Energy Saving of Inverter Air Conditioner and R32 Refrigerant

DAIKIN VIETNAM

13th May 2017

Environment

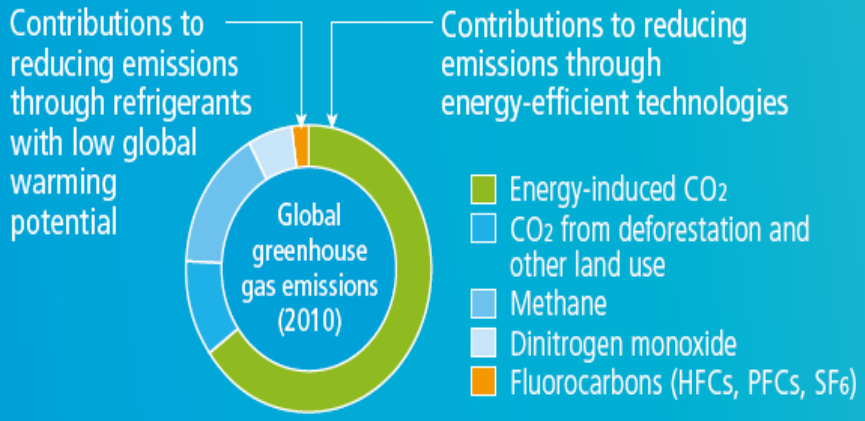
Why is it Important?

Achieving both Environmental Protection and Business Expansion

Environmental problems such as climate change constitute top priorities for manufacturers. In addition, air conditioners consume large amounts of energy during their operation, and hydrofluorocarbons that are used as refrigerants contribute to climate change. We are striving to reduce greenhouse gas emissions throughout the entire supply chain, develop products and services, and carry out environmental and social contribution to contribute to sustainable growth both for Daikin and for the Earth.

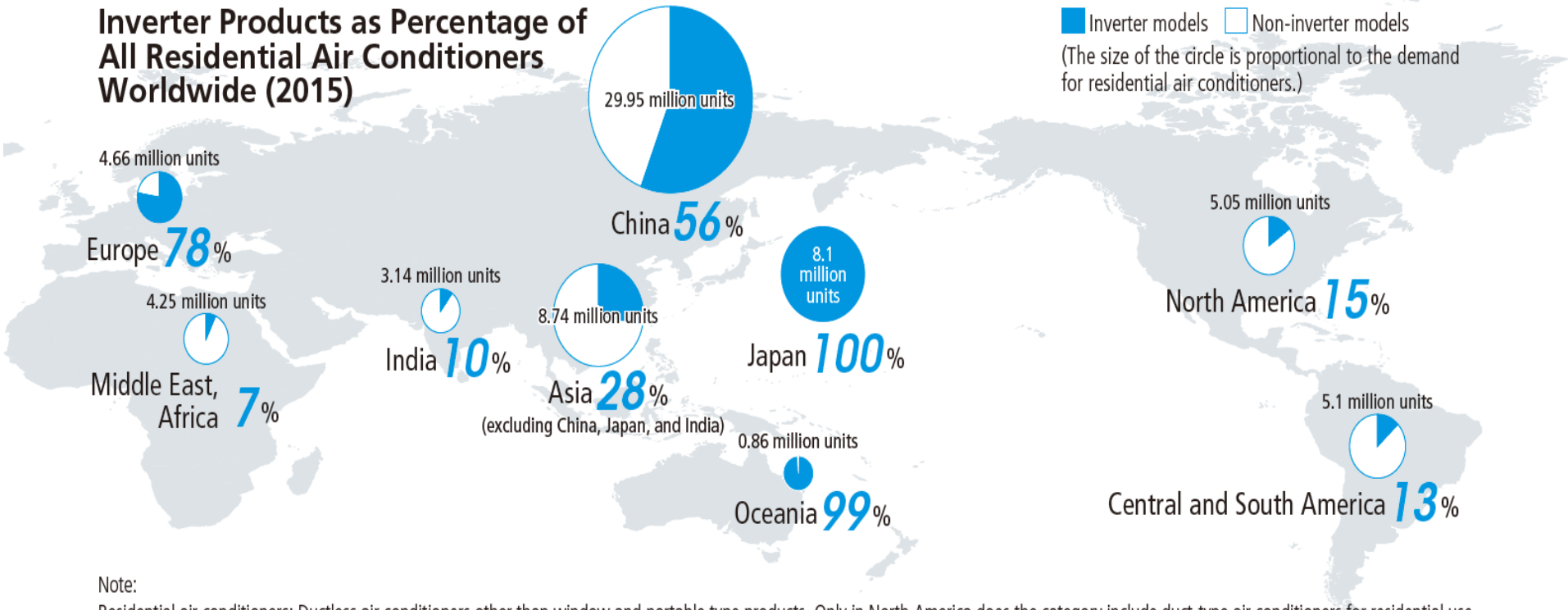
DAIKIN'S **POLICY**

Introduce State-of-the-art Technologies to the Market in Order to Address Environmental and Energy Issues



Note: Contribution of Working Group III to the Fifth Assessment Report of the IPCC

Portion of Inverter Residential Air Conditioners Worldwide (2015) and in Vietnam (Mar 2017)



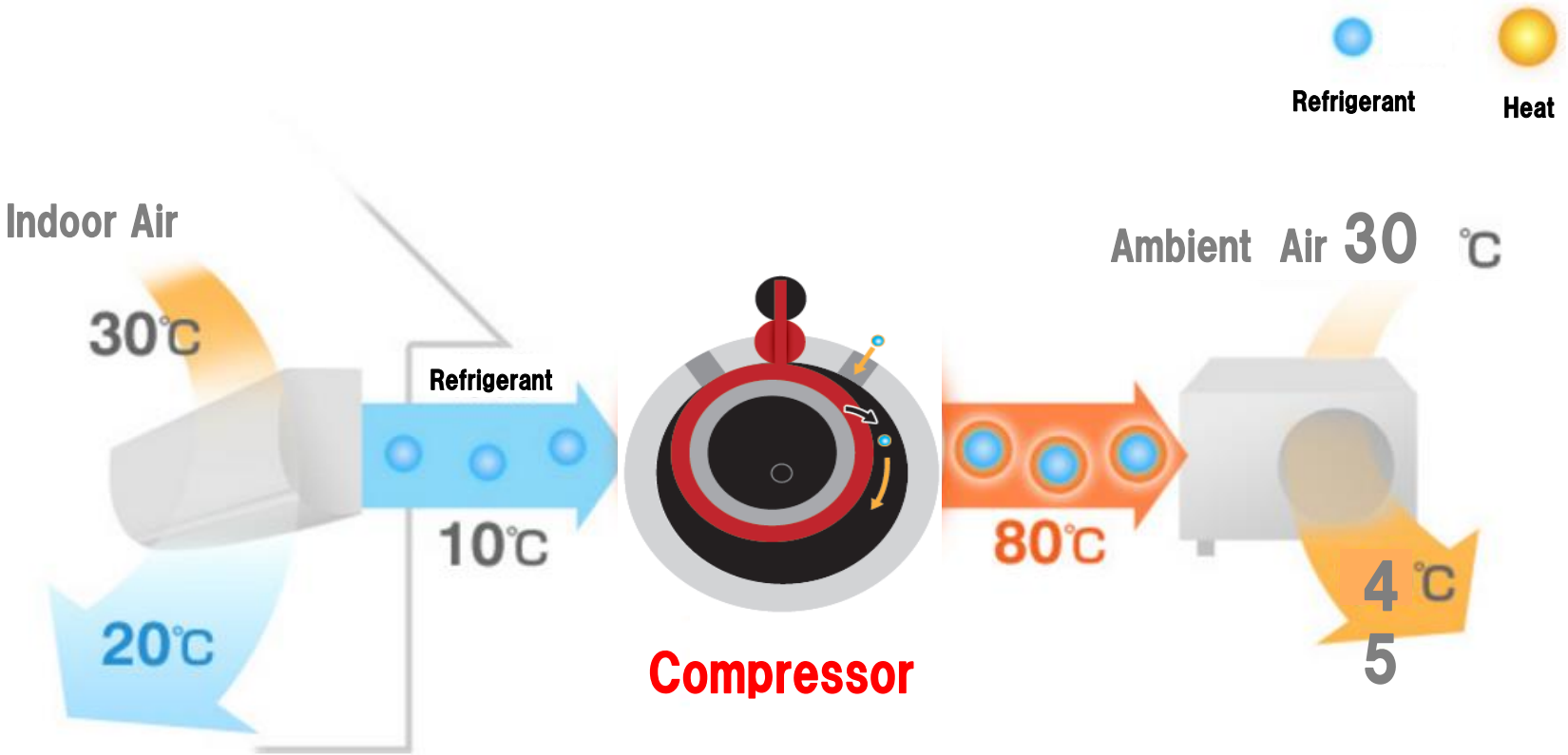
Note:
Residential air conditioners: Ductless air conditioners other than window and portable type products. Only in North America does the category include duct-type air conditioners for residential use.
Source: Compiled by Daikin based on data from the Japan Refrigeration and Air Conditioning Industries Association

What is "Inverter" ?

Mechanism of Air Conditioner

What convey the refrigerant?

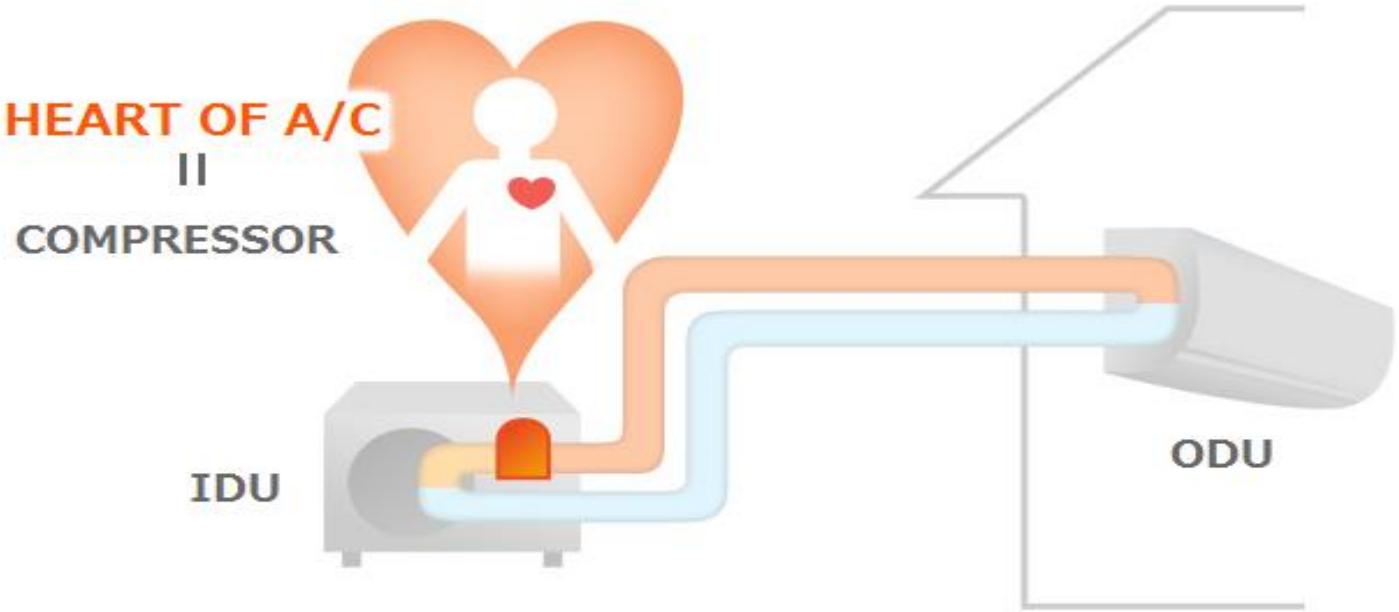
Compressor is the pump to deliver the refrigerant between the indoor unit and the outdoor unit.



Mechanism of Air Conditioner

What convey the refrigerant?

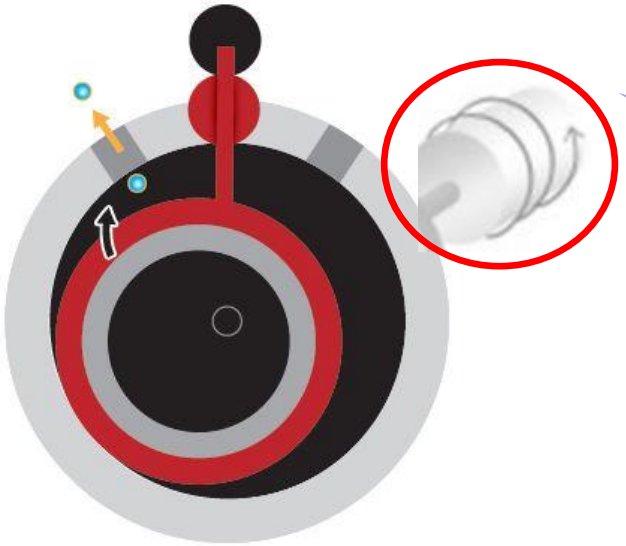
Compressor controls the temperature of refrigerant which receives the heat from the air.



Daikin is a world leading company who manufactures not only air conditioner but also compressor.

Mechanism of Air Conditioner

About control system of compressor



2 types of motor
for compressor

- Non-Inverter
- Inverter

Non-Inverter

ON/OFF
control ONLY

Inverter

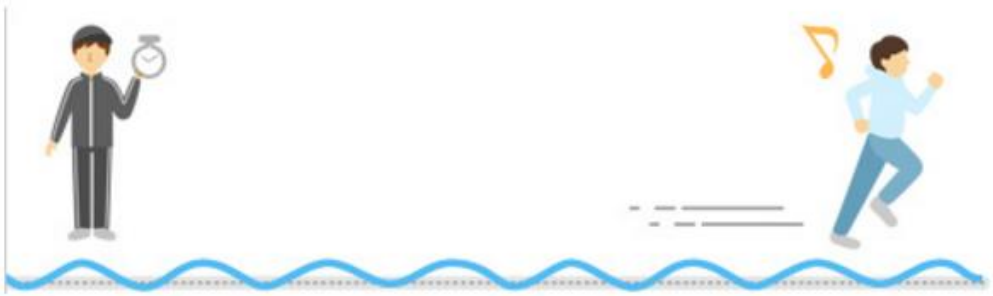
enable to
control flexibly

The difference between Non-INV and INV

1 A/C WITHOUT INVERTER

Repeating hard training and rest brings big exhaustion of strength and the load to body is big.

2 A/C WITH INVERTER

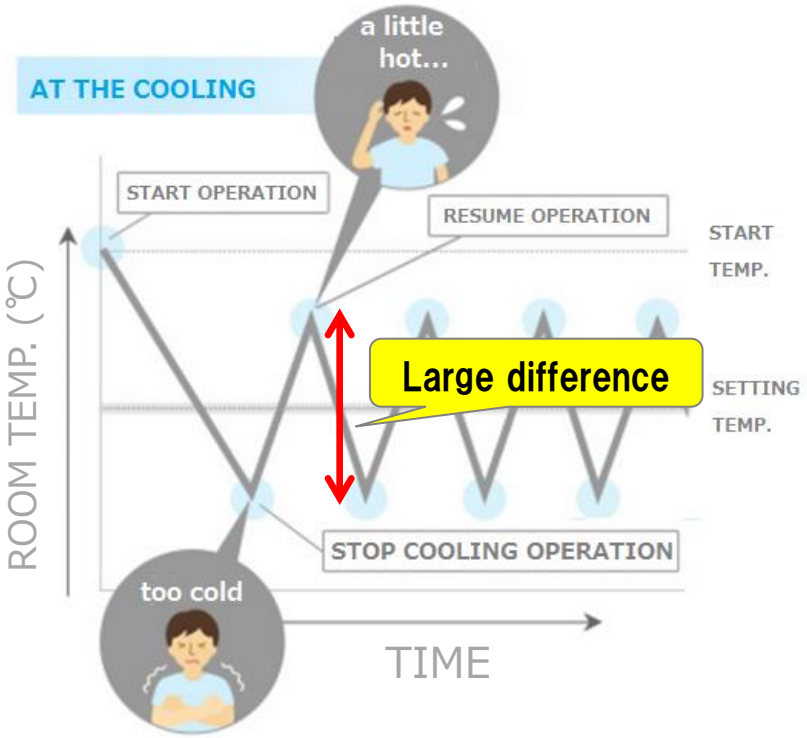


If the runner can keep an appropriate load under the advise from trainer, the runner would be able to keep running efficiently

The difference between Non-INV and INV

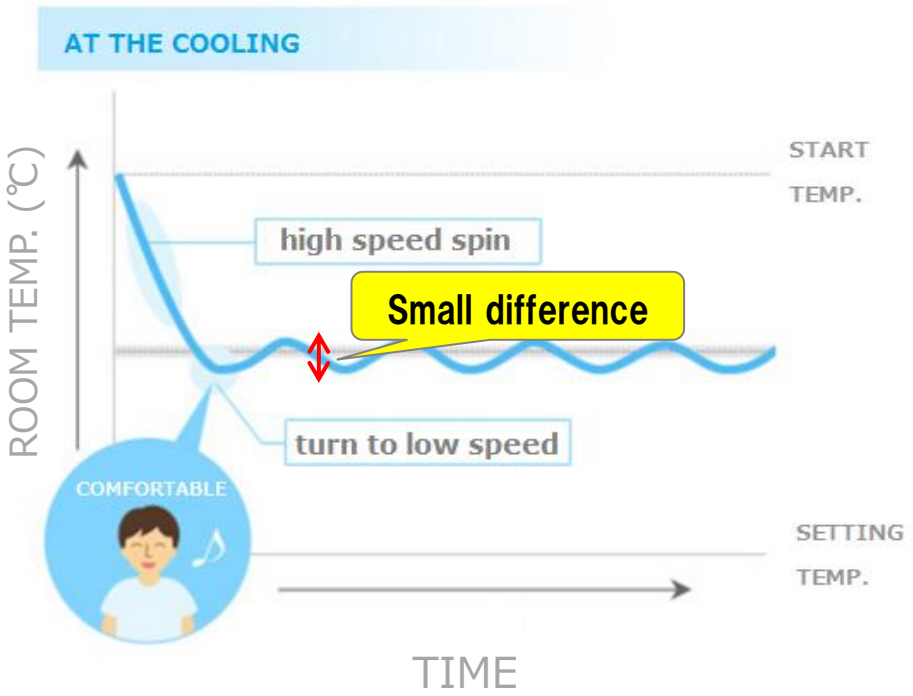
NON-INVERTER

A/C without inverter brings bad efficiency.
Ex.) unstable room temp., high power consumption, etc…

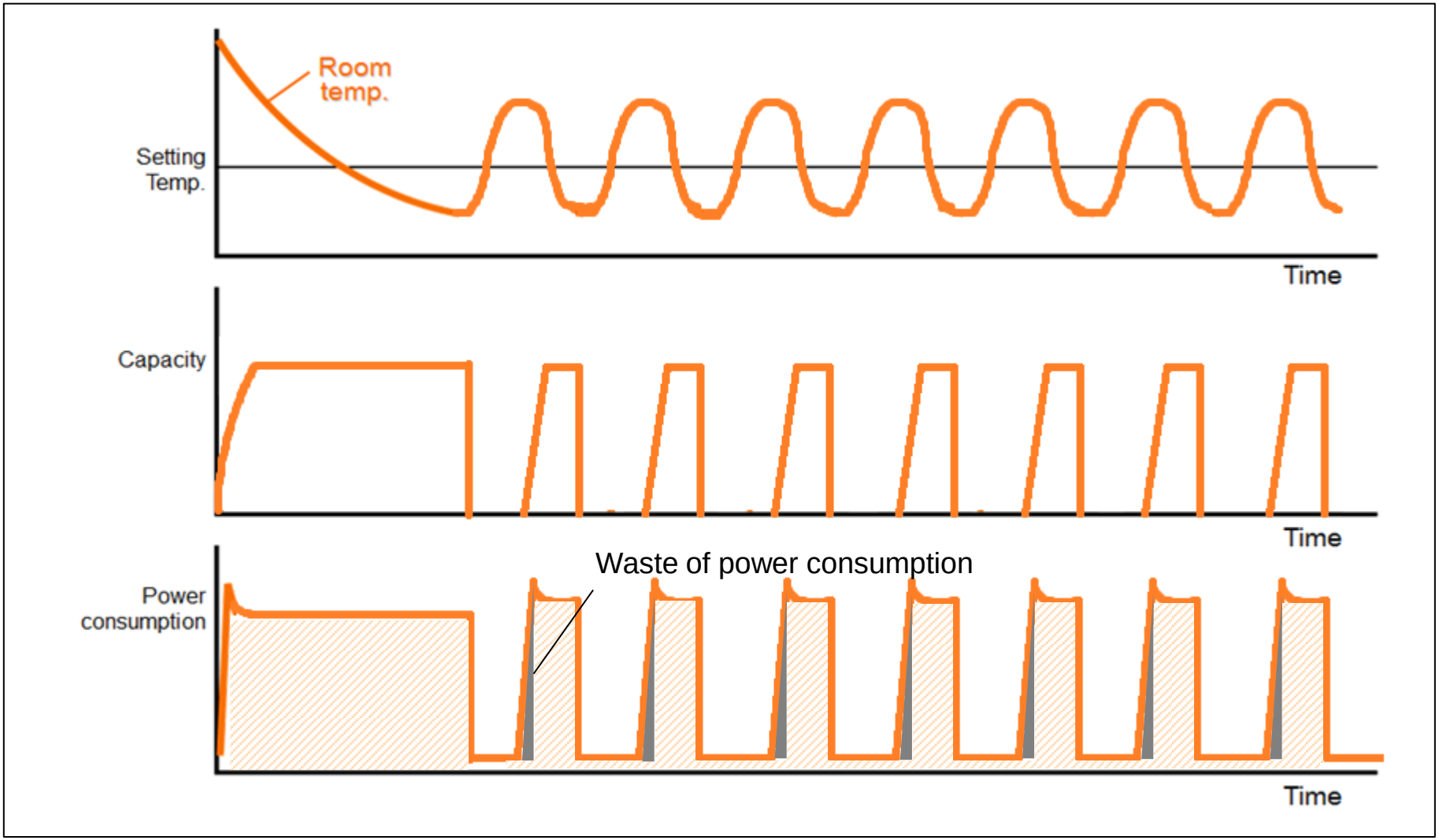


INVERTER

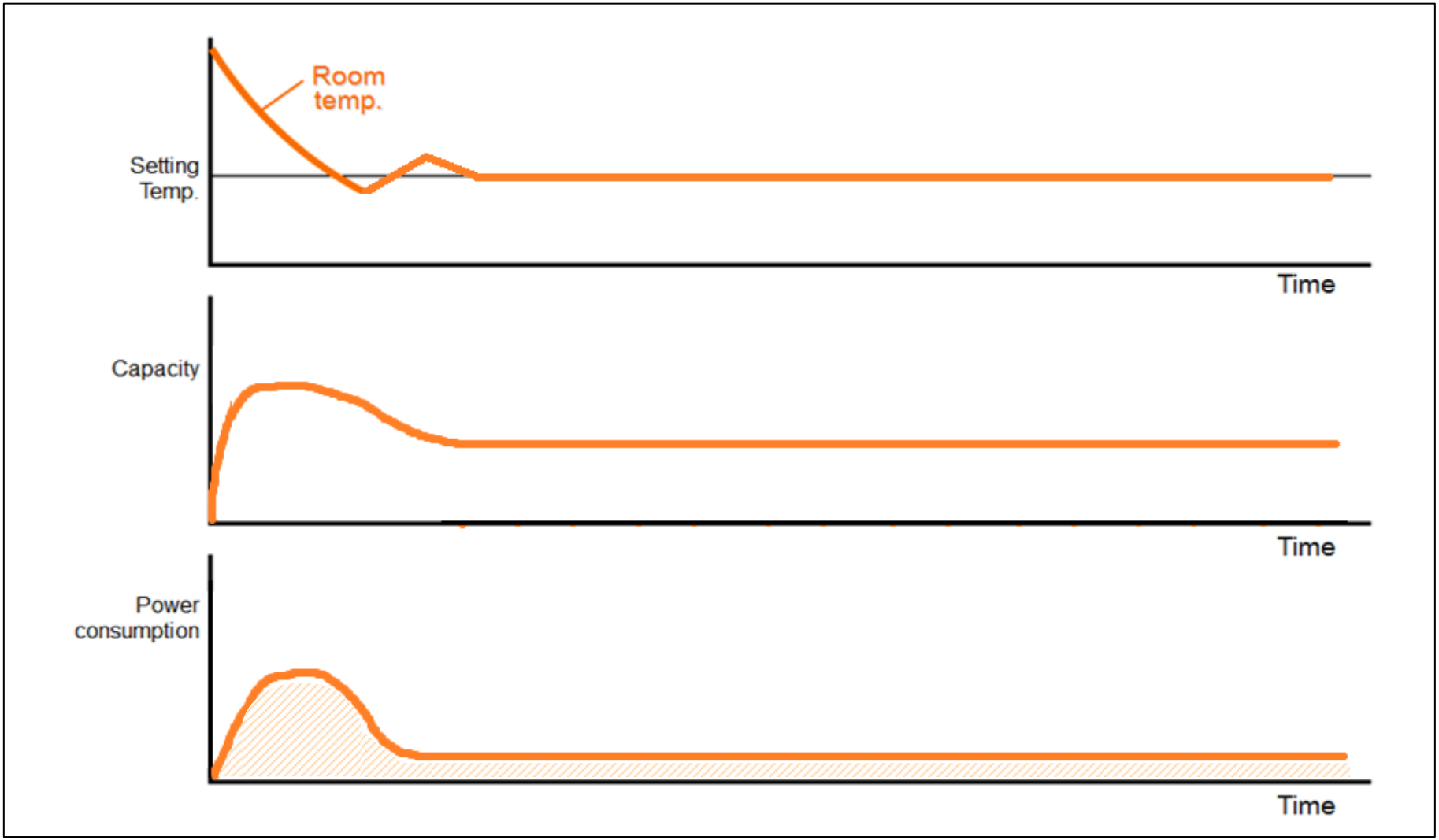
A/C with inverter can actualize energy saving comfortably, because it can accurately adjust room temp.



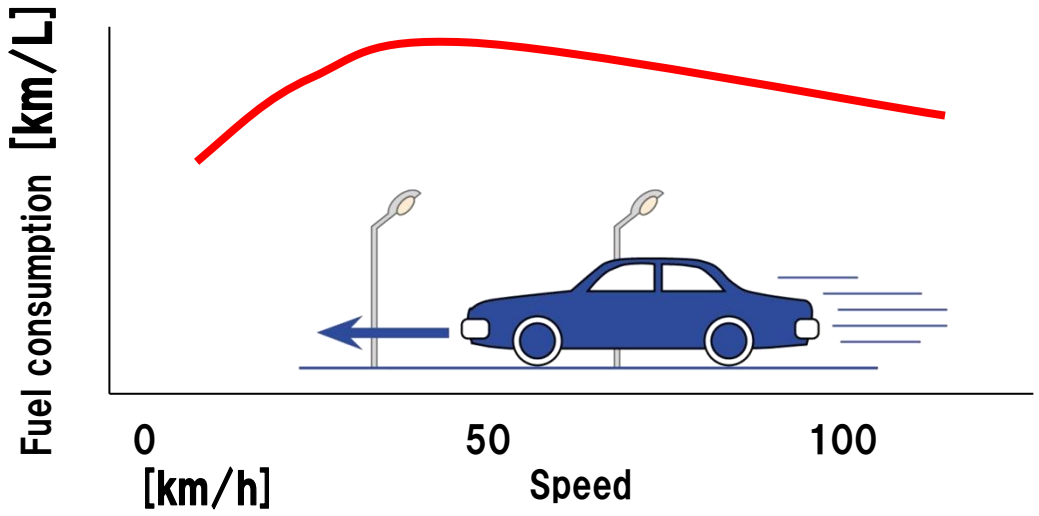
Operation pattern for Non-Inverter (setting temp./capacity/power consumption)

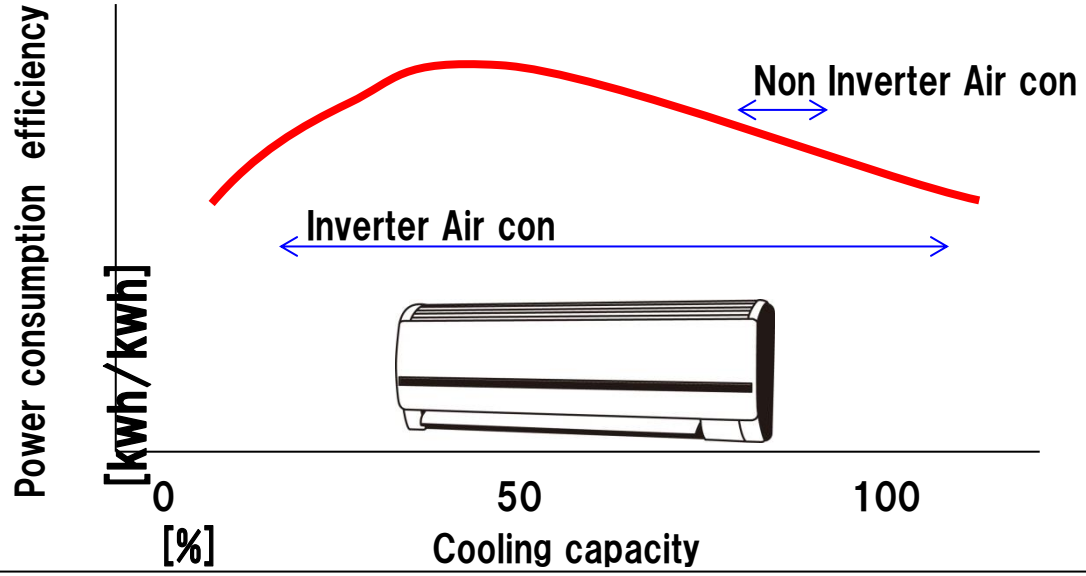


Operation pattern for Inverter (setting temp./capacity/power consumption)



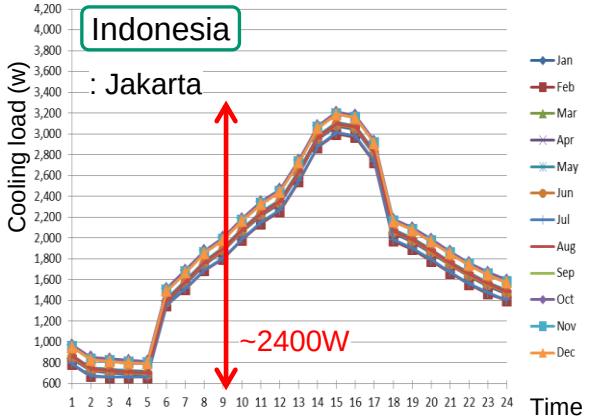
Cooling capacity and energy saving

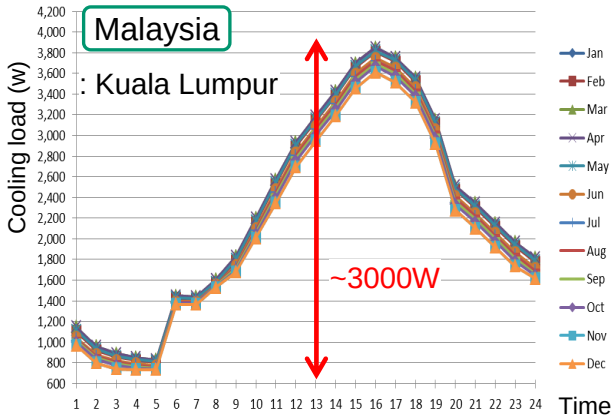


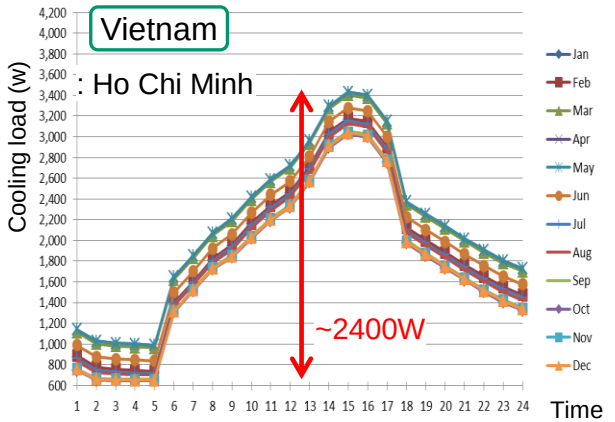


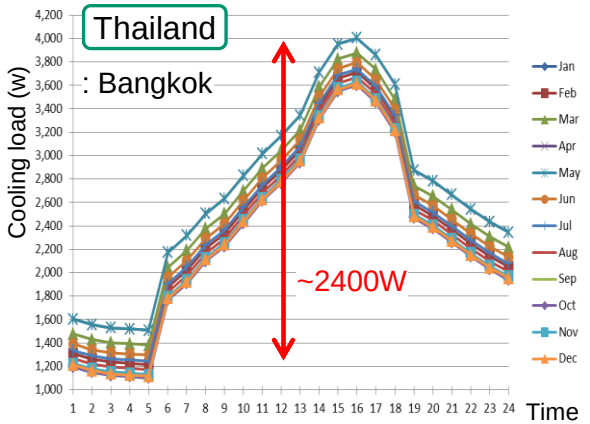
Cooling capacity and energy saving

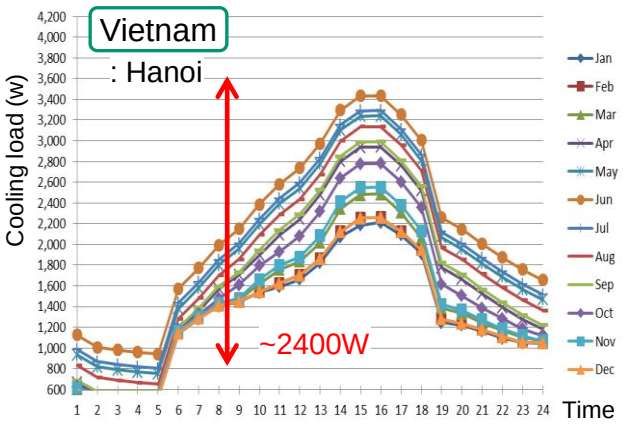
Air conditioning loads is changing by hour during a day in each country.

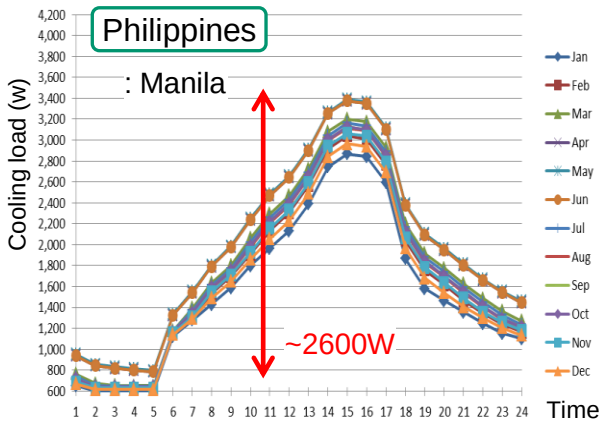








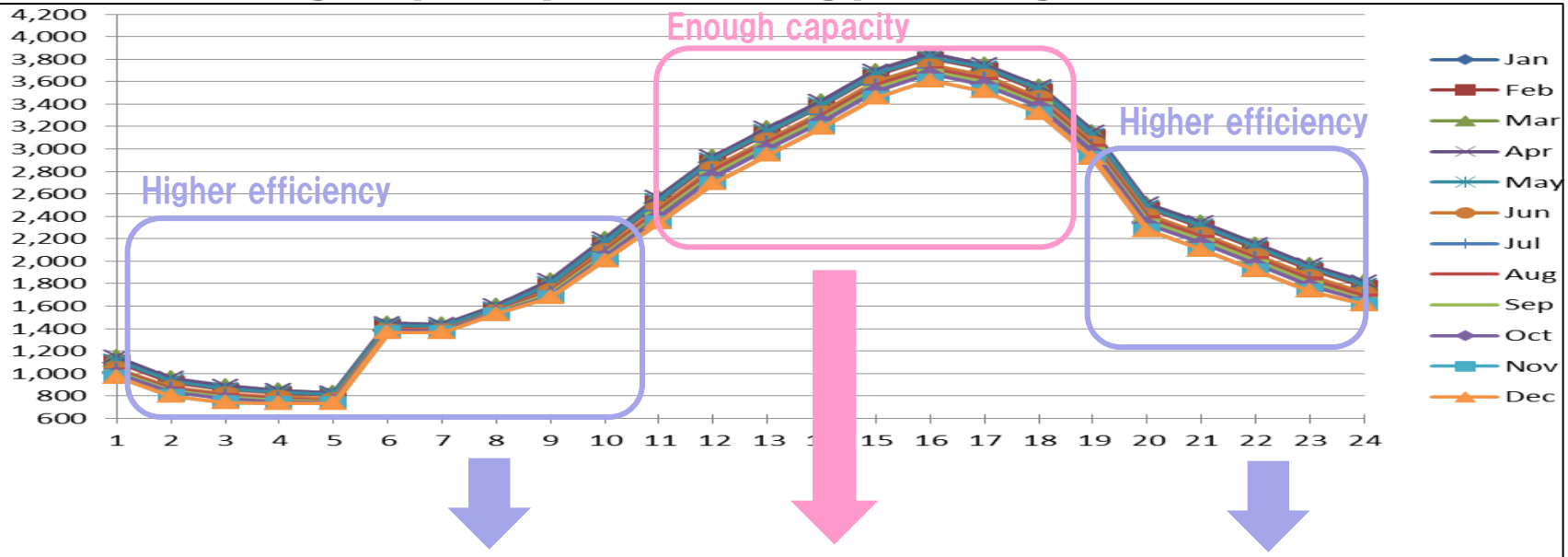




<Calculation conditions>
- 3 people stay (all day)
- With room lamps (lighting rates are set per hour)
- Use ambient temp. data for the day in each city with setting AHRAE Design Ambient Temp. as peak ambient temp.
- Preset room temp.: Design conditions in each city
- Natural ventilation
- With heat-generating devices (such as TV)
- With windows (with curtains)
- Sleep hours: 24:00-6:00

* Annual A/C loads of rooms to be cooled by average representative models (calculated with Daikin's software DACCS-HKG)

Cooling capacity and energy saving for Inverter



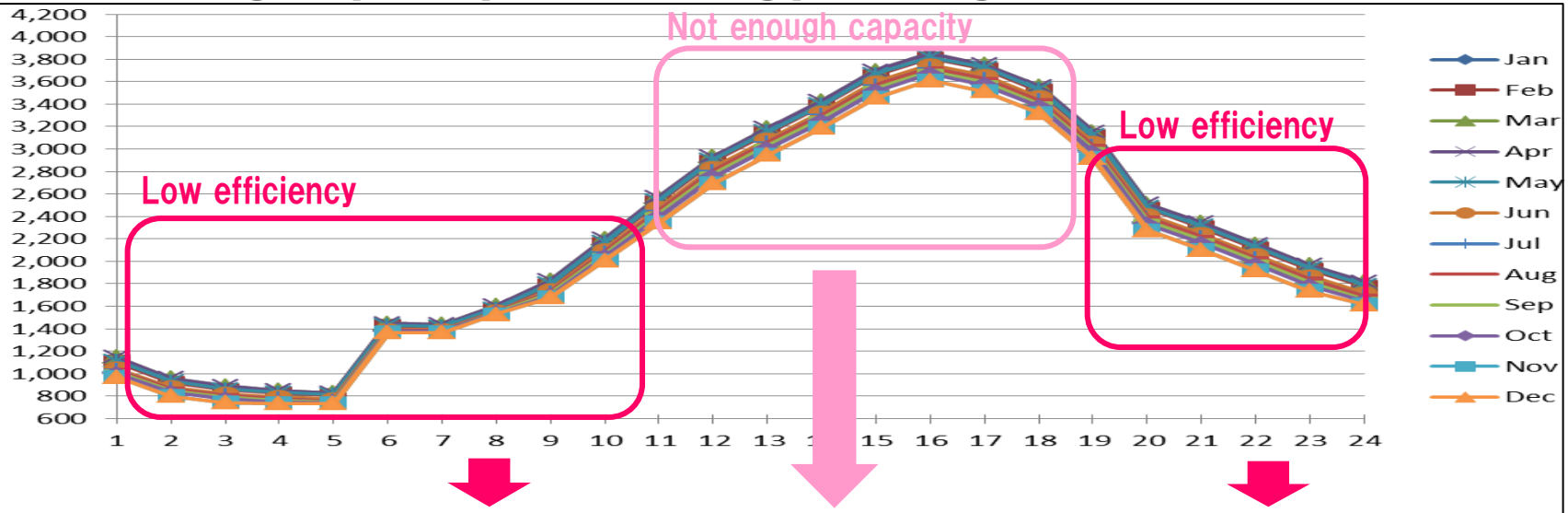
	Morning	Noon～After noon	Evening	Night
Necessary Cooling Capacity (Cooling load)	Low～Mid	High～Too High	High～Mid	Low～Too Low
Air-con Cooling Capacity	50～80%	100～120%	80～60%	50～20%
Power Consumption Efficiency	Mid	Low	Mid	High

Lower power consumption efficiency, but enough cooling

Higher power consumption efficiency, with lower capacity

What is Inverter ?

Cooling capacity and energy saving for Non Inverter

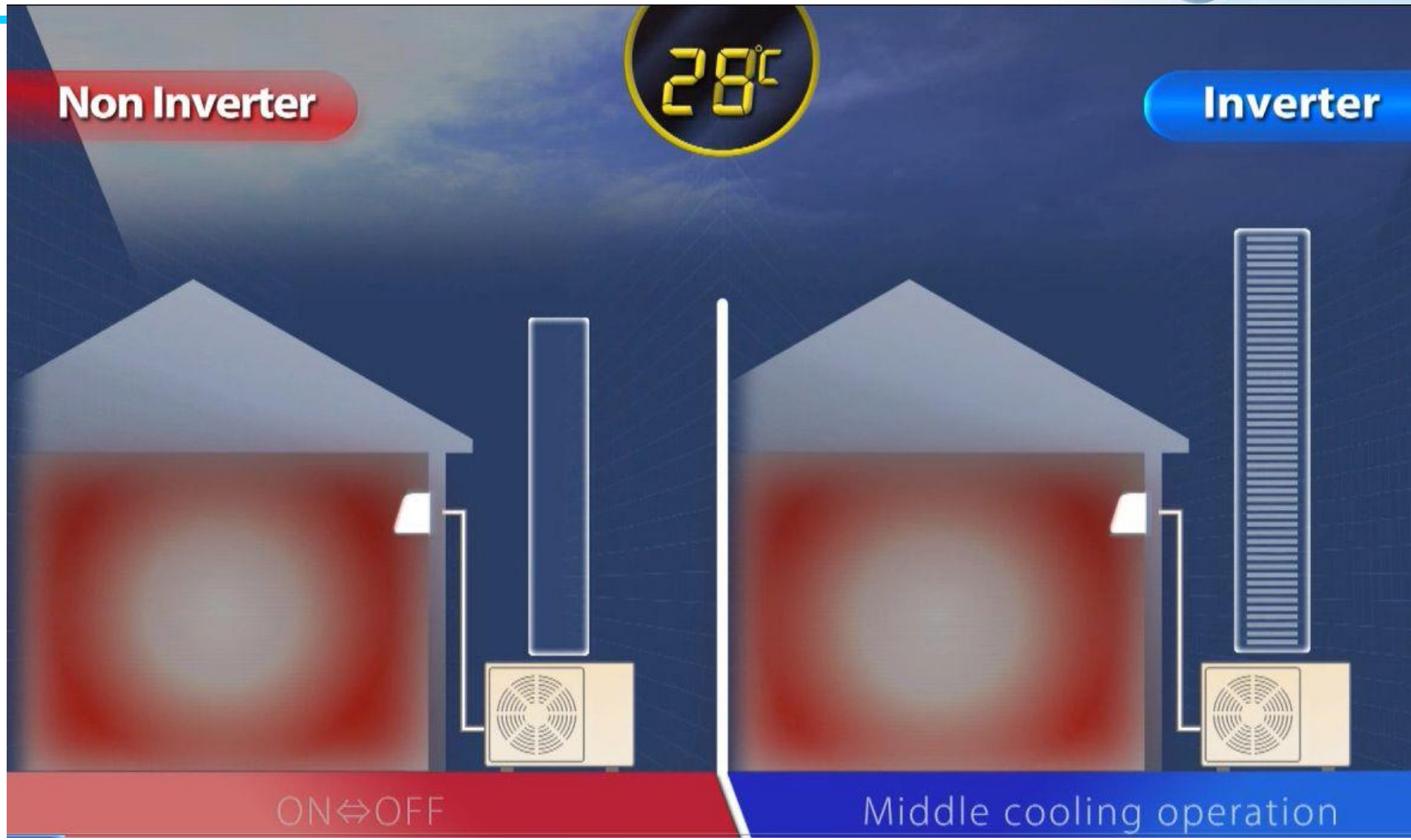


	Morning	Noon～After noon	Evening	Night
Necessary Cooling Capacity (Cooling load)	**Low～Mid**	**High～Too High**	**High～Mid**	**Low～Too Low**
Air-con Cooling Capacity	**Around 100%** **with often ON ⇔OFF**	**Around 100%** **sometime with not enough capacity**	**Around 100%** **with often ON ⇔OFF**	**Around 100%** **with always ON ⇔OFF**
Power Consumption Efficiency	**Low**	**Low**	**Low**	**Too Low**

Comparative higher power consumption efficiency, but not enough cooling

Lower power consumption efficiency, with frequent ON/OFF

What is Inverter ?



Energy Saving through Next Generation Refrigerant

Properties of HFC-32

Potential of Refrigeration capacity :1.6 times of R410A

Ozone Protection

Energy resources

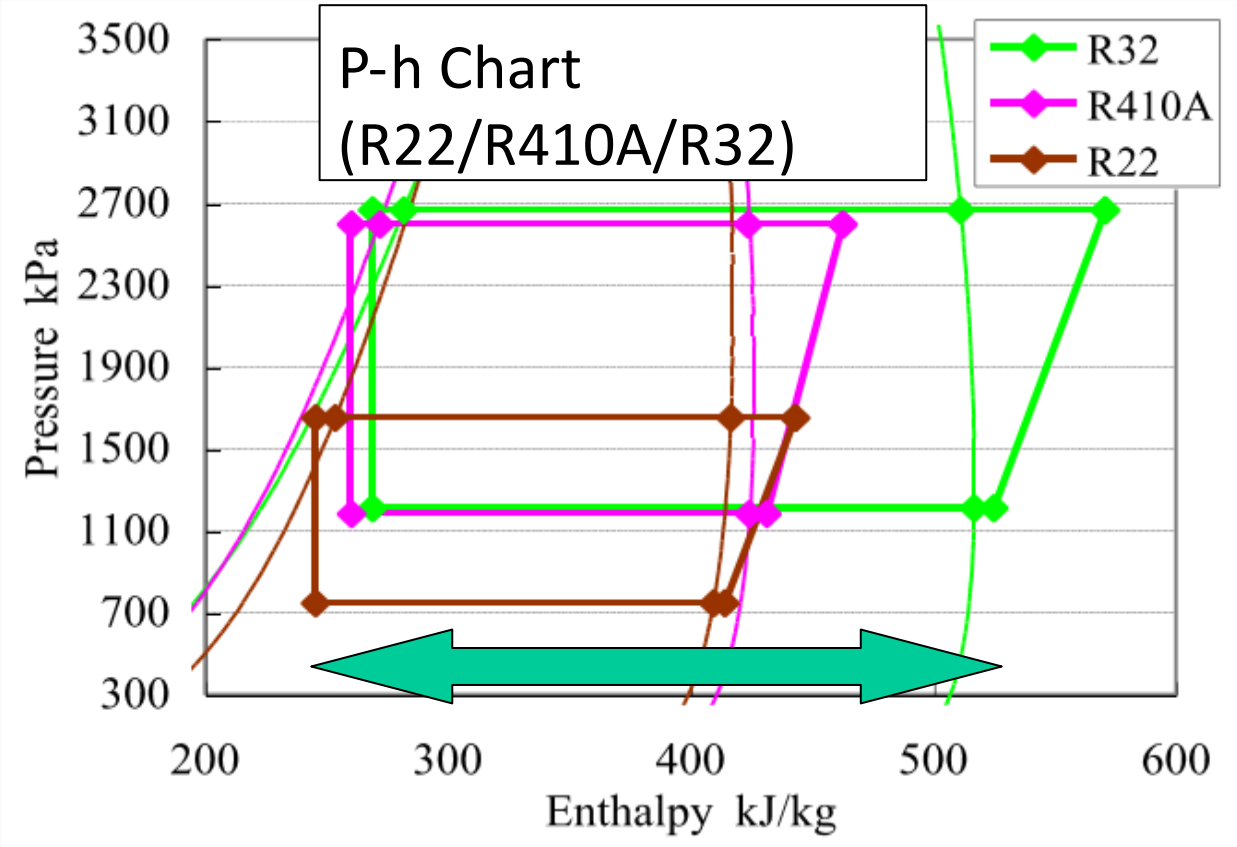
Climate Change

Peak Load

3100

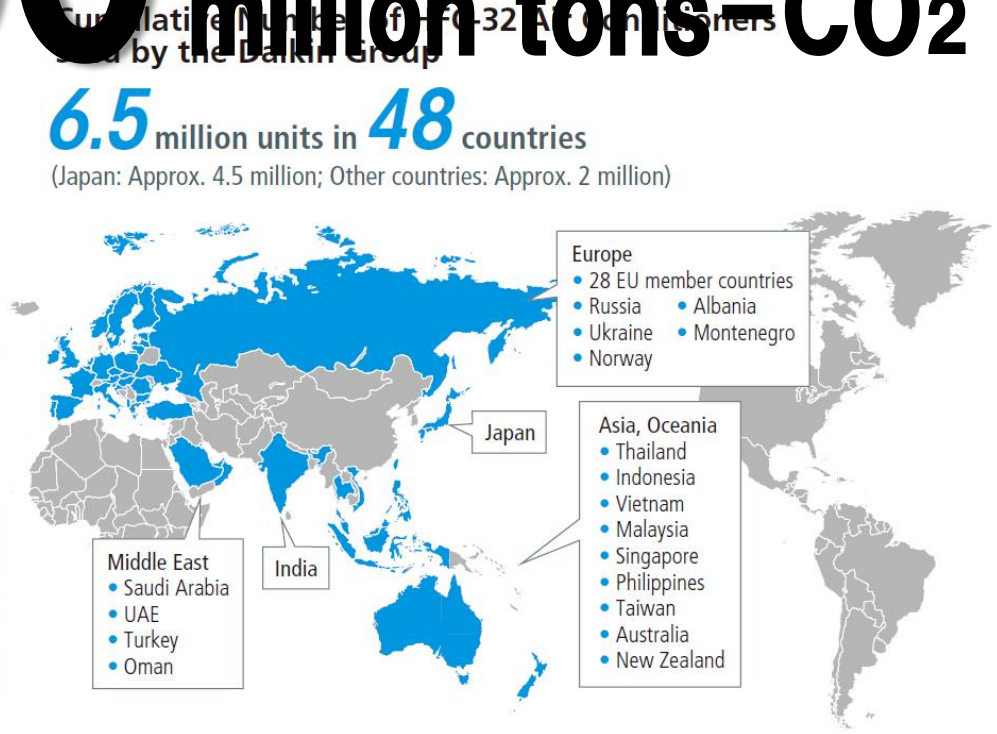
Safety

2300



- Lower pressure loss, when capacity is same, leads to thinner piping diameter
- Higher coefficient of heat transfer compared to R410A
- Charge volume reduction
- Large Enthalpy/Kg →totally **30% reduction** against R410A

Converting from R-410A to HFC-32 would reduce Global Warming Impact in 2030 by approx. 800 million tons-CO_2



Energy Saving in Practical Use (Humidity Control)

Energy Saving Impact by Temperature Setting

setting temperature :1℃ ⇧,
electricity consumption :max. approx.10% ⇩

Example: In case a set temperature is raised from 27℃ to 28℃.

Annual Impact		Calculation Condition
Energy Saving (Electricity Reduction)	CO2 Reduction	
30.24 kWh	10.6 kg	In case air conditioner's (2.2 kW) set temperature for cooling is raised from 27℃ to 28℃ at the time the outside temperature is at 31℃. (operating time: 9 hours / day)

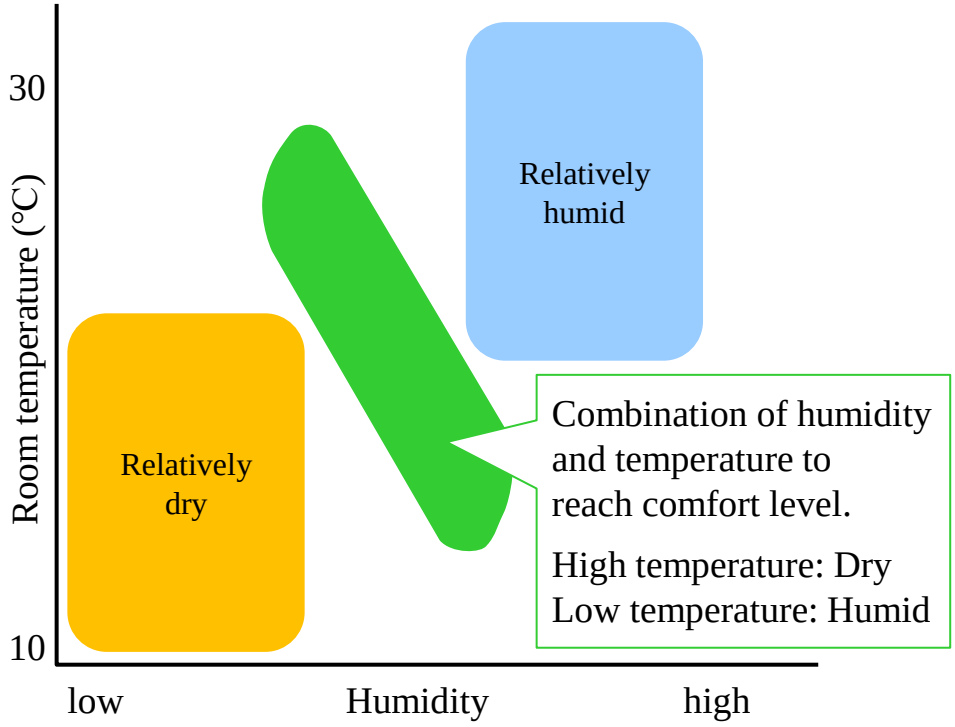
Source: The Energy Conservation Center, Japan
※Estimation under the usage in summer in Japan

However, comfort may decrease as temperature rises…

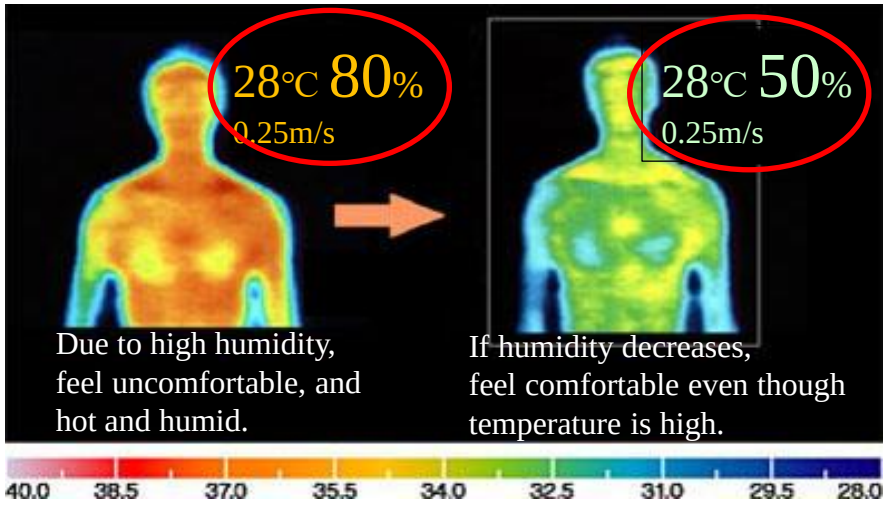
Provide Comfort by Humidity Control

Comfort ≠Temperature only,
Comfort = Temperature & Humidity

■Combinations of Humidity and Temperature



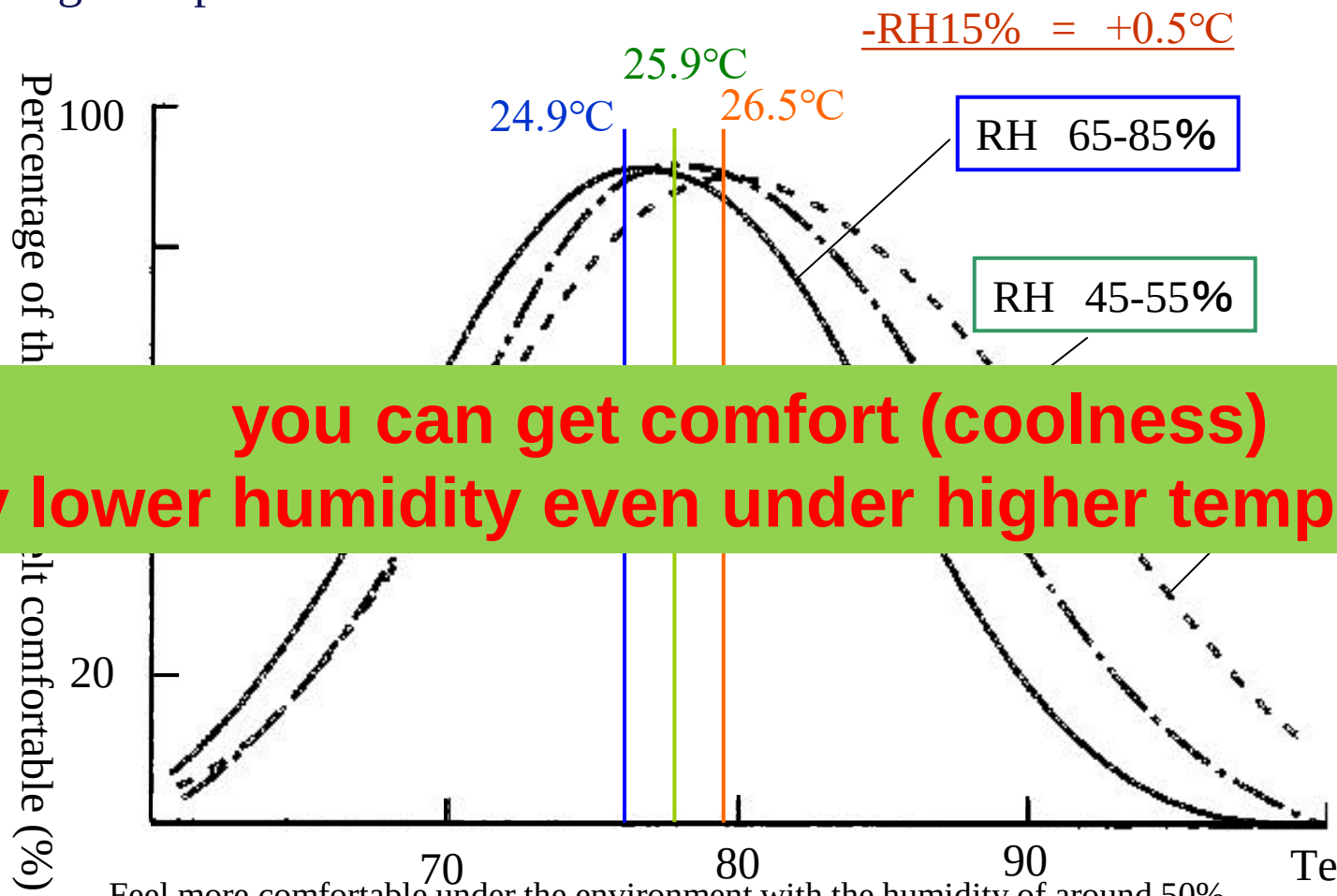
■Comparison of sensible temperature by humidity



※Survey by Daikin Industries Ltd.
The above images are based on the estimation.

Temperature & Humidity Condition and Comfort

The proportion of those who felt comfortable increases as the humidity lowers even under high temperature.

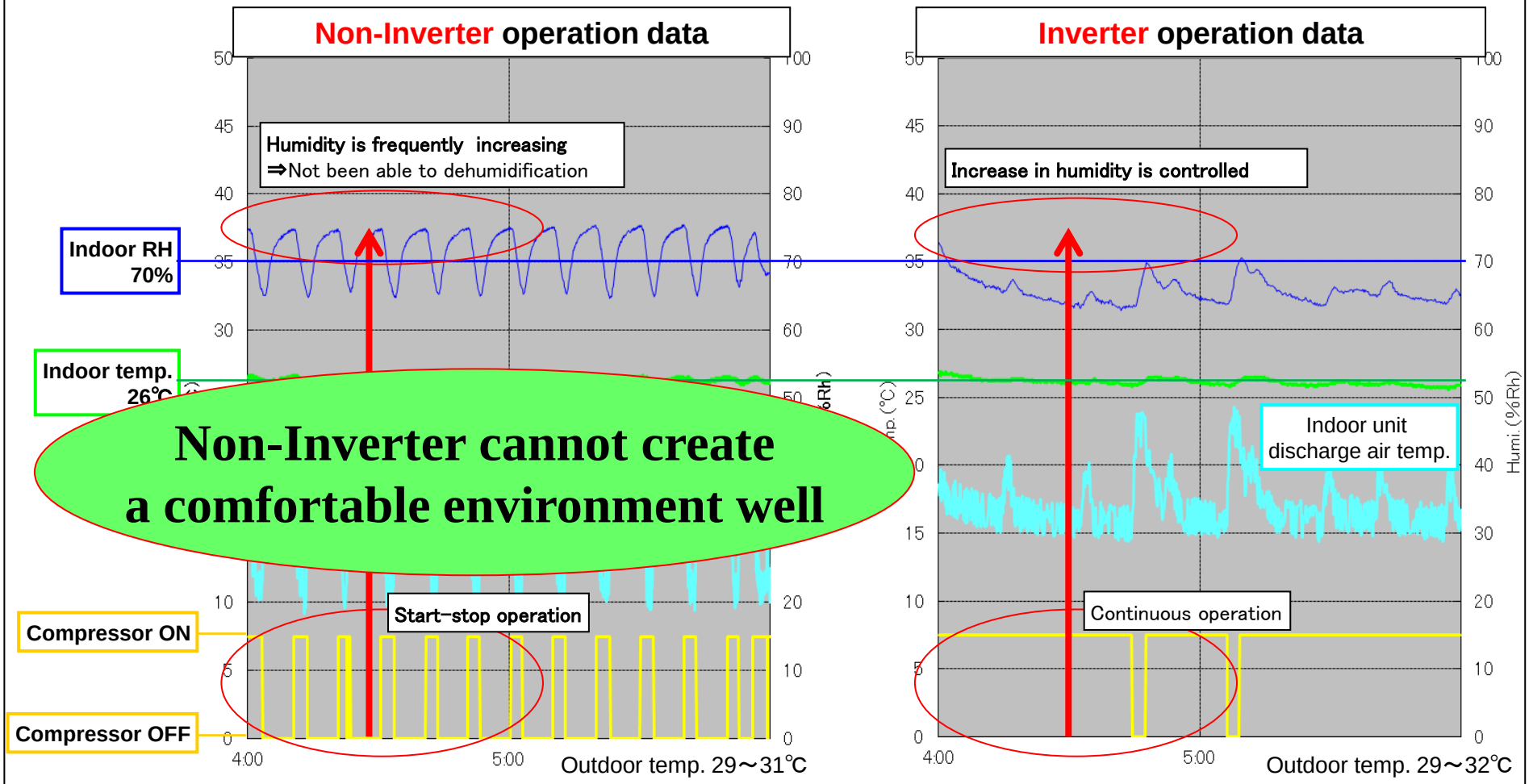


you can get comfort (coolness)
by lower humidity even under higher temperature

Feel more comfortable under the environment with the humidity of around 50% than with the humidity of around 70% even though the temperature is 1℃ higher.
(★humidity of 20% is equivalent to the sensible temperature of 1℃.)

Comparison of Humidity Control

In practical situations, **NON inverter** operate with many start-stop operation, so increase in humidity is often seen by the stop,
Inverter can operate with reducing the start-stop operation by low capacity operation (compressor low rotation), there is an advantage in comfort.

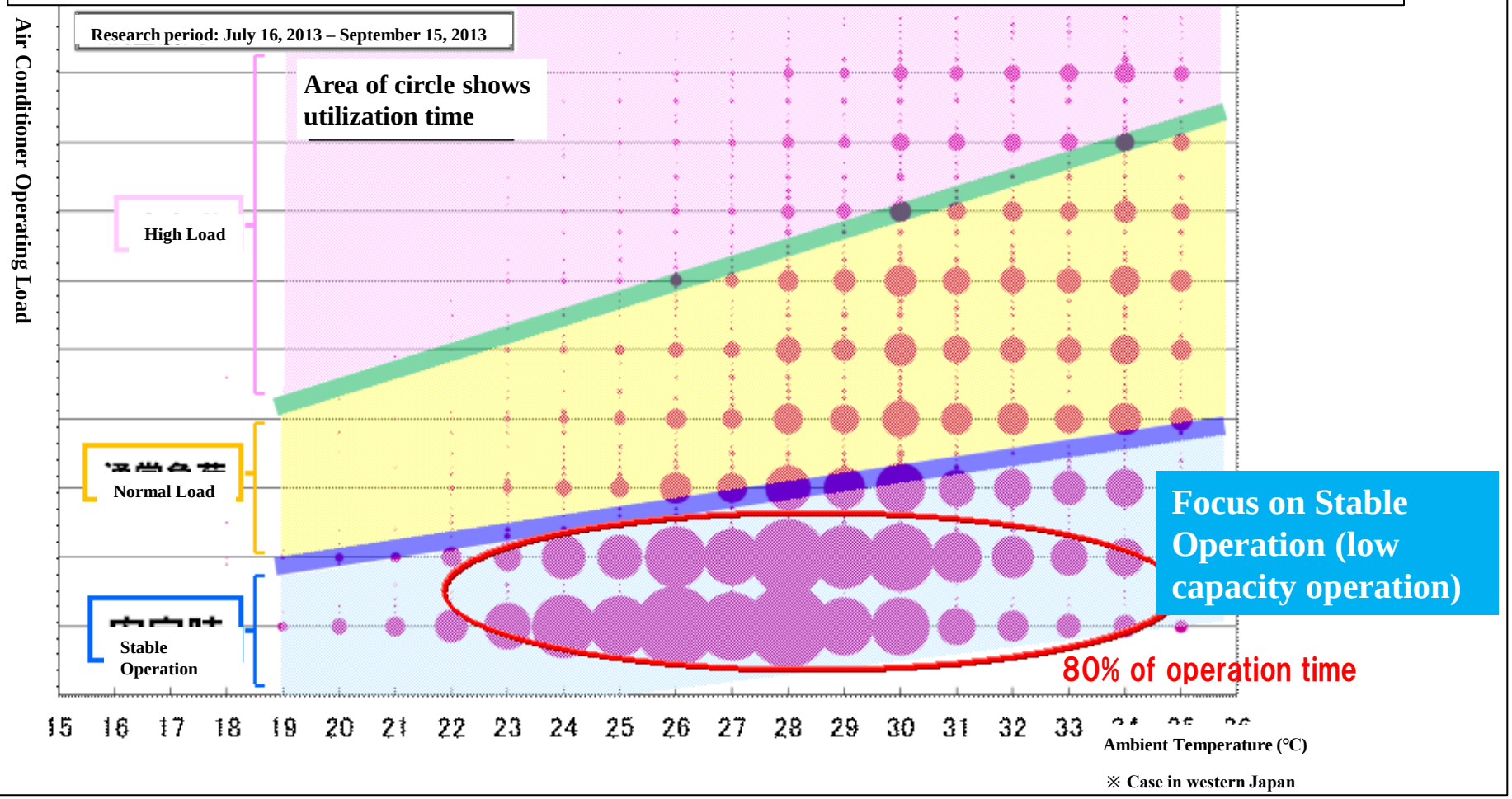


•※Survey by Daikin Industries Ltd.

New technology of Humidity control

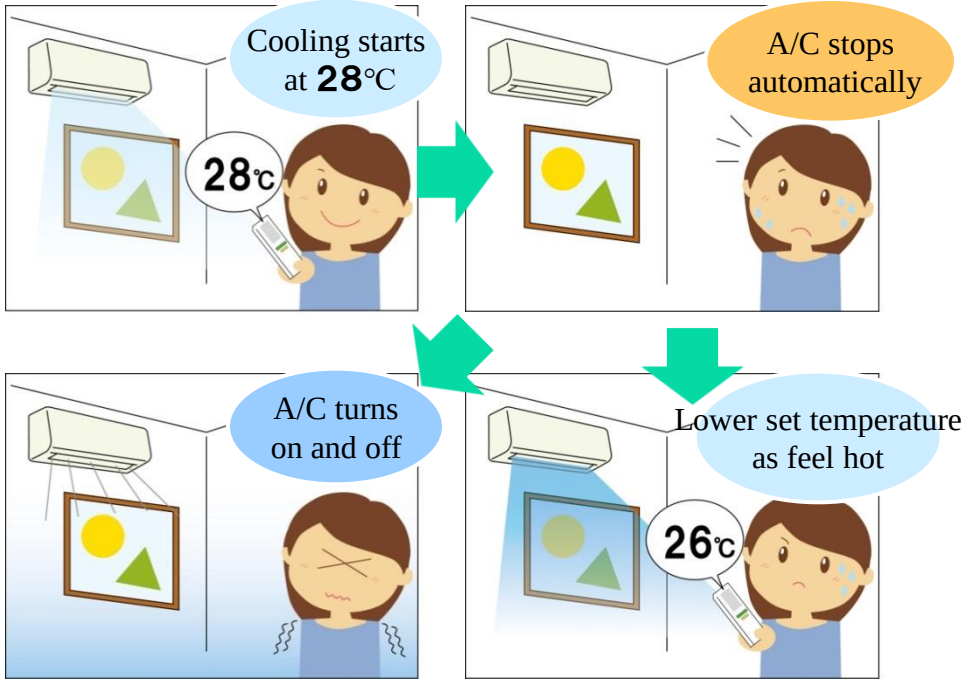
Air Conditioners stably operate at around set temperature about 80% of their operation time in practical situation.

Operation in summer: Comparison of operating time by air conditioner loads and ambient temperatures
(Daikin data: N=261 nationwide)



New technology of Humidity control

Have you experienced such situation?



Repeatedly feel cold and hot in turn, and temperature cannot be adjusted appropriately.

After reaching set temperature, A/C turns off and feel hot. If set temperature is lowered, feel cold.

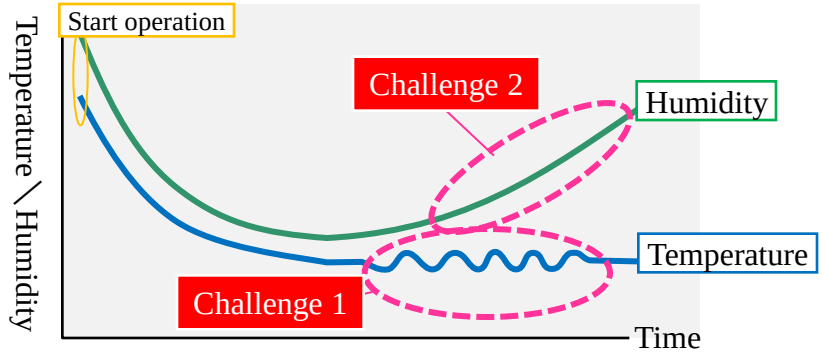
Challenge 1: Temperature does not stabilize

After reaching set temperature, A/C repeatedly turns on and off and room temperature fluctuate because A/C

Challenge 2: Hot & High Humidity

After reaching set temperature, feel hot and humid because A/C becomes unable to dehumidify and room temperature rises.

■Temperature and Humidity change during operation (Conventional Operation)



If set temperature is lowered because of feeling hot

Challenge 3: Higher Electricity Bill & Not Good for Health

If set temperature is lowered to seek comfort, extra electricity may be incurred.
Moreover, too much air cooling is not good for health.

New technology of Humidity control

①Not feel hot and humid because dehumidification is sufficient

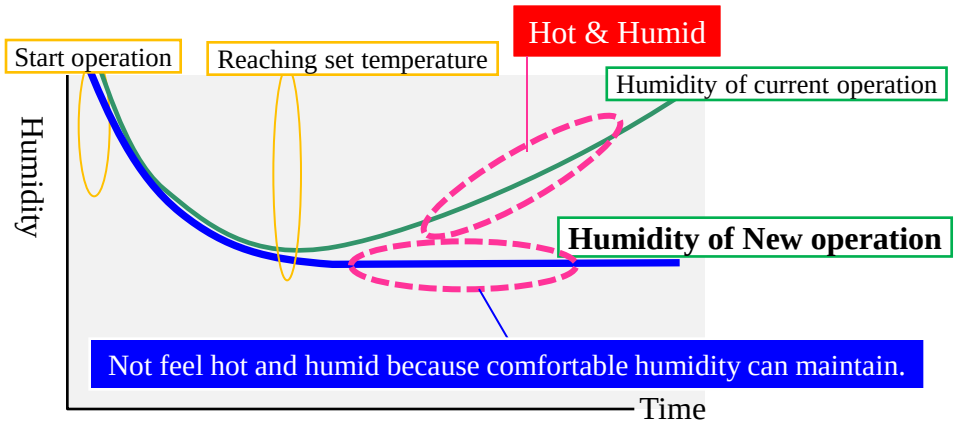
Current

Feel hot and humid because humidity increases after temperature stabilizes.

New

Comfortable humidity can maintain because dehumidification can be done even after temperature stabilizes.

■Temperature change after starting operation (image)



②Feel comfortable even if set temperature is relatively high as not feel hot and humid.

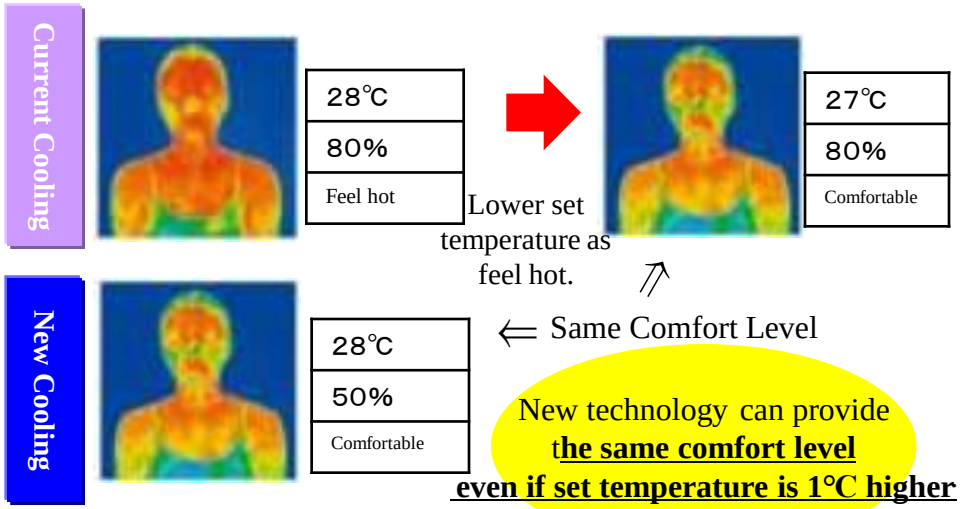
Current

Lower set temperature because dehumidification is not sufficient even after reaching the original set temperature.

New

Feel comfortable even if set temperature is relatively high because dehumidification at set temperature is sufficient.

■In case the temperature of room with 70 humidity from 29℃ to 28℃



※Comfort was evaluated with PMV value.

New technology of Humidity control

<Summary>

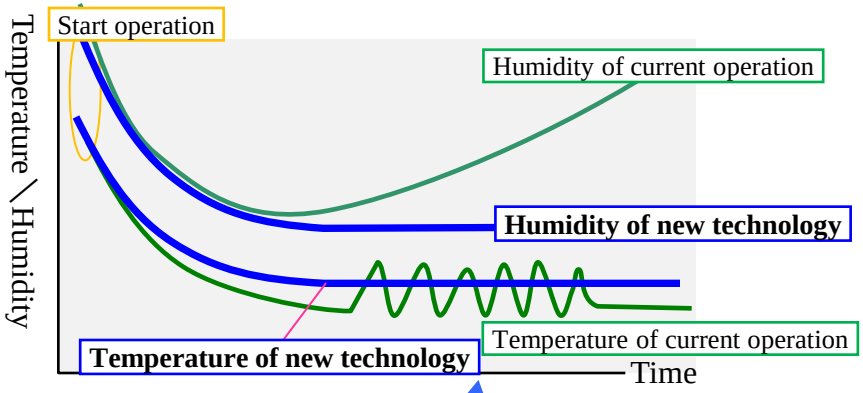
NEW humidity control ①

A/C can control temperature **with ±0.5℃ accuracy.**

Steadily maintain temperature.

Remote control can also set by 0.5℃.

■Temperature change after starting operation (image)



NEW humidity control ②

A/C can dehumidify the air while operating cooling mode even after the temperature stabilizes after reaching set temperature.

As A/C can maintain appropriate humidity, feel comfortable instead of feel hot and humid even though set temperature is relatively higher.

Temperature and Humidity are Stable

Features of new technology of DAIKIN product

Flagship Model “Urusara7”

The new flagship model has 7 features, made possible by DAIKIN’s original technology

Thank you!!