annual utility charges were found to between $1.00 and $1.50 per square foot per year, with annual costs ranging between $2,163 and $3,259, which are considered quite high for homes of this size in the Southern California climate zone. Moreover, the measured enclosure leakage and duct leakage values were significantly above the allowable values. Even more interestingly, we note that regardless of the size and age of the houses, all houses have a 100,000 BTU furnace and a 4 to 5 ton capacity air conditioner installed.

What did Home Performance achieve? The homeowner of the 1952 house carried out the recommended improvements using the services of qualified home performance contractors, and a Test-Out of the house was undertaken thereafter. Following the improvements, which included proper installation of new ducts and sealing of the house, the duct leakage was greatly reduced by about 98% to only 12 cfm from the initial 555 cfm, and the enclosure leakage was reduced by almost one-half to 2,864 cfm from the initial 5,245 cfm. With reduced air leakages, adequate insulation, and proper design of the HVAC system, the new air conditioner installed had a capacity of only 1.5 tons in comparison to the previous 4 tons unit ? a substantial reduction in installed capacity. For this house, the heating system was re-designed to install a hydronic furnace running on the domestic hot water heater, thereby completely eliminating the combustion furnace for heating. The residents of this house reported that the improvements made their home comfortable to live in. (Source: Healing Spaces by Design).

Carbon Footprint: Based on pre-improvement 12-month utility bill data alone, the carbon footprint for the 1952 home included in the above Table is calculated as: Electricity: 11,140 kWh/year = about 1,000 kWh/month, which gives about 8 metric tonnes CO_2 emissions per year. Gas: 614 Therms/year = about 50 Therms/month, which gives about 4 metric tonnes CO_2 emissions per year. In comparison, one average passenger vehicle emits about 6 metric tonnes CO_2 per year. Following implementation of recommendations made due to the Home Performance work, the carbon footprint of the home is considerably reduced due to reduction in the installed HVAC capacity and other measures. Pre- and post-improvement carbon footprint comparisons will be made when the 12-month post-improvement utility bill data for this home becomes available.

(This article is based on a presentation made by the author at the 7th Annual Green Building Municipal Conference and Expo, The Gas Company Energy Research Center, Downey, 17 April 2008). **Further information on Home Performance is available on the author's website at www.ashoka.net).**