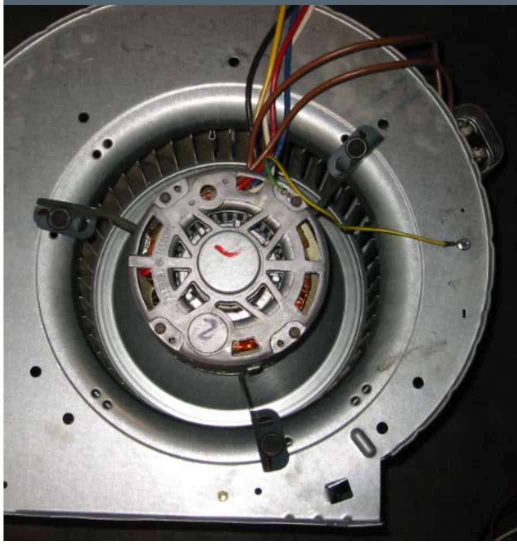


BUILDING AMERICA TOP INNOVATIONS 2013 PROFILE

INNOVATIONS CATEGORY:
1. Advanced Technologies and Practices
1.2 Energy-Efficient Components

TOP INNOVATOR:
LBNL

High-Performance Furnace Blowers

U.S. homeowners who install high-performance furnace blowers with well-designed and installed ducts can expect savings of 45% of fan energy or about 300 kWh/yr per home. Advanced blower technology could benefit the 63% of existing U.S. homes that have central air furnaces and any new homes built with central air systems.

BUILDING AMERICA TOP INNOVATIONS

Recognizing Top Innovations in Building Science – The U.S. Department of Energy's Building America program was started in 1995 to provide research and development to the residential new construction and remodeling industry. As a national center for world-class research, Building America funds integrated research in market-ready technology solutions through collaborative partnerships between building and remodeling industry leaders, nationally recognized building scientists, and the national laboratories. Building America Top Innovation Awards recognize those projects that have had a profound or transforming impact on the new and retrofit housing industries on the road to high-performance homes.

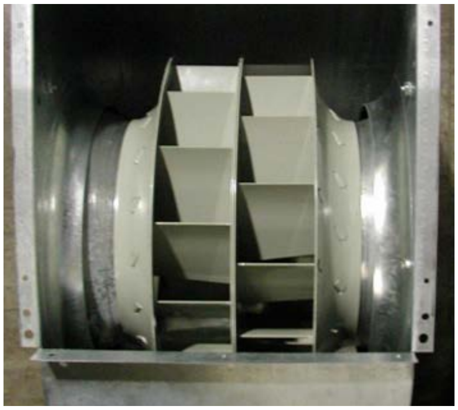
LBNL's work led to the creation of a standard for rating blowers, credits for the use of good blowers in Federal tax credit programs and energy codes, and consideration in current Federal rulemaking procedures.

More than 60% of U.S. households currently use central forced-air heating and cooling systems and a large percentage of new homes built today are equipped with a central forced-air furnace and air conditioner. Although furnaces, air conditioners, and heat pumps have become significantly more efficient over the last couple of decades, residential forced-air system blowers have not experienced similar improvement. Studies using field testing have shown that the most common blowers have efficiencies of only 10% to 15%. These low efficiencies indicate that there is significant room for improvement in the efficiency of the motors and the aerodynamic performance of the fans. Another important consideration is that essentially all of the wasted electricity is manifested as heat, which reduces air conditioning equipment's cooling performance.

In 2007, Lawrence Berkeley National Laboratory (LBNL) undertook a study for the U.S. Department of Energy to assess the performance of residential furnace blowers for heating, cooling, and air distribution applications. LBNL sought to compare their performance at the rating conditions specified by the Air Conditioning and Refrigeration Institute (ARI) for annual fuel utilization efficiency (AFUE) and seasonal energy efficiency ratio (SEER) and at real installed conditions.

A testing program was undertaken at two laboratories to compare the performance of furnace blowers over a range of static pressure differences that included standard rating points and measured field test pressures. Three different combinations of blowers and residential furnaces were tested. The laboratory test results for blower power and airflow were combined with DOE2 models of building loads, models of air conditioner performance, standby power, and igniter and combustion air blower power to determine potential energy and peak demand impacts.

(Top left) Building America research teams have recommended electronically commutated motors (ECMS) on central air furnace blowers based in part on LBNL's research.



LBNL tested the performance of a standard fan *(left)* and a prototype fan *(right)*. The standard fan used a permanent split capacitor motor while the prototype fan used a brushless permanent magnet (BPM) fan. Since the speed of the BPM motor is electronically controlled, it can be set specifically to match the airflow requirements of the application; i.e., less power is needed if the fan is being used for ventilation only or if less heat or cooling is called for. The fan blades are more aerodynamically designed and there is less turbulence due to air spillage at the ends.

The results showed distinct differences between the two types of furnace blower motors: the permanent split capacitor (PSC) and the more efficient brushless permanent magnet (BPM). The high static pressure differences in real installations reduce the advantage that BPM-driven blowers have at DOE/ARI rating conditions such that for cooling, the two motor technologies have essentially the same power consumption, although the reduction in airflow for the PSC-driven blower results in 10% lower air conditioner efficiency. For heating, the advantage of the BPM blower is approximately halved when changing from standard test conditions to installed conditions, although the BPM blower has the advantage of maintaining airflow that avoids the safety implications of the PSC blower's lower airflow. The BPM blower retains its advantage for multi-speed systems that can operate for many hours in low-fire mode. To better reflect blower performance, LBNL recommended that appliance rating test procedures be amended to use realistic system static pressures of between 0.5 and 0.8 in. water column (125 and 200 Pa) and that utility rebate programs ensure that rebates are provided for multi-speed systems and/or systems that have a field measured low static pressure difference below 0.5 in. water column (125 Pa).

LBNL's work raised awareness of the contribution of blower power to HVAC energy use and led to the creation of a Standard for Rating Blowers (CSA 823-11). It also led to credits for the use of good blowers in Federal tax credit programs and energy codes (e.g., California Title 24), and consideration in Federal rulemaking procedures. This work also documented the high duct system static pressure problem endemic to the majority of residential HVAC systems. It has led to significant efforts to reduce static pressures in the home performance industry and to proposed changes in blower test procedures to reflect true operating pressures. Because of this research, standards organizations and energy-efficiency programs can now specify and reward the use of better performing blowers, which results in lower HVAC energy use for all homes with central air systems.

This research is especially significant for high-performance homes where extremely low air leakage requirements have led to the need for continuous fresh air ventilation, a function that greatly benefits from the energy savings of variable speed fan motors. The innovation has helped to identify a neglected area of energy savings that contribute to zero net-energy homes.

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