Topics

# Energy-efficient Products for Better use of Energy in the Home

*OVERVIEW: Recent years have seen growing interest in the idea of creating "zero energy homes" as a means of countering global warming. While photovoltaic and other power generation systems for producing energy, batteries, and other devices for storing energy all play important roles, so too does the energy saved by improvements in the efficiency of the appliances used in the home. This important aspect has attracted attention toward improving the energy efficiency of various products for the consumer-electric market. This article describes energy-efficient products that were awarded prizes in the product and business model category at the presentation of the 2013 Grand Prize for Excellence in Energy Efficiency and Conservation.*

## ECOCUTE HOME HEAT PUMP WATER HEATER WITH CARBON DIOXIDE AS NATURAL REFRIGERANT

### Development Background and Overview

SINCE water heating accounts for approximately 30% of energy use in the home, improvement of its energy efficiency has an important role to play. With EcoCute*1 for the home having been added in March 2013 to the list of products covered by the standards of the Top Runner Program (target year: FY2017) established by Japan's Energy Conservation Law (Act on the Rational Use of Energy), further improvements in efficiency can be anticipated. Accordingly, by developing the most energy-efficient models on the market*2 and utilizing the technologies they employ, Hitachi Appliances, Inc. was able to lead the market in achieving the FY2017 Top Runner standards, specified by the Energy Conservation Law, for the BHP-FV46ND and all other models in its new FY2013 product range (see Fig. 1).

### Energy-saving Technologies for Home EcoCute

To improve energy efficiency, Hitachi developed its own components for use in highly efficient heat pumps (evaporator, scroll compressor, and water/refrigerant heat exchanger) (see Fig. 2).

The following section describes the technologies used in models such as the BHP-FV46ND, a mains-pressure water heater that is fully automatic and features a standard type tank and high efficiency (the technologies used vary between models).

To improve the heat exchange performance of the evaporator, a high density of smaller refrigerant tubes has been used, and to minimize the loss of heat pump performance due to the increase of pressure drop resulting from the use of smaller tubes, Hitachi developed a multi-branch tube arrangement that improves performance by achieving equal refrigerant distribution by utilizing the characteristics of mist flow immediately downstream of the expansion valve.

For the scroll compressor, Hitachi shrunk the gap between scroll laps to reduce loss due to leakage, and also reduced heating re-expansion loss by developing a new lubrication design for the compression chamber. For the water / refrigerant heat exchanger, Hitachi also improved performence by using smaller refrigerant tubes to enhance heat transfer efficiency, and by extending the total length of the tubes to increase the area of heat transfer surfaces.

In recognition of these detailed and proprietary energy efficiency technologies, Hitachi's home EcoCute (55 models, including the BHP-FV46ND) received the Director-General's Prize, the Agency for Natural Resources and Energy at the presentation of the 2013 Grand Prize for Excellence in Energy Efficiency and Conservation (in the product and business model category).

*1 The name "EcoCute" is a generic term used by power companies and water heater manufacturers in Japan for electric water heater heat pumps that use natural refrigerants.

*2 As of February 26, 2014. In the category of home heat pump water heaters for normal environments, (1) The BHP-FV37ND has a annual water heating and heat-retention efficiency(JIS) of 3.6 in the category of storage capacity from 320 L to 460 L, and (2) The BHP-FV46ND has a annual water heating and heat-retention efficiency(JIS) of 3.5 in the category of storage capacity from 460 L to 550 L. The calculation method for annual water heating and heat-retention efficiency(JIS) is stipulated in JIS C 9220:2011. The value varies depending on factors such as the region, selected operation mode, and usage.

*Fig. 1—BHP-FV46ND.*
*This is the flagship model in Hitachi's range of mains-pressure water heaters. It is fully automatic and features a standard type tank and high efficiency.*

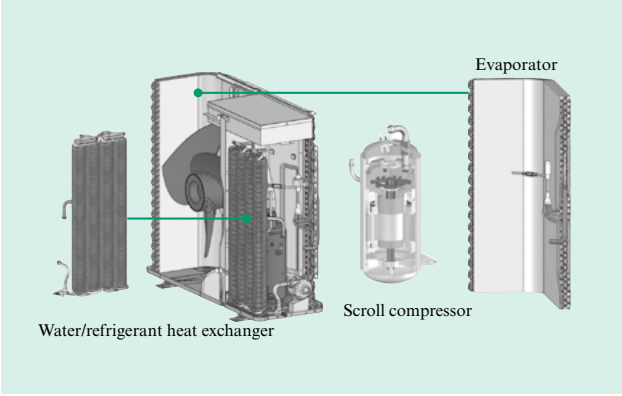


*Fig. 2—Main Components in Highly Efficient Heat Pump.*
*The figure shows the evaporator, scroll compressor, and water/refrigerant heat exchanger. The energy efficiency of these components has been improved through in-house development.*

## LED LIGHTING COMBINING HIGH LIGHT OUTPUT WITH ENERGY EFFICIENCY

### Development Background and Overview

With rising awareness of the need to save power, improving the energy efficiency of lighting, which makes up a significant proportion of power consumption by homes and other facilities, is an important task. In this context, the excellent energy efficiency of light-emitting diode (LED) ceiling lights has led to growing demand for their use as the main form of lighting in the home.

When Hitachi conducted a survey of what factors people consider when purchasing LED ceiling lights, many of the respondents expressed a desire for products that not only served their underlying purpose of providing good illumination, but were also energy efficient. Hitachi developed 22 models, including the highly efficient LEC-AHS1410B ceiling light, that have the intrinsic energy consumption efficiency of between 102.4 lm/W and 104.8 lm/W, while also providing maximum lighting for each room size, between eight and 14 tatami mats, defined in a standard*3 published by the Japan Lighting Manufacturers Association for specifying the floor area that can be illuminated by a light.

### Features and Energy Efficiency Technologies of LED Ceiling Lights

A characteristic of LED lights is that making them brighter typically causes them to produce more heat, and the resulting rise in the temperature of the LED module reduces their light emission efficiency. This makes it difficult to combine high light output with energy efficiency. These products incorporate proprietary technologies, including large

*3 "Residental catalog applicable room size standards"(Guide 121:2011) for specifying the floor area that can be illuminated by a light. Floor area is measured by number of tatami mats, where one mat is 910 mm × 1820 mm.

heat dissipating structures and dome LED units incorporating a lens function, to control the heat from the LEDs, and to combine high efficiency with a high level of illumination across the room (see Fig. 3).

And, seven of these models have a self-regulating function that uses a sensor to measure the level of external light and automatically turn down or extinguish the light. These functions and performance features achieve a high level of energy efficiency without sacrificing the level of illumination desired by users.

In recognition of the features of these products, which include their high efficiency and high output, 22 models of LED ceiling lights (released in FY2013) received Chairman's Prizes, the Energy Conservation Center, Japan at the presentation of the 2013 Grand Prize for Excellence in Energy Efficiency and Conservation (in the product and business model category).

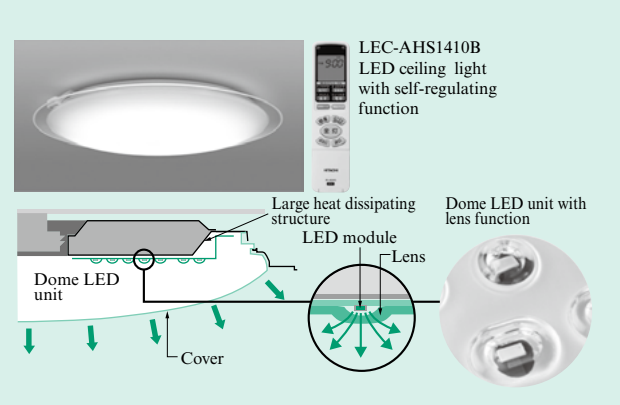


*Fig. 3—Appearance and Technical Features of LED Ceiling Light. The figure shows a large heat dissipating structure and a dome LED unit with a lens function.*

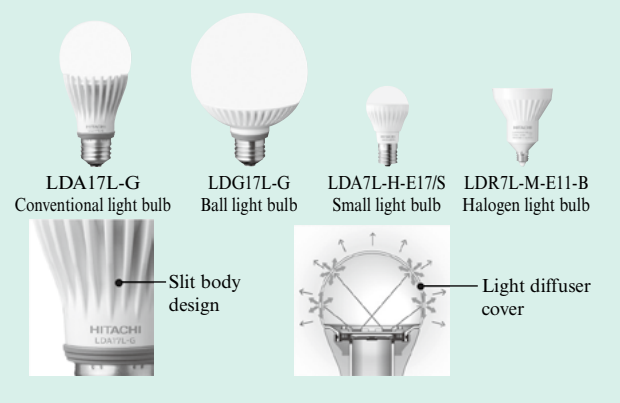


*Fig. 4—Technical Features of LED Light Bulb. The figures show the slit body design and light diffuser cover.*

## Features and Energy Efficiency Technologies of LED Light Bulbs

Light bulbs have traditionally been used in a wide range of different lighting devices, such as downlights and pendants. Converting these to LED has the potential to save a large amount of electric power. However, problems such as the heat generated by LEDs make it difficult to house them in units of equivalent size to light bulbs.

By adopting a slit body design that can effectively dissipate the heat from LEDs and light diffuser covers that spread the light from the LED, Hitachi succeeded in producing an LED light with a standard light bulb fitting (E26 screw base) that combines a spread of light similar to a light bulb and equivalent illumination to a 100-W incandescent light bulb, while keeping the size similar to that of a traditional light bulb (see Fig. 4). The LED light has approximately one-fifth the power consumption of an incandescent light bulb*4.

Hitachi has also produced compact models in small light bulb, ball light bulb, and halogen light bulb sizes to facilitate their installation in a wide range of different light-bulb-containing devices in the home and other facilities.

Simply replacing conventional, ball, small-size, and halogen light bulbs with LED light bulbs can save significant amounts of energy.

In recognition of these technologies, 15

models of LED light bulbs (released in 2012 and 2013) received Chairman's Prizes, the Energy Conservation Center, Japan at the presentation of the 2013 Grand Prize for Excellence in Energy Efficiency and Conservation (in the product and business model category).

## REFRIGERATOR-FREEZERS COMBINING LARGE CAPACITY AND ENERGY EFFICIENCY

### Development Background and Overview

The trend in refrigerators is toward larger sizes in response to changes in consumers' lifestyles, including people taking advantage of services such as food delivery systems to buy food in bulk. This has intensified the need to improve the energy efficiency of large refrigerators that consume considerable amounts of energy. This has made it important to combine technologies in order to achieve the conflicting objectives of energy efficiency and larger refrigerator capacity.

Meanwhile, growing health awareness has reinforced the need for refrigerators to minimize the loss of freshness in the food they contain.

In response, Hitachi has continued to make advances in refrigeration by developing its own proprietary technologies, including dual-fan cooling and frost recycling cooling techniques for saving energy, and a vacuum*5 preservation technology for keeping food fresh. By incorporating these energy-saving technologies into its product series, Hitachi is able to supply appliances that offer excellent economics to a greater number of customers (see Fig. 5).

### Key Energy-saving Technologies for Large Refrigerators

*4 Comparison between an LED light bulb (LDA17L-G, rated power consumption: 16.7 W) and a 100-W Hitachi incandescent light bulb (LW100V 90 W, rated power consumption: 90 W).
*5 Vacuum means a state of having air pressure smaller than the atmospheric pressure.

**(1) New dual-fan cooling technique for refrigeration compartment**

In place of the conventional method for cooling the refrigeration compartment, which is to locate a cooling fan above the evaporator, Hitachi has developed a new concept for saving energy that uses a dedicated refrigeration compartment cooling fan


*Fig. 5—Refrigerator-freezer Equipped with Vacuum Compartment[R-G6700D(XT)]*
*Food is kept even fresher and more nutritious in the vacuum compartment*

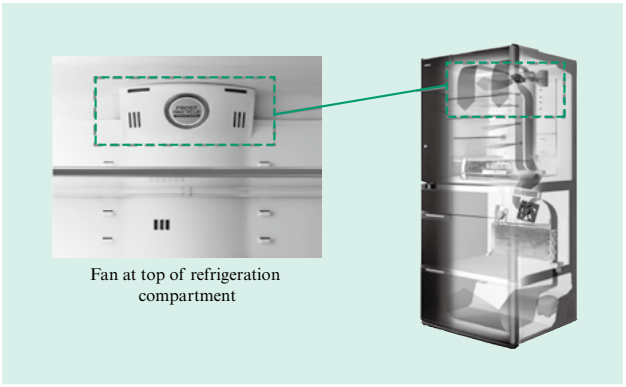


*Fig. 6—Dual-fan Cooling.*
*A dedicated fan at the top of the refrigeration compartment works in tandem with the cooling fan to cool the refrigeration compartment quickly.*

located at the top of the compartment to minimize over-cooling in the refrigerator.

Specifically, the dedicated fan is positioned at the top of the refrigeration compartment, which is more prone to warm air entering when the door is opened. This minimizes wasteful energy consumption by working in tandem with the conventional cooling fan to shorten cooling times by rapidly circulating cool air to all areas of the refrigeration compartment (see Fig. 6).

**(2) Frost recycling cooling**

This energy-saving technology, which utilizes the frost on the evaporator, was first introduced in FY2009 models. Because frost deteriorates cooling performance, the practice generally had been merely to remove this by defrosting. In contrast, the new technique uses the cooling power of the frost to cool the refrigeration compartment and vegetable compartment while the compressor is not running. The moisture from the frost also acts to keep food from drying out.

**(3) Improved insulation**

The insulation used in refrigerators consists of vacuum insulation panel and urethane foam insulation. Hitachi introduced its own vacuum insulation panel made of double packing bags and glass wool in its FY2004 models. Now, Hitachi has increased the covered area of vacuum insulation panel and improved insulation performance by utilizing its own composition of urethane, with excellent fluidity, in the glass door.

**(4) Energy-saving modes**

Hitachi has introduced two energy-saving modes. The energy-saving modes cut power consumption by reducing cooling to the compartments within tolerable level and by operating the compressor at a lower speed. The second mode, designed for when the user is away from home, operates on even lower power by further reducing the compressor speed.

In recognition of these proprietary energy efficiency technologies, 11 models (including the R-G6700D) in the Vacuum-chilled FS Series of refrigerator-freezers received Reviewer's Prize at the presentation of the 2013 Grand Prize for Excellence in Energy Efficiency and Conservation (in the product and business model category).

## CONCLUSIONS

This article has described EcoCute for the home, LED lighting, and large capacity refrigerator products, all of which were awarded prizes in the product and business model category at the presentation of the 2013 Grand Prize for Excellence in Energy Efficiency and Conservation. By developing products with even better energy efficiency and encouraging their wider adoption, Hitachi Appliances, Inc. believes it can contribute to the creation of a low-carbon society.

## ABOUT THE AUTHORS

Yutaka Enokizu

*Hot Water Supply Systems Design Department, Tochigi Home Appliance Works, Home Appliance Group, Hitachi Appliances, Inc. He is currently engaged in the development and design of heat pump water heaters.*

Takashi Okada

*Design Department V, Home Appliance Group, Taga Home Appliance Works, Hitachi Appliances, Inc. He is currently engaged in the development and design of LED lighting products.*

Toshihiko Nagamori

*Refrigerator Design Department, Tochigi Home Appliance Works, Home Appliance Group, Hitachi Appliances, Inc. He is currently engaged in the development and design of household refrigerators.*