



Perfecting the Air

Carbon Neutrality Solution:

Healthy and Energy Efficient Air Conditioning(AC) system for ASEAN market

Feb 15, 2024



Perfecting the Air

Agenda

- 1. Look back activity at CEFIA**
- 2. Further energy/CO2 reduction by control software**
- 3. CO2 reduction impact in ASEAN market**
- 4. Summary**



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1. Look back activity at CEFIA (1) Overview

1. 4th, CEFIA, Daikin(DK) proposed **“AC-ECP (Air conditioning system with excessive cooling protect)”**, as Carbon Neutral Solution and started verification in Thailand.
2. 5th, CEFIA, DK reported verification result and approved as **CEFIA flagship project**.
3. Today, in this AC webinar, DK **update verification result**.

4th CEFIA
Feb 16, 2023

Introduced CN solution

- ① Market change after covid 19
-Energy consumption increased **due to ventilation**
- ② **Excessive cooling culture in ASEAN**
-AC temp. setting is too low



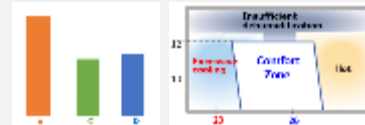
ex: 23 °C wearing jacket

-Proposed “AC-ECP”.
Started verification in Thai

5th CEFIA
Aug 25, 2023

Reported verification result

- ① Digest result
-**Energy/CO2 reduction**
-Comfort by **ASHRAE std 55**



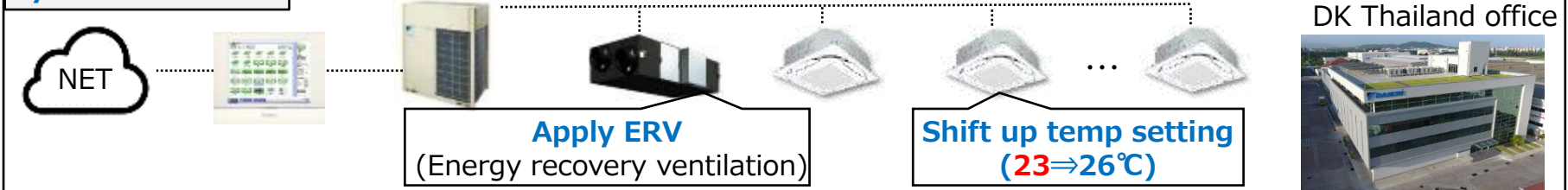
- ② **Further testing**
- ③ Expand to Vietnam in 2024

-CEFIA flagship project

AC Webinar
Feb 15, 2024

Today, DK update verification result

System overview

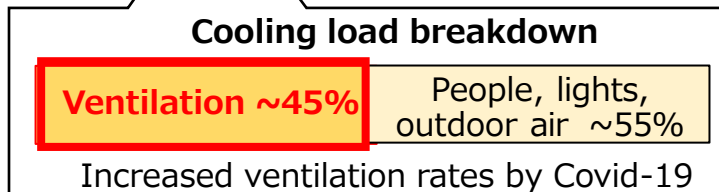
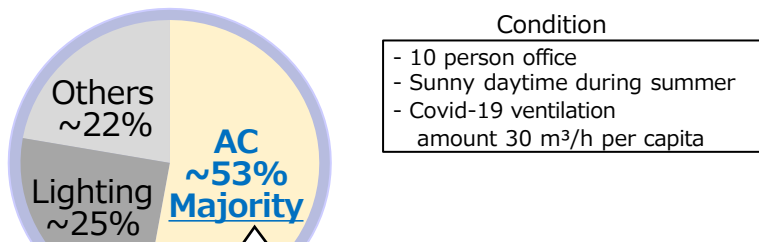


1. Look back activity at CEFIA

(2) Market

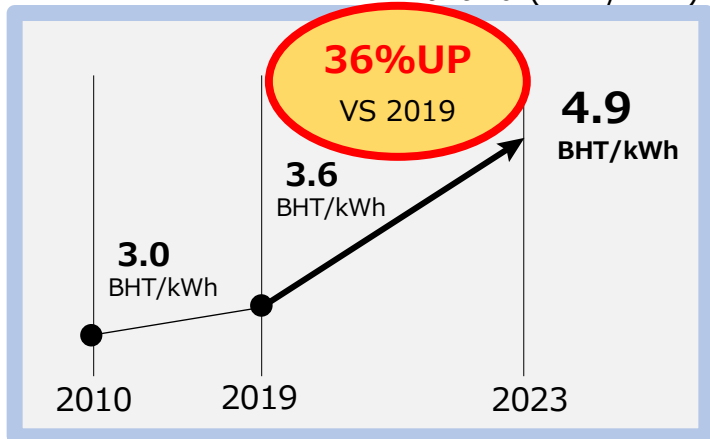
1. Change after covid-19 pandemic

1) Energy consumption of AC is increasing due to the increased ventilation by covid-19



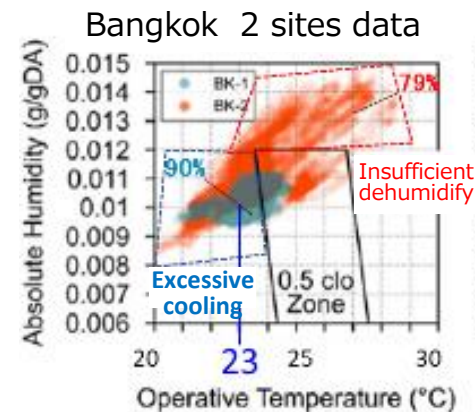
2) Energy bills are also rising due to unstable international situation.

Thailand (BHT/kWh)

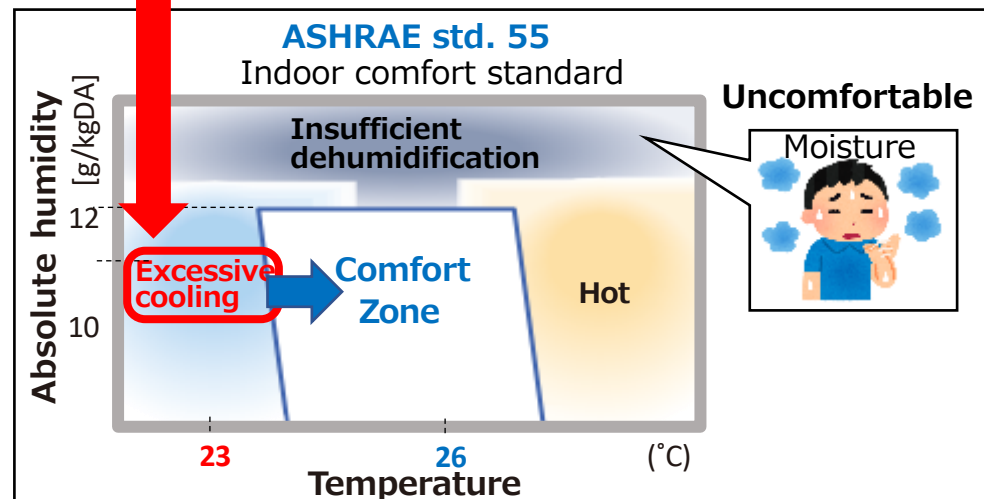


2. Excessive cooling culture in ASEAN

1) AC temp. setting is low at office. ex: 23 degree, wearing jacket.
If we can change this culture, big energy saving is achieved.

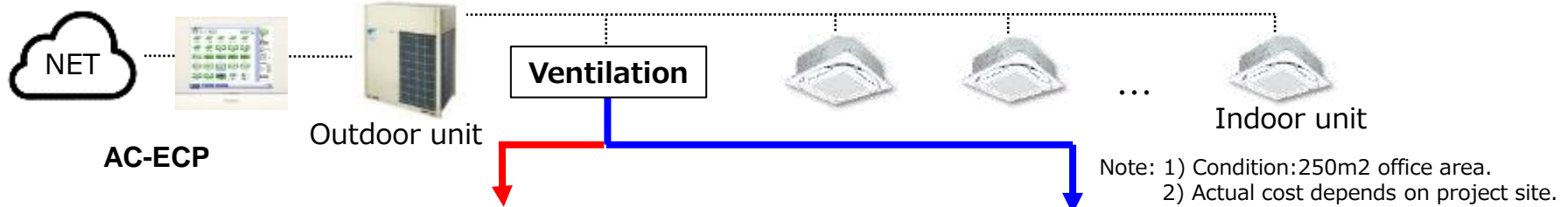


Source
Yuta Fukawa, Ryota Murakami, Masayuki Ichinose, Field study on occupants' subjective symptoms attributed to excessive cooling environments in air-conditioned offices in hot and humid climates of Asia, Build. and Environ. 195 (2021) 2,5.



1. Look back activity at CEFIA (3) "AC-ECP" as CN Solution

- Promote ventilation and AC that can simultaneously achieve energy saving and comfort.
- Replace normal ventilation with **energy recovery ventilation, ERV**, reducing the load of heat and moisture from the outside air, making it comfortable even at 26°C degree.



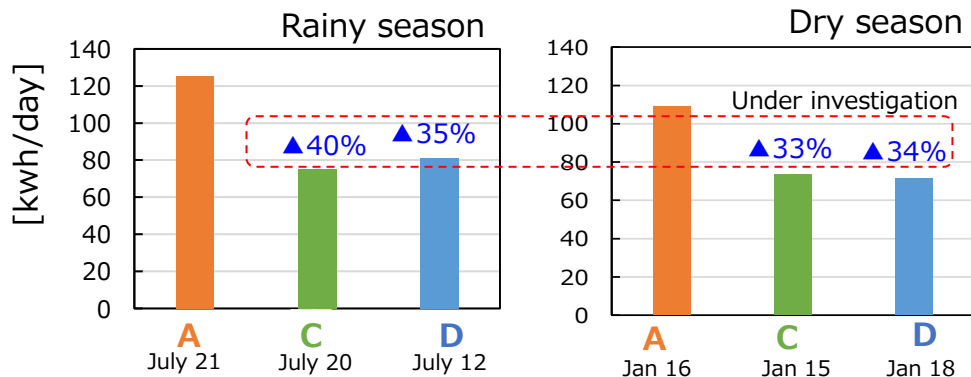
	Normal ventilation	AC-ECP		
	No energy recovery	Energy Recovery Ventilation (ERV)		
Ventilation type	System A Unprocessed outside air is supplied.	System C Heat exchanger	System D Cooling	System E Optimized control AC -CO2 demand control -Positive pressure control
AC set temperature	23 °C	26 °C		
Comfort	Excessive cooling X	Within ASHRAE std55 comfort zone △ ○		
AC capacity	18 HP	12 HP		
Cost index		Down sizing of AC to almost offset ERV		
Energy	100%	66%	66%	53%
Equipment(AC, Venti)	100%	75%	99%	101%

1. Look back activity at CEFIA (4) Digest of verification result

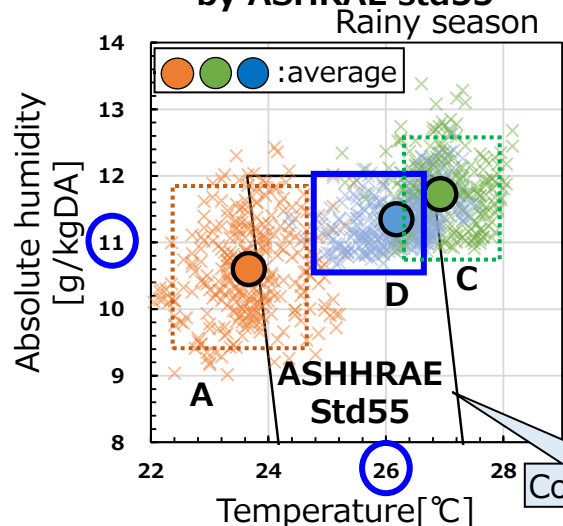
A: Conventional Natural ventilation, C: ERV only, D: ERV with Refrigerant coil

1. Approx 40% of energy was saved in case of proposed "AC-ECP(C&D)" compared to normal ventilation(A).
2. AC-ECP (D) is the most comfortable because,
 - 2-1) No excessive cooling(26C), enough de-humidify(average 11g/kgDA) ⇒ Mostly in ASHRAE comfort zone.
 - 2-2) Questionnaire result is also matching with ASHRAE std55 evaluation.

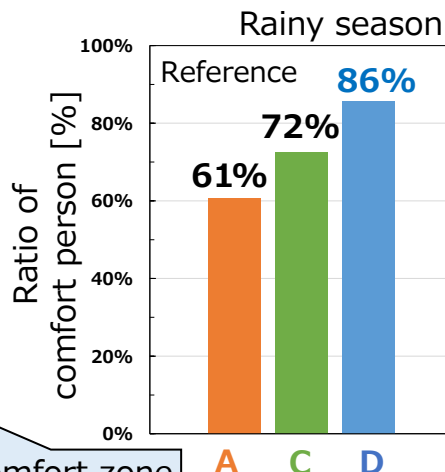
1. Energy consumption per day



2-1) Comfort zone by ASHRAE std55



2-2) Comfort by Questionnaire



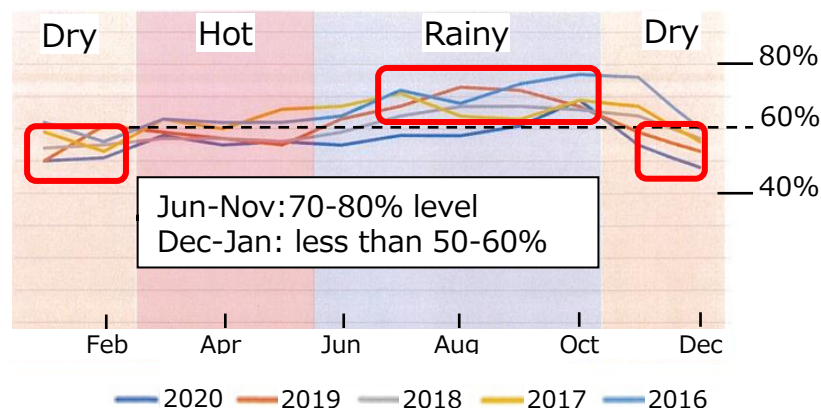
<Ref info>

-Verification site
Daikin R&D building in Bangkok at 4th Floor

[Target office area]
-Office area: 200m²
-Ceiling height: 2.7m
-People: 50~20人

[Sensor location]
-5 location
-temp, humid, CO₂

-Bangkok relative humidity by season





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2. Further energy/CO2 reduction by control software

1. CO2 demand control feature.

When less people in the office, ventilation amount need to be "Low". But when many people, it is "Hi" to avoid energy loss. It is automatically switched by control system.

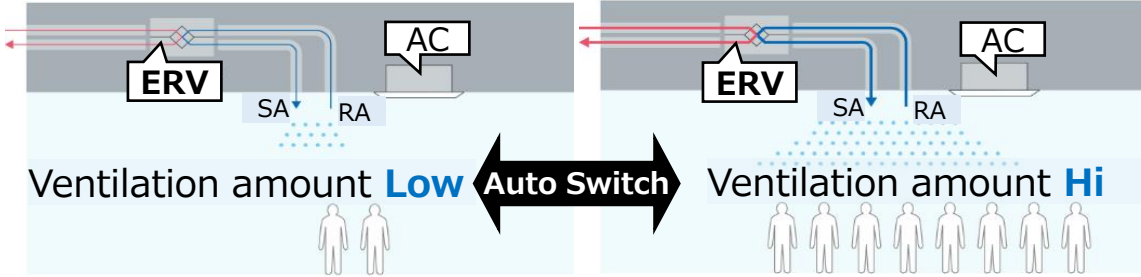
2. Verification result

People at verification site fluctuate from 20 -50 persons in a day from time to time. By switching ventilation amount Hi & Low, approx. 8% of further energy/CO2 was saved.

1. CO2 demand control feature

When **Less people** in the office

When **Many people** in the office



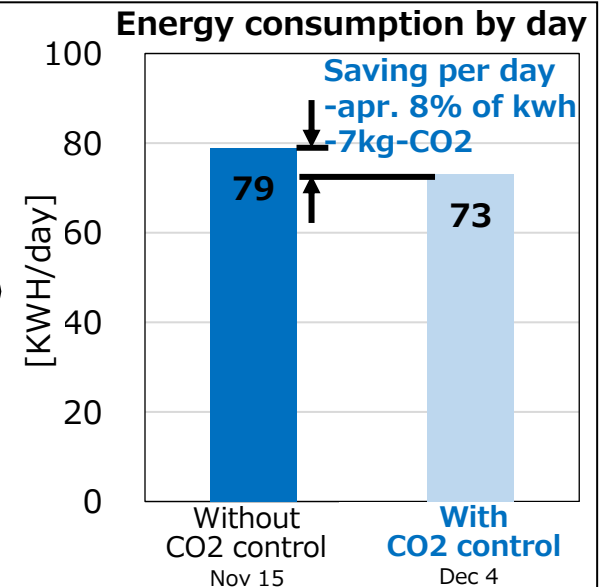
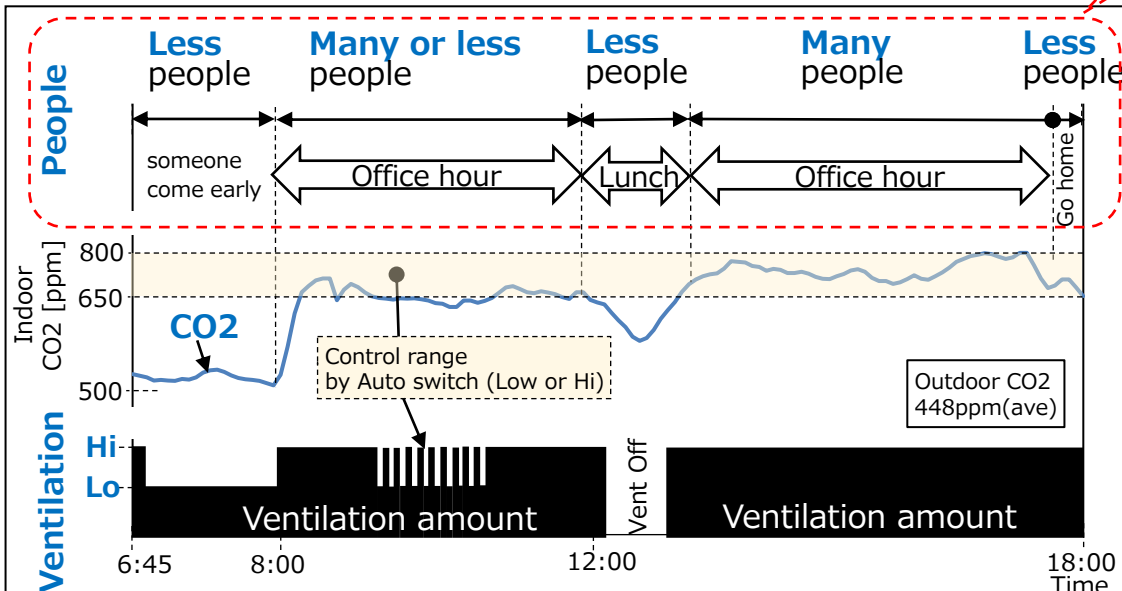
People at verification site

Fluctuate from 20 to 50 persons in a day from time to time.



250m2 x 2.7m H

2. Verification result





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3. CO2 reduction impact in ASEAN market

- 1. "AC-ECP" impact for VRF type AC is estimated roughly,
 - CO2 emission: **2,724 kt-CO2/year**
 - Thermal power generator: **27.2 units**

	Total VRF stock (2008-2023)		Annual energy consumption
	K unit	K HP	G WH/year
Thailand	217	2,600	3,480
Vietnam	206	2,470	3,300
Indonesia	152	1,820	2,400
Singapore	137	1,640	2,200
Philippines	98	1,180	1,580
Malaysia	82	980	1,320
ASEAN total	892	10,700	14,300

Convert

Number of Thermal power generator (natural gas)		kt-CO2/year reduction
Without AC-ECP	With AC-ECP 40% reduction	
unit	unit	
16.6	6.6	663
15.7	6.3	628
11.6	4.6	464
10.5	4.2	419
7.5	3.0	300
6.3	2.5	251
68.1	27.2	2,724

Condition

- 1) Total VRF stock: based on Daikin research.
- 2) Annual energy consumption = 16,031kwh/12HP/year. approx. 10hr operation/day x 250day/year
- 2) Central type AC is excluded.

<Remark for impact>

- 1.Coal fuel source: approx. 1.8 times against natural gas case
- 2.Residence market: approx. 4 times bigger



	Thermal power generator
Rated power	50MW/unit
Operation rate	70%
Operated power	35MW/unit

- Daikin "AC-ECP", using ERV with refrigerant coil, contribute to CN
 - by reducing heat load and humidity from outdoor air, **comfort and big energy saving is achieved---approx. 40%.** (AC set temp is shifted 23°C→26°C+CO2 demand control)
 - Roughly speaking, market impact is estimated **2,724 kt-CO2/year reduction for VRF market in ASEAN.**



Further action

- Understand impact of "natural ventilation(air tightness)" on energy/CO2 saving.
- **Expand to Vietnam** for its verification

**To be continued
at next CEFIA**