



**Environmental & Energy Branch
Public Works Department Malaysia**



**A CARBON NEUTRAL
Conference On Sustainable Building South East Asia
“New Opportunities & Challenge”**



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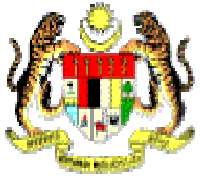
**Control of Moisture &
Infiltration for Advanced
Energy Efficient Buildings
in the Tropics**



Presentation



1. Problem Statement
2. Objective and Goal
3. Relationship Between Infiltration and Energy Consumption
4. Infiltration Measurements
5. Findings
6. Conclusions




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Problem Statement



**MALAYSIAN
STANDARD**

MS 1525:2007

CODE OF PRACTICE ON ENERGY
EFFICIENCY AND USE OF RENEWABLE
ENERGY FOR NON-RESIDENTIAL BUILDINGS

ICS: 91.040.01
Descriptors: code of practice, building, energy conservation, energy efficiency

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5.9 Air Leakage

5.9.1 General requirement

The building envelope should provide adequate barrier to prevent uncontrolled mixing of outside air with air-conditioned space.

NOTE. The energy required to remove moisture from uncontrolled leakages of outside air into the building is one of the highest energy load contributed by the external environment into a building in the tropical climate. In a leaky building, the energy used to remove moisture would be higher than the energy used to remove heat contributed by solar radiation.

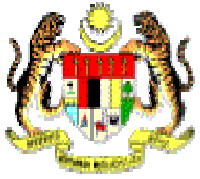
5.9.2 All open-able fenestration and doors between conditioned space and non-conditioned space should have an advisory label on it requesting that fenestration and doors are to be kept closed when not in use.

5.9.3 Any duct that provides a connection between conditioned space to outside air should have a damper in between to prevent air leakages into conditioned space when the duct is not in operation.

5.9.4 Where the false ceiling is used as return air plenum to the AHU (air handling unit); partitions should be placed in the false ceiling space between conditioned space and naturally ventilated space to prevent air leakages.

➤ The MS 1525:2007 Page 19, 5.9 Air Leakage;
Only provides a **recommendation** on controlling building air-tightness as it has been identified to contribute significantly to building energy use.

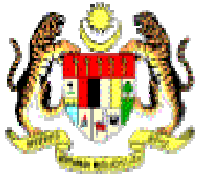
There is no targeted infiltration standard, as there is no existing database on building air-tightness in Malaysia.



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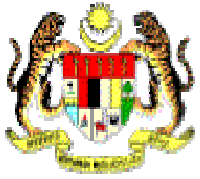
Objective and Goal

Objective

To disseminate infiltration rates of 10 government buildings in Malaysia.

Goal

To set up an infiltration rate database of 50 government buildings in Malaysia.



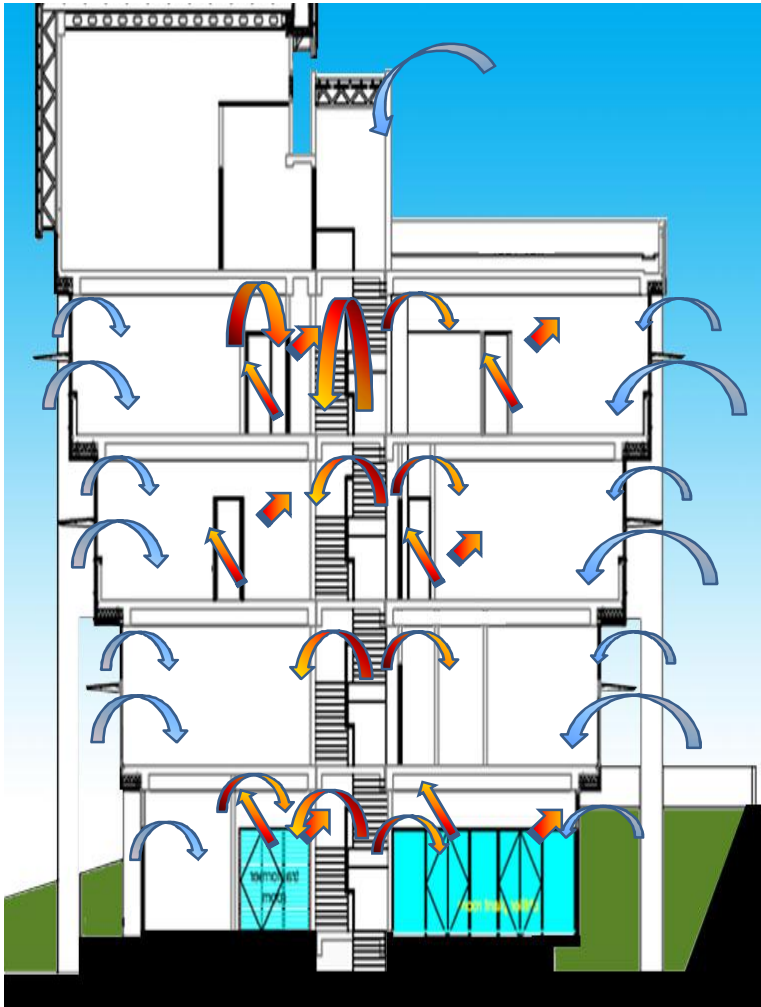
Presentation



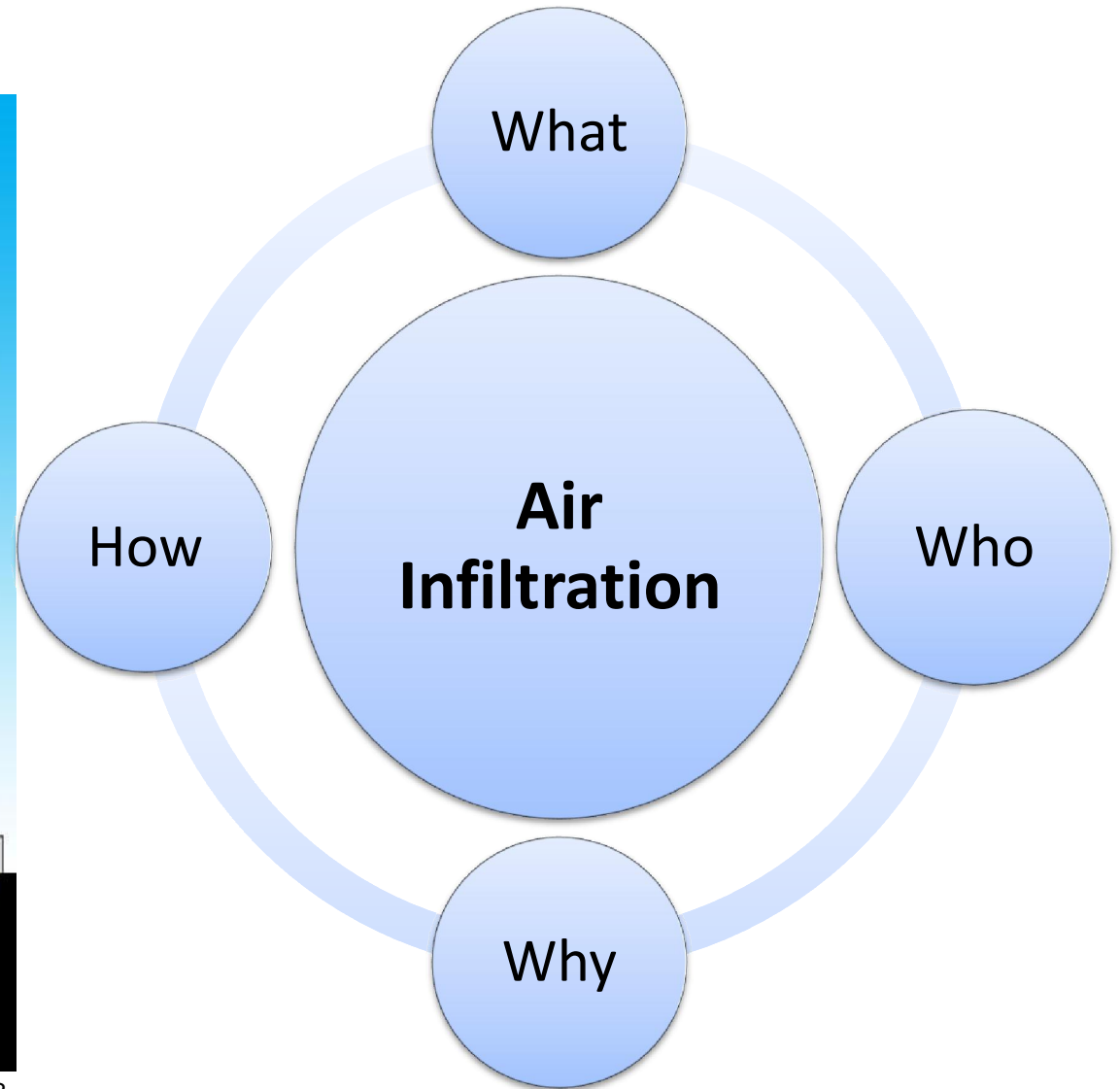
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Air Infiltration-introduction

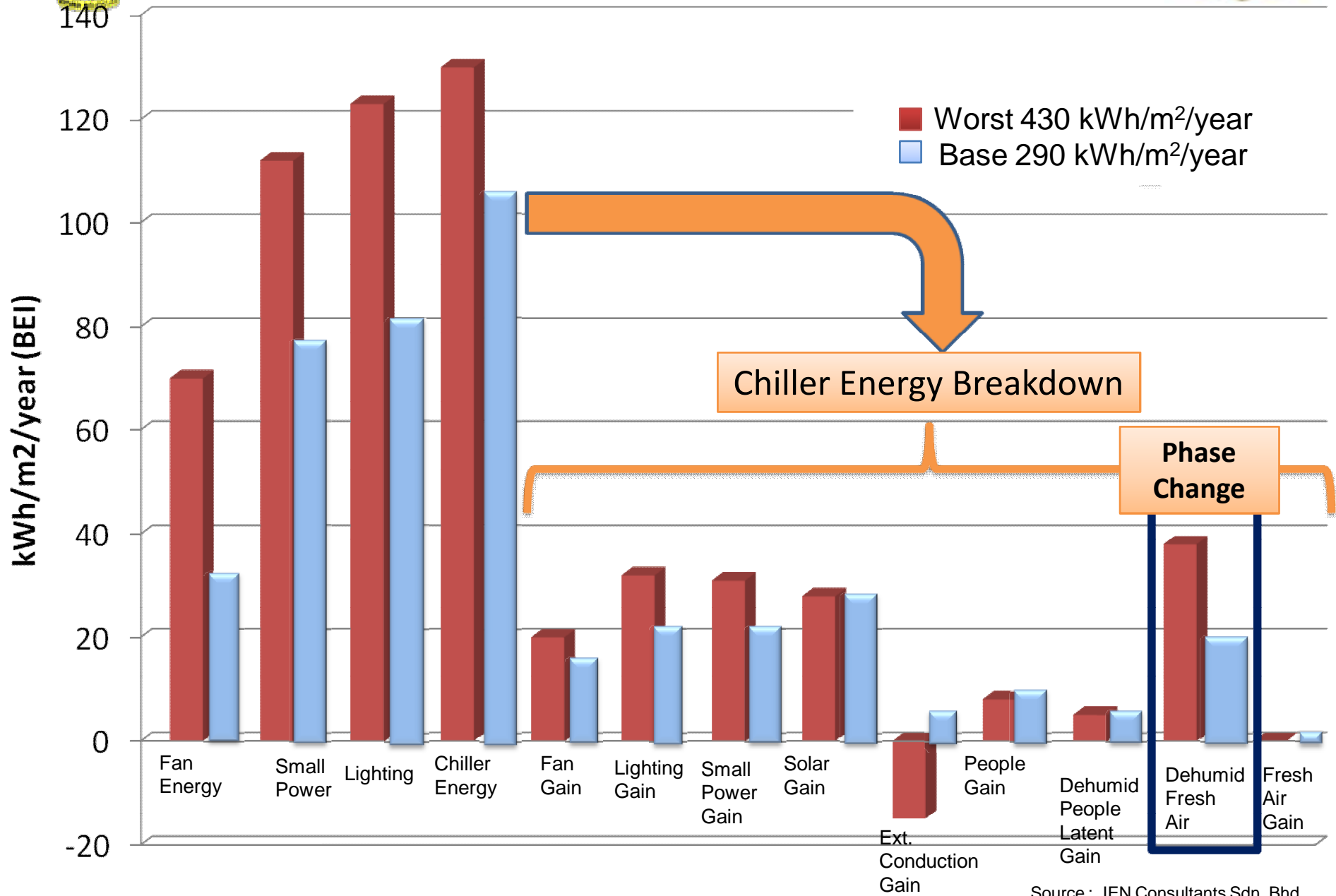


Source : CAST,JKR.





Energy Breakdown In A Building





Why We Should Worry About Air-Leakage



” Annual cooling cost per building.

➤ RM 205 /day or RM 57,000 per year*.

*Average floor area of 14,000 m² (based on case studies)

” Makes our office uncomfortable and unhealthy

➤ Can produce mould in the office area due to very high humidity.



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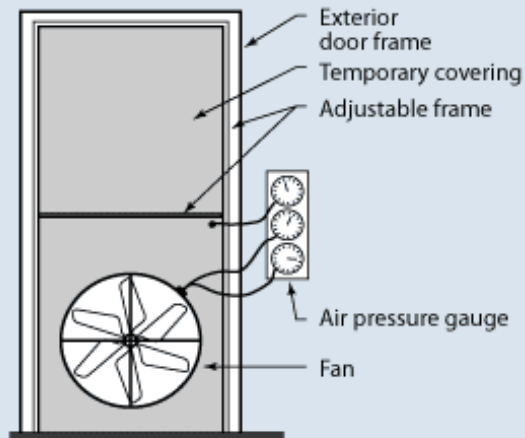
Existing Methods



Blower Door Air Infiltration Test

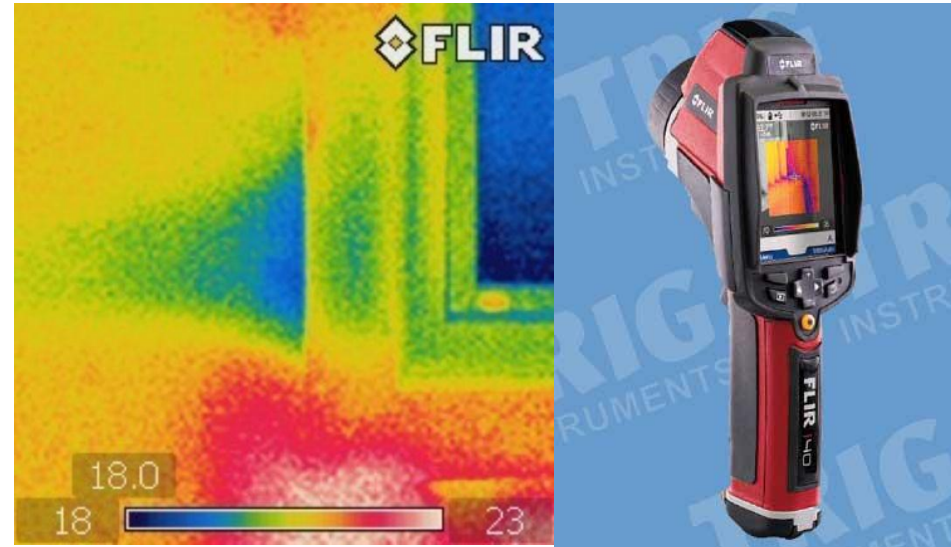
Diagnostic Tools

Testing the airtightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE/ EPA ENERGY STAR Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.



High Cost!
Difficult to operate!

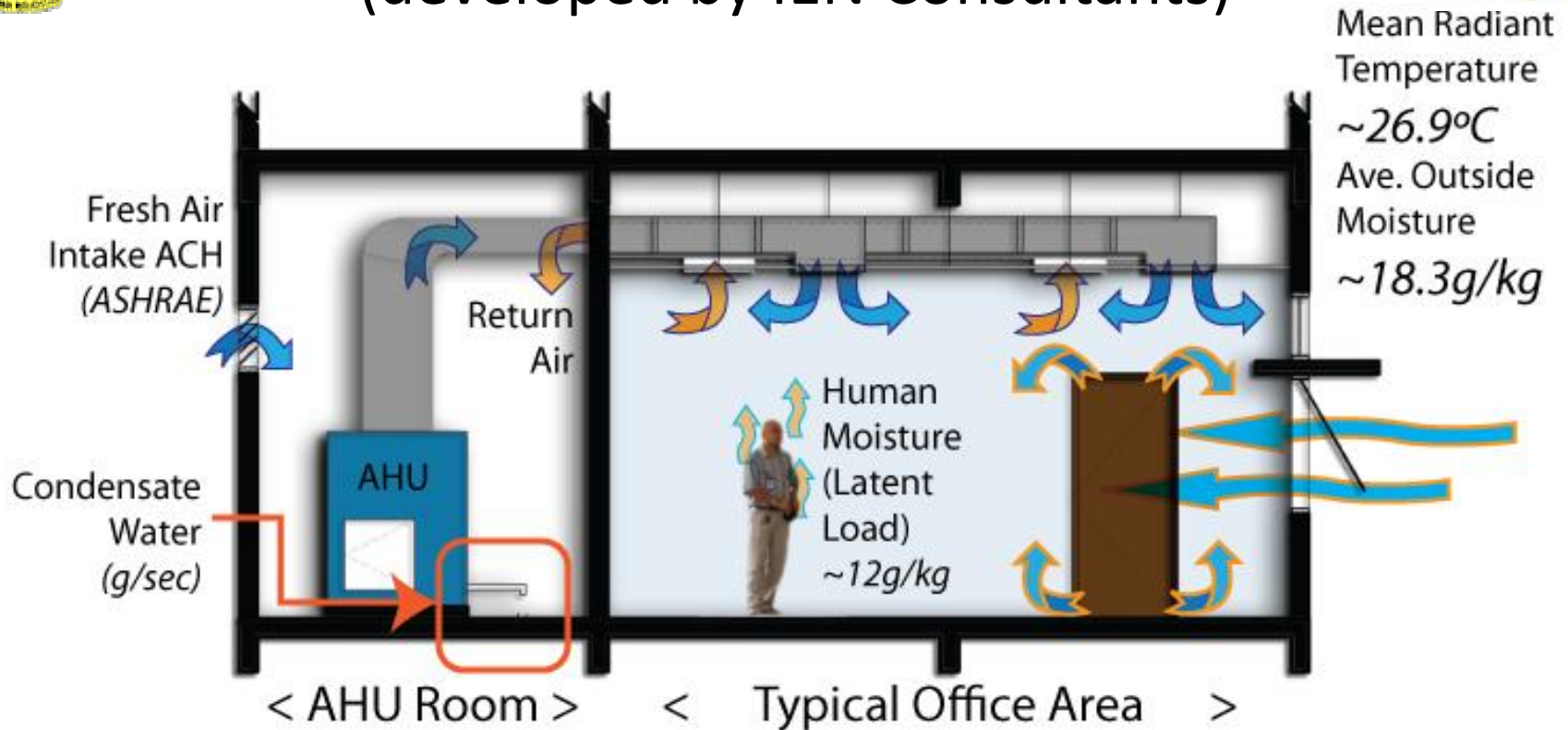
Infrared Thermal Imaging Survey



Not Suitable for Tropical Climate – the difference in temperature between outside and inside is not much



New Method used for this case study— (developed by IEN Consultants)



**Rate of
condensate
water produced**

=

Rate of moisture that goes into building

+

Rate of moisture from occupants

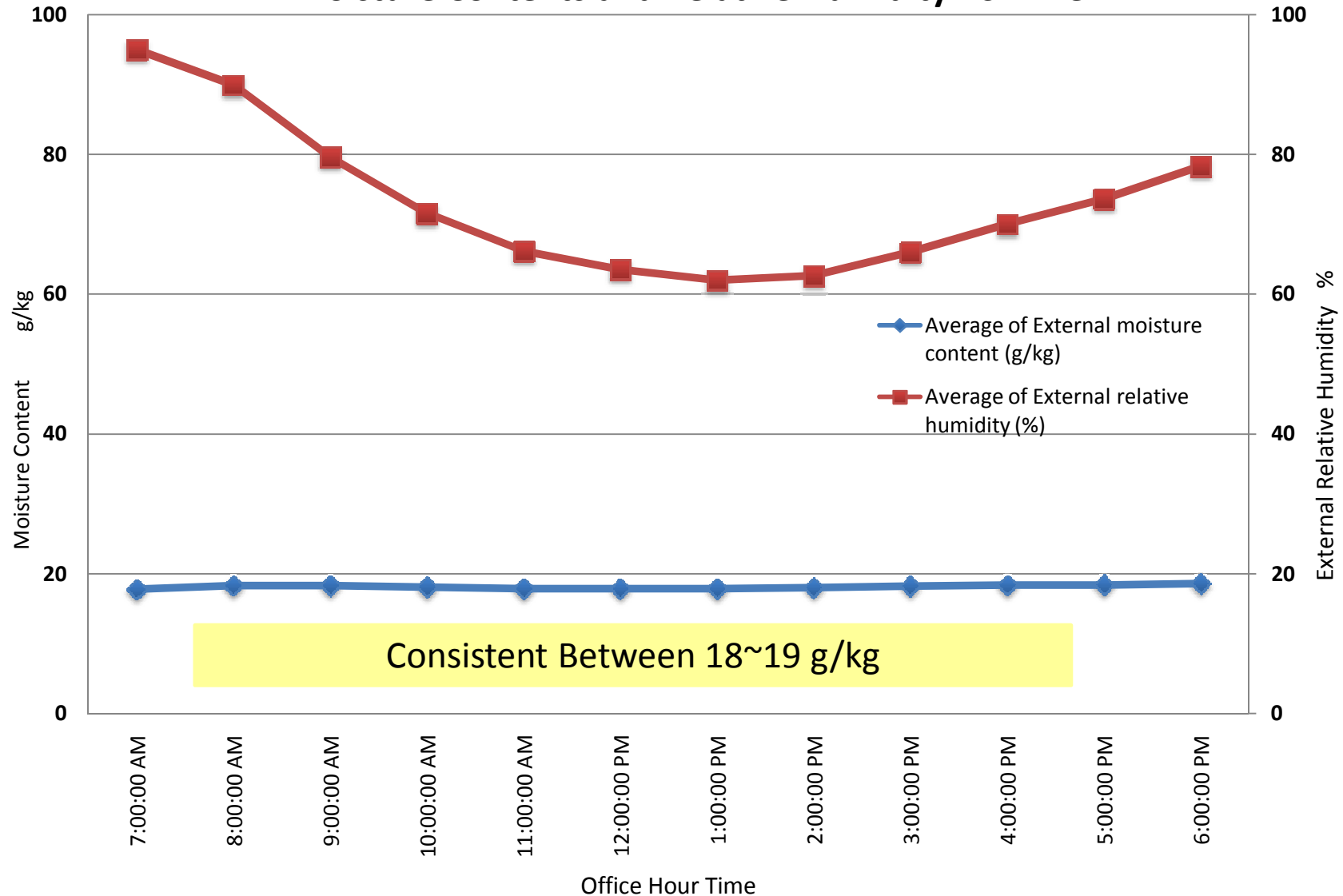
The more unnecessary outside air coming into A/C room, the more Energy is needed to remove the moisture. → **Energy Wastage**



Average External Moisture Contents and RH for Malaysia Weather



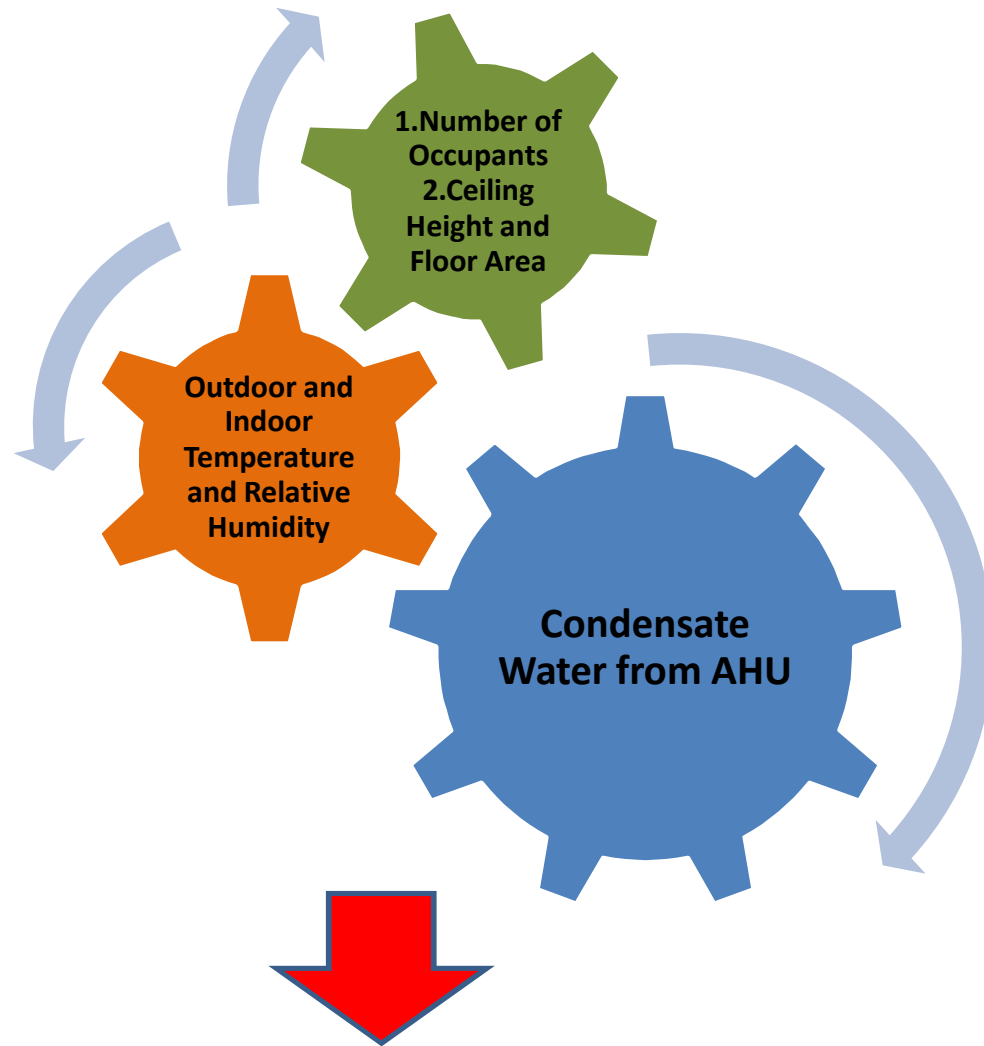
Moisture Contents and Relative Humidity VS Time



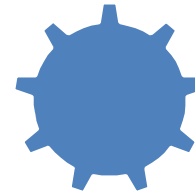
Consistent Between 18~19 g/kg



METHODOLOGY



Infiltration Rate



Measure the condensate water with digital weight.



Measure the temperature and relative humidity with HOBO Data Logger.



Extract the building info from the building layout .



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Case Studies At Putrajaya



1



Block E 4/5 Ministry of Energy, Green Technology and Water.(Low Energy Office Building)

2



Block E3 Ministry of Higher Education

3



4G3 Ministry of Natural Resources and Environment

4



Block C6 Department of Statistics

5



Block C7 PWD Putrajaya , Election Commissioner and Public Services Commissioner

6



Block A Prime Minister's Office

7



Block B8 Prime Minister's Department

8

9



Block C4 & C5 Ministry of Science, Technology and Innovations

10



Block C2 Public Services Department



Infiltration Test Results

No	Description of Areas	Total Fresh Air Measured (ACH)	Fresh Air recommended by ASHRAE (ACH)	Exceeded by
1	Block E4/5 Ministry of Energy, Green Technology and Water.(Low Energy Office Building)	0.33	0.32	2%
2	Block E3 Ministry of High Education	0.68	0.46	48%
3	4G3 Ministry of Natural Resources and Environment	0.59	0.39	51%
4	Block C6 Department of Statistics	0.81	0.41	99%
5	Block C7 PWD Putrajaya , Election Commisioner dan Public Services Commisioner	0.81	0.39	108%
6	Block A Prime Minister Office	0.88	0.41	114%
7	Block B8 Prime Minister Department	0.88	0.40	122%
8	Block C4 Ministry of Science, Technology and Innovations	1.06	0.42	151%
9	Block C5 Ministry of Science, Technology and Innovations	1.90	0.41	364%
10	Block C2 Public Services Department	2.02	0.42	382%
Average		1.00	0.41	144%

Average Infiltration Rate is 1.0 ACH which has exceeded ASHRAE requirement by 144%.





Potential Savings for 10 Government Buildings in Putrajaya



Result of findings

- Average 1.0 ACH
- Average 18 g/sec water collected per AHU
- Cost Infiltration per day = RM 205/day/building
- Cost Infiltration per year = RM 57,000 / year / building * 280 working days

JKR Recommendation

- 0.5 ACH
- 10 g/sec water collected per AHU
- Cost Infiltration per day = RM 103/day/building
- Cost Infiltration per year = RM 28,000 / year/building * 280 working days

Potential savings per year / building → RM 28,000 / year / building*

* Average floor of 14,000 m²



“No Good” Example



No	Tingkat	AHU	Water Collected (grams)	Sec	Total Condensation Rate (g/sec)	Cond - Occ (g/sec)	Infil (kg air/sec)	Infil (m3 air/hour)	ACH infiltration
Average			590.00	13.33	47.00	38.37	4.26	13648	2.02

At least one window opened for each floor !



Good Example (MEGTW)



Keep windows and doors closed between air-conditioned spaces and non-conditioned spaces.
→ **Good housekeeping**

No	Tingkat	AHU	Water Collected (grams)	Sec	Total Condensation Rate (g/sec)	Cond - Occ (g/sec)	Infil (kg air/sec)	Infil (m3 air/hour)	ACH infiltration	ACH Ashrae	Exceeded by
1	All	All	569.07	15.00	37.94	32.65	3.68	11617.76	0.33	0.32	2%



Conclusion



1. **Good detailing** for windows, doors and openings, and good workmanship.
2. **Involvement of all stakeholders . roles & responsibilities.**
3. **Awareness program & good housekeeping** to keep the building air-tight (**keep windows and door closed**).
4. The optimum solution is to install a **motorized fresh air ventilation louver** in all AHU rooms that is controlled via a CO₂ sensor.
5. For a start, **0.5 ACH** is suggested to be used as an **acceptance criteria** upon completion of a government building.



ELIMINATES AIR
INFILTRATION



SUSTAINABLE
BUILDING
ENVELOPE



REDUCES
ENERGY
CONSUMPTION

The End

Thank You