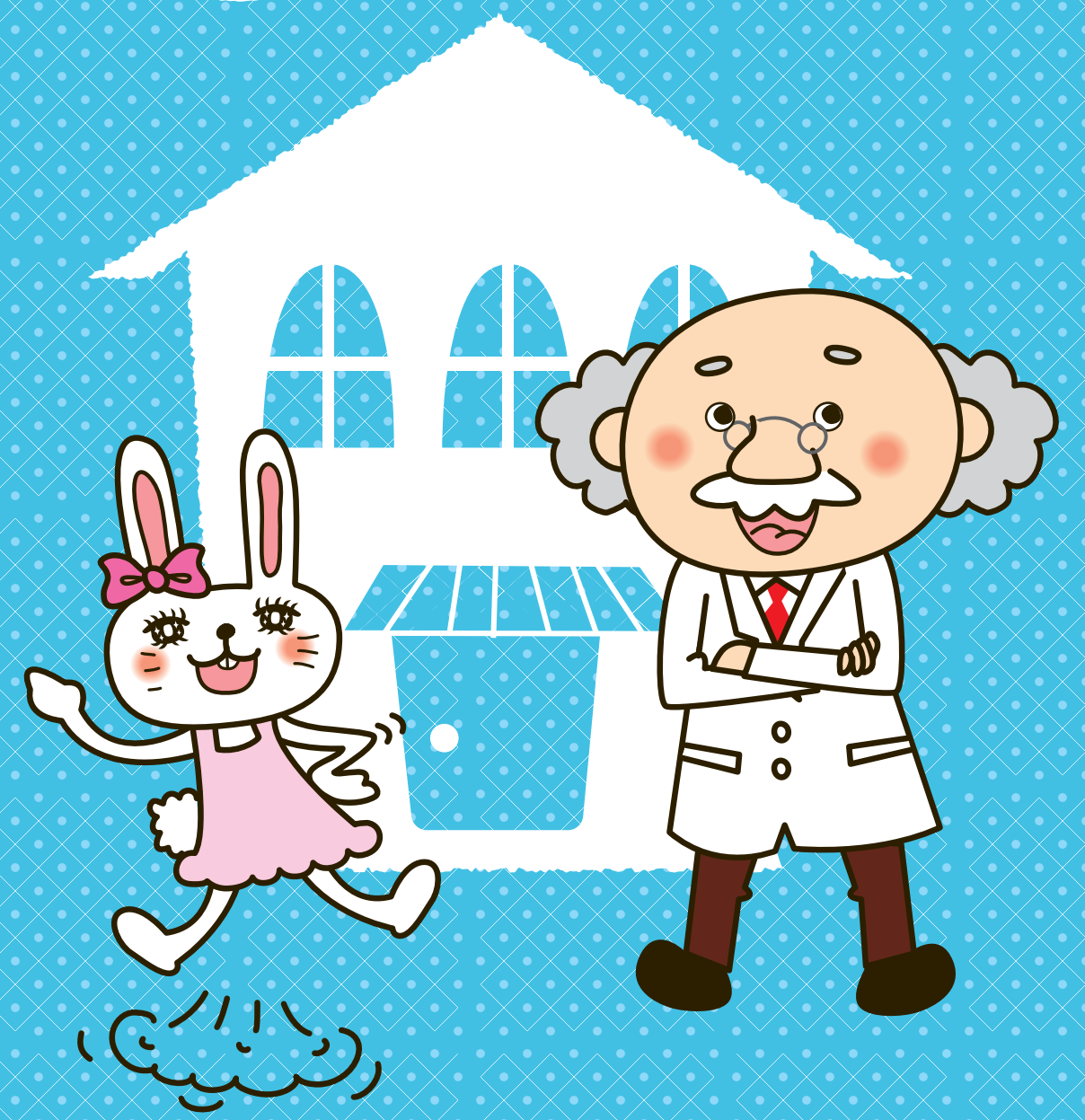
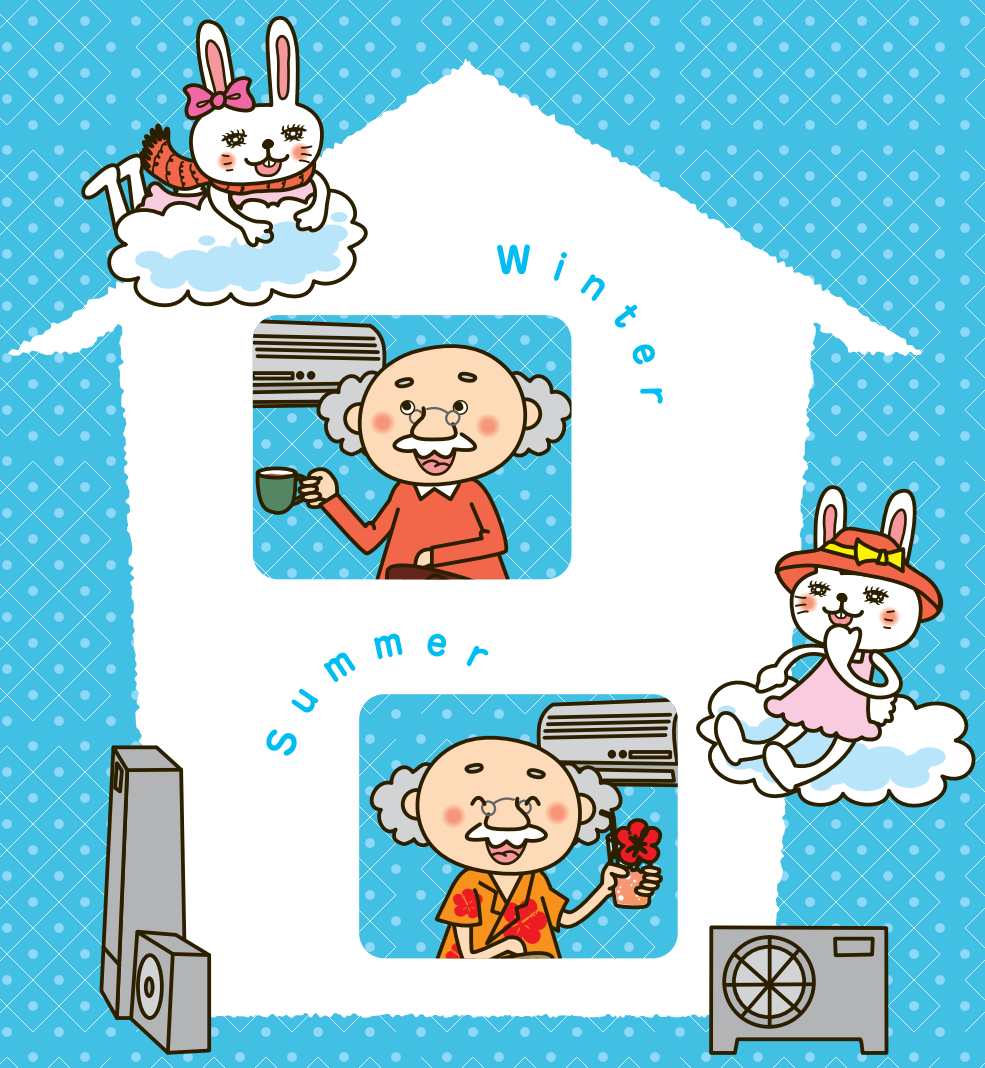
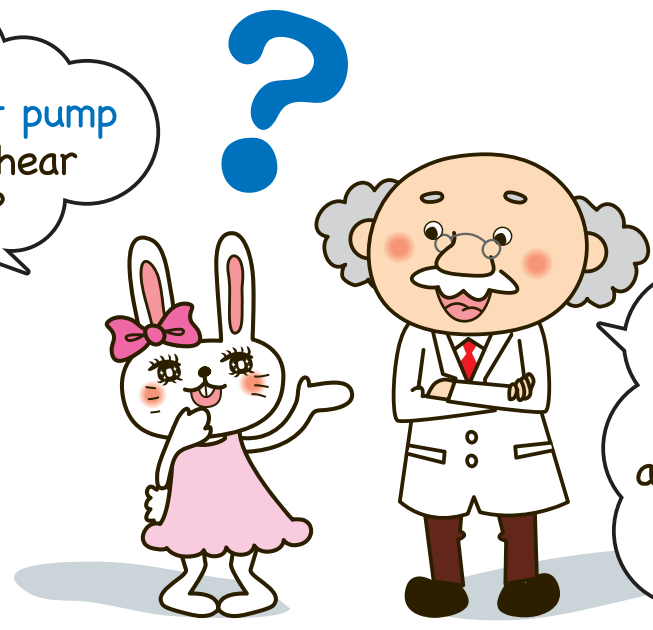


Heating Cooling and Hot Water Supply via Thermal Energy of Air

# Convincing Wonders of Heat Pumps



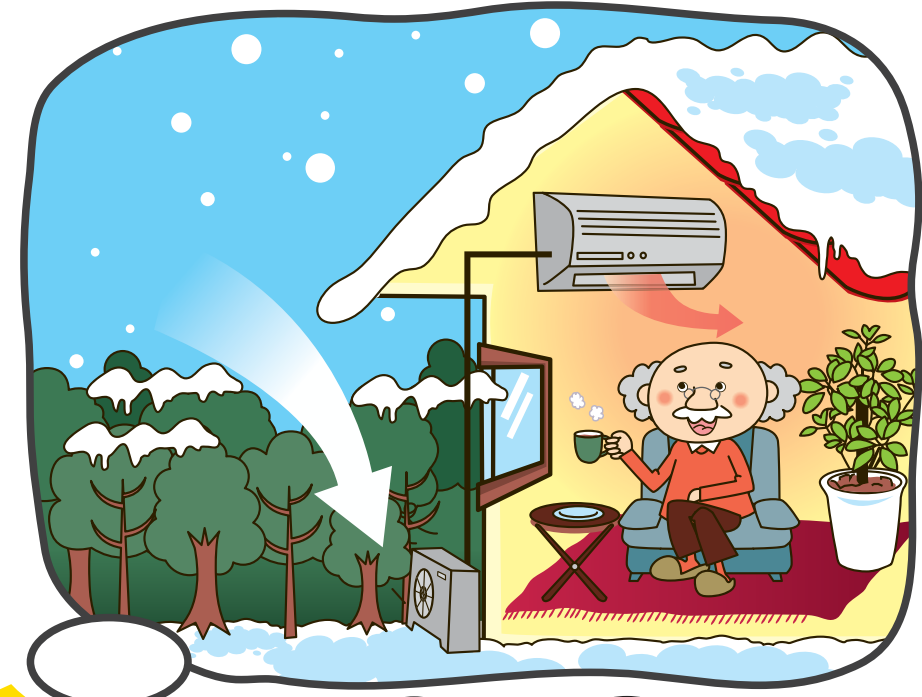
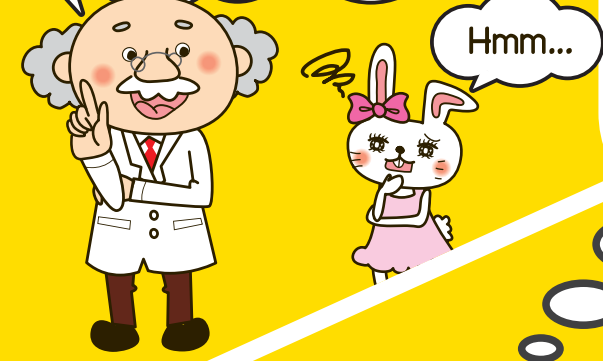
Doctor, what is the **heat pump** that we often hear nowadays?



A heat pump is a clever system that makes the home a comfortable space by using the thermal energy of air.

Thermal energy of air?

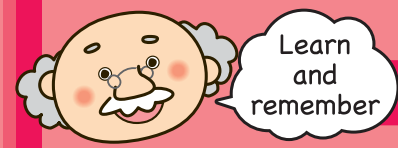
For example, do you know why warm air comes out of an air conditioner in the middle of winter?



It is because a heat pump collects heat from the outside air.

How in the world does it collect heat from the outside air?

Well then, let me explain the clever mechanism of a heat pump!



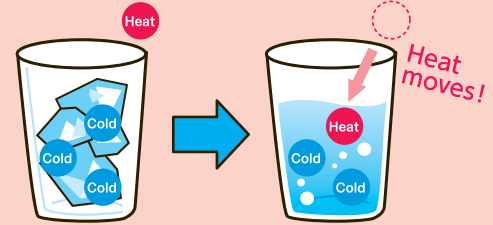
# The Nature of Heat, the basis for heat pumps

To begin with, do you know anything about the nature of heat?

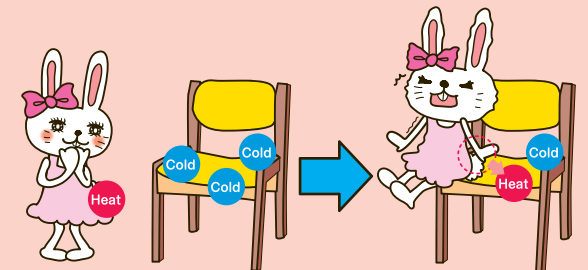
## 1 Heat Movement

Heat moves from **HOT** places to **COLD** places.

For example  
 • If you put some ice cubes in a glass,  
 • the air heat (thermal energy of air) moves to ice cubes and melts the ice cubes.



For example  
 • If you keep sitting on a chair,  
 • the seat becomes warm.

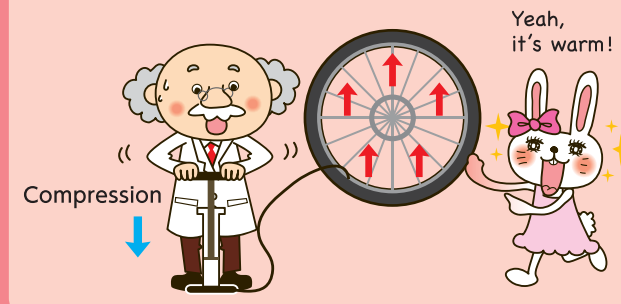


★As water flows from high places to low places, heat travels from hot places to cold places when two things, which differ in temperature, contact.

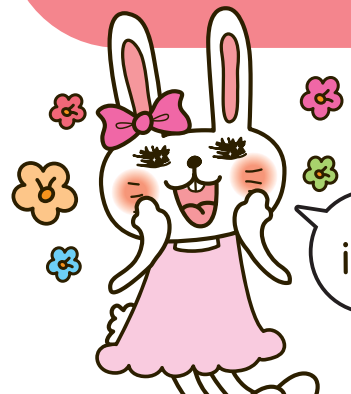
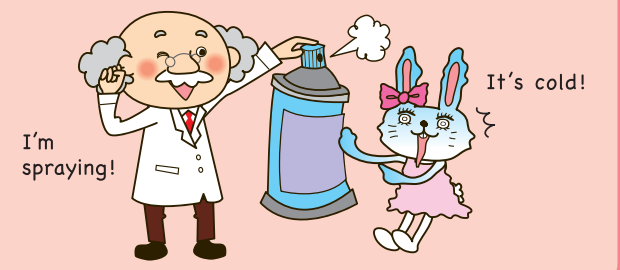
## 2 Pressure and Heat

The temperature of gas **increases** when **compressed** and **decreases** when **expanded**.

For example  
 • If you pump up air into your bicycle tire,  
 • the inside air gets **compressed** and its **temperature goes up**.

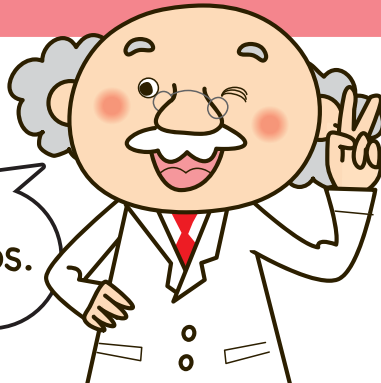


For example  
 • If you spray something repeatedly,  
 • the gas inside the container will **expand**, **lowering** the pressure inside the container and **the temperature** of the inside gas.



Heat is interesting!

These two heat properties are essential for heat pumps.





# Nature of Heat, the basis for heat pumps

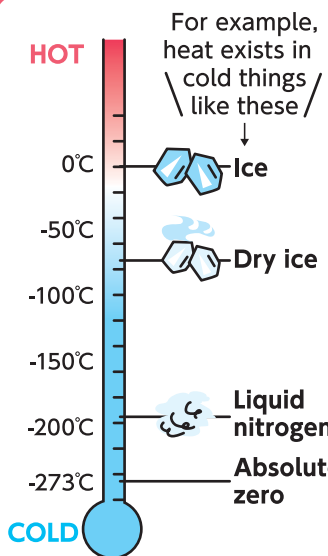
I have some questions for you.

When the temperature of air is at  $0^{\circ}\text{C}$ , do you think heat exists?

I don't think any heat exists in cold places...?!

The right answer is "It does exist."

Heat exists not only in warm places, but also in cold places!



**Heat exists at low temperatures up to  $-273^{\circ}\text{C}$ .**

Liquid nitrogen can take heat away from cold ice cubes and dry ice. Because liquid nitrogen is colder than ice cubes and dry ice!

Really? I didn't know that.

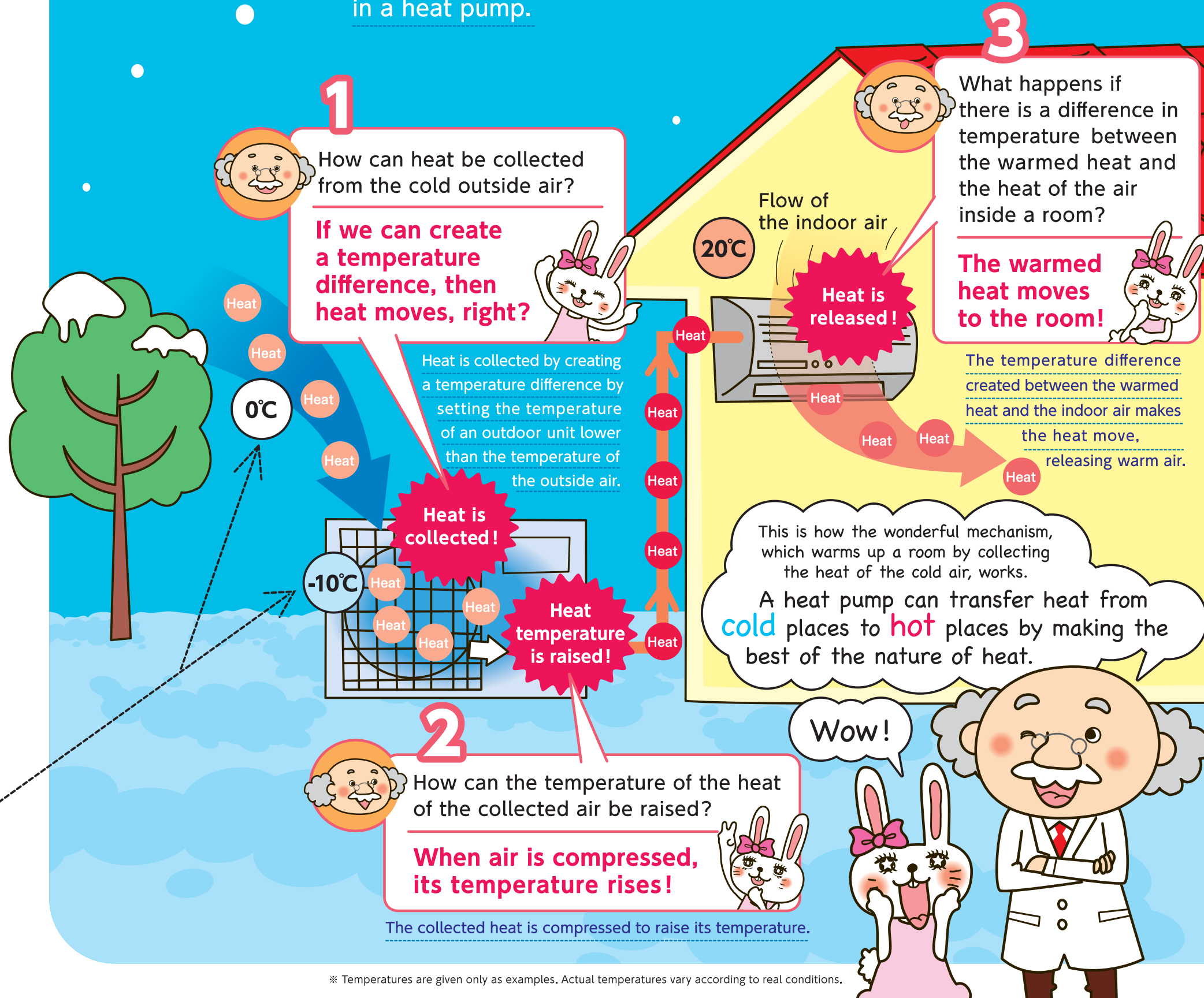
In short, if you want to collect heat from the air at  $0^{\circ}\text{C}$ , all you have to do is to create a **colder place!**

I see! That way, heat will spontaneously move!

Let's take an air conditioner as an example.

# Heat pumps effectively extract heat from air by making the best of the two properties of heat

Let's see how the two properties of heat are used in a heat pump.



\* Temperatures are given only as examples. Actual temperatures vary according to real conditions.

Thorough elucidation of a heat pump!

# Let's take a close look at the mechanism of a heat pump!



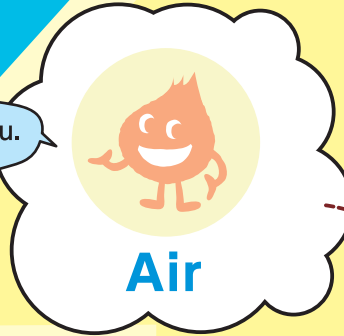
In a heat pump, there is material that carries heat in an efficient manner.

It efficiently carries heat while changing its form according to temperature and pressure.



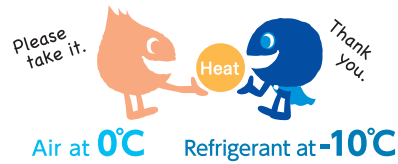
I am a heat carrier.

I am around you.



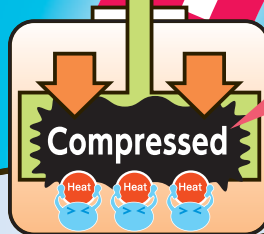
Air

This is inside a heat exchanger. This is a place where the heat of the outside air is received.



Electric Power

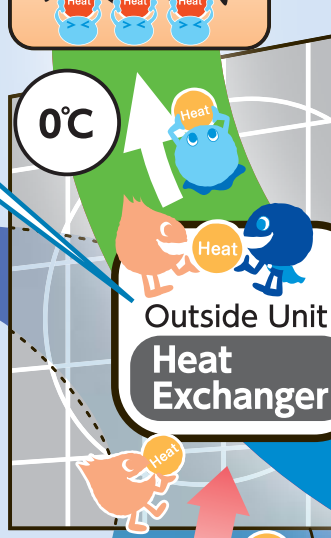
When air is compressed, temperature increases.



When air expands, temperature decreases.



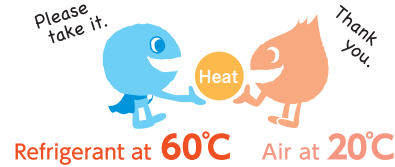
Outside Unit Heat Exchanger



Heating

A flowchart depicting how the cold outside air warms up a room.

Heat is handed from a refrigerant to air in a heat exchanger.



The temperature difference makes heat transfer and hot air is released.

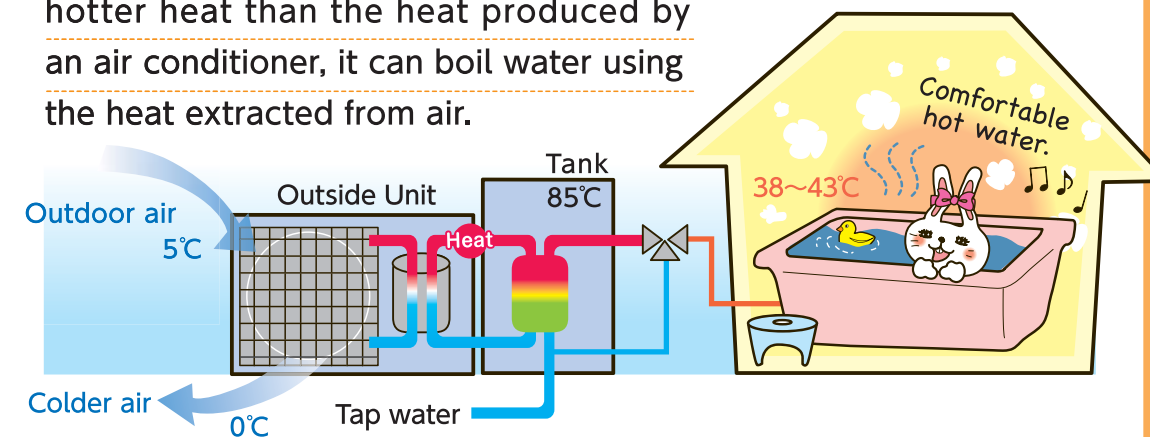


\*When the room temperature is set at 20°C.

Application

## EcoCute, a system that uses the heat extracted from air to boil water

A heat pump is also used in a water heater that supplies hot water. Since EcoCute uses CO<sub>2</sub>, a natural refrigerant that can generate hotter heat than the heat produced by an air conditioner, it can boil water using the heat extracted from air.



The reason why the air released outside is cold is because heat has transferred.



START!



\*Temperatures are given only as examples. Actual temperatures vary according to real conditions.



Thorough elucidation of a heat pump!

# Let's take a close look at the mechanism of a heat pump!



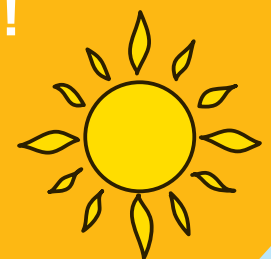
For cooling, it works just the opposite way!

Warmed heat is handed over to the outside air in a heat exchanger.  
Thank you. Heat Please take it.  
Air at 35°C Refrigerant at 65°C



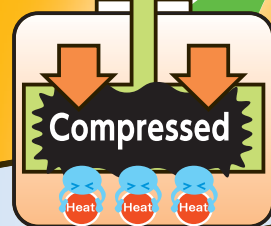
The indoor heat is being carried outdoors.

## GOAL!



### Electric Power

When air is compressed, temperature increases.



65°C

Outside Unit Heat Exchanger



Air expands

40°C

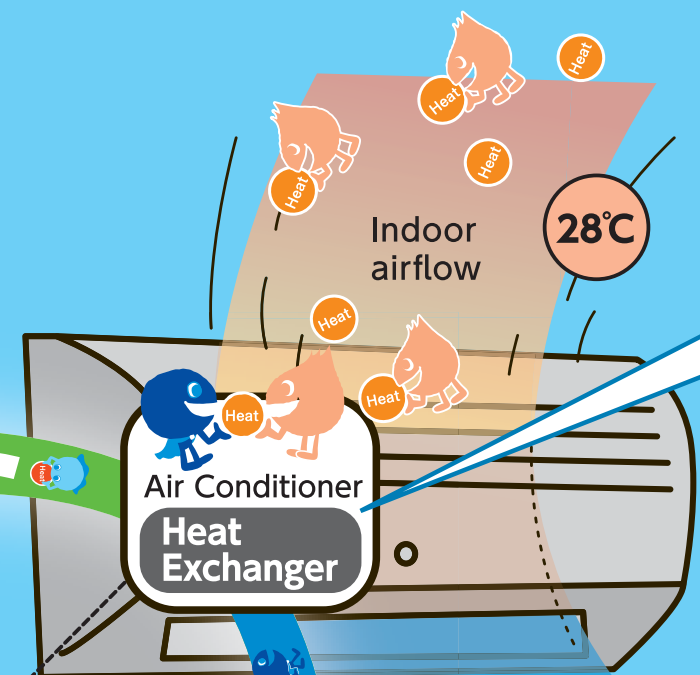
35°C

Outdoor airflow

## Cooling

A flowchart depicting how the heat of the inside air is carried outdoors to cool a room.

### START!



Indoor airflow 28°C

Air Conditioner Heat Exchanger

Heat is handed over from air to refrigerant in a heat exchanger.  
Thank you. Heat Please take it.  
Refrigerant at 5°C Air at 28°C

Did you understand how a heat pump works?



23°C

※When the room temperature is set at 28°C.

## Summary

- 1 Heat pumps use the nature of heat in a clever manner.
- 2 Heat pumps extract heat required by creating places with a high temperature and places with a low temperature.
- 3 Heat pumps are capable of heating and cooling spaces and boiling water by using the heat extracted from air.

A heat pump is an efficient and energy-saving system since it uses the heat extracted from air for space heating, space cooling, and hot water supply!



If you want to know more about heat pumps, try our Web course! [www.hptcj.or.jp/e/](http://www.hptcj.or.jp/e/)

※Temperatures are given only as examples. Actual temperatures vary according to real conditions.

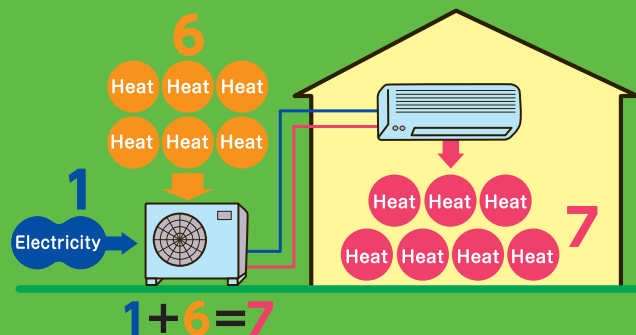
# A heat pump, which uses the heat extracted from air, saves energy significantly!



Since use of a heat pump allows you to obtain more thermal energy than consumed, you can use precious energy effectively. It is also an environmentally friendly system since it significantly reduces CO<sub>2</sub> emissions.

Since it generates heat in an efficient manner,

The amount of electricity consumed is about 1/7<sup>\*1</sup>

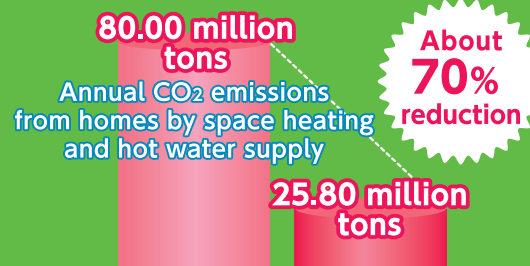


The latest heat pumps sold in Japan can generate 7<sup>\*\*2</sup> thermal energy by using 1 electric energy. Their high efficiency reduces electricity consumption to about 1/7<sup>\*1</sup>, leading to significant energy savings.

<sup>\*1</sup> Compared to electric heaters  
<sup>\*\*2</sup> For the latest heat pumps sold in Japan

Since it saves energy, it is also friendly to the environment.

Drastically reduces CO<sub>2</sub> emissions from homes



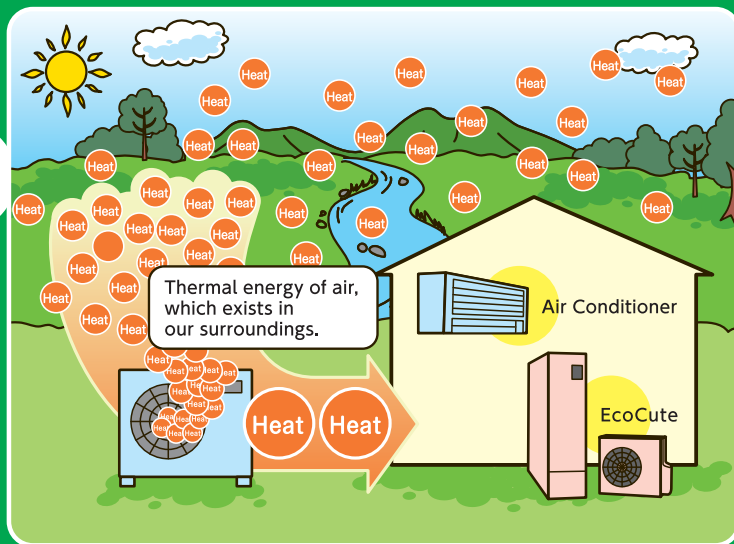
Estimates by the Heat Pump & Thermal Storage Technology Center of Japan

If all domestic heaters and water heaters were replaced by heat pumps, it would reduce CO<sub>2</sub> emissions by about 54.00 million tons. This amount accounts for about 5% of Japan's total CO<sub>2</sub> emissions.

(Compared to the 2008 level)

Moreover,

Since heat pumps generate renewable energy as is the case with photovoltaic generation and wind generation, they are clean and ecological systems!

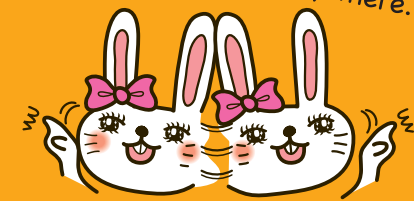


<sup>\*\*</sup>Renewable energy is defined as energy which comes from non-fossil energy sources (such as aerothermal energy, water power, geothermal energy, solar energy, and biomass) and which can be continually replenished on a human timescale.

The Sophisticated Methods of Energy Supply Structures, which went into effect in August 2009, defined the "heat extracted from air," which heat pumps use, as renewable energy. It means that the heat extracted from air is one of the natural energies, such as solar and wind energy. Heat pumps attract world attention as a system that provides clean and environmentally friendly energy and that replaces petroleum.

<sup>\*</sup>The EU (European Union) Renewables Directive, which was published in April 2009, defines the thermal energy of air, which heat pumps use, as renewable energy.

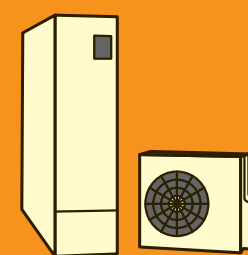
# Heat pumps in your surroundings, such as air conditioners and EcoCute



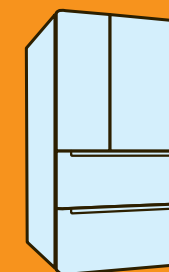
Heat pumps are used in many things, which include not only air-conditioning and hot water supply systems, but also refrigerators, freezers, and the dry function on washing machines. A heat pump is one of the environmentally friendly technologies used for things that we all use.



Air Conditioner



EcoCute



Refrigerator



Washing Machine

with a heat pump-based dry function

## Use of heat pumps in a variety of facilities

Heat pumps continue evolving. Today, there are heat pumps that can generate heat of higher temperatures in larger amounts than heat pumps for home use. There are also heat pumps with higher efficiency. In the future, heat pumps are expected to further spread into commercial and industrial facilities.

Office Building



Hospital



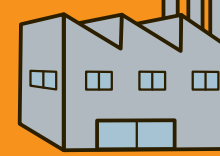
Hotel



Commercial Facilities



Factory



The areas where heat pumps are used are ever expanding!

