SUSTAINABLE MECHANICAL SYSTEMS IN BUILDING

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Content

- Introduction
- Sustainability Development Goals (SDG)
- SDG Target and Mechanical System contribution
- Challenges
- Conclusion
- Q&A


Sustainability means ***meeting our own needs without compromising the ability of future generations to meet their own needs.***
"United Nations Brundtland Commission"

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future

169 targets

3084 events

1303 publications

5474 actions

In Malaysia, SDG is incorporated in Wawasan Kemakmuran Bersama 2030.

National SDG Council
(chaired by Prime Minister)

Establish direction for SDG implementation, set national agenda and milestones and prepare reporting to UN High Level Political Forum

Steering Committee
(chaired by Director General of EPU)

Formulate SDG Roadmap, monitor progress of targets, identify issues and report to National SDG Council

Working Committee INCLUSIVITY

Goal 1 : No Poverty
Goal 2 : Zero Hunger
Goal 5 : Gender Equality
Goal 10 : Reduced Inequality

Working Committee WELL-BEING

Goal 3 : Good Health & Well-being
Goal 11 : Sustainable Cities and Communities
Goal 16 : Peace, Justice and Strong Institutions

Working Committee HUMAN CAPITAL

Goal 4 : Quality Education

Working Committee ENVIRONMENT & NATURAL RESOURCES

Goal 6 : Clean Water and Sanitation
Goal 7 : Affordable and Clean Energy
Goal 12 : Responsible Consumption and Production
Goal 13 : Climate Action
Goal 14 : Life Below Water
Goal 15 : Life on Land

Working Committee ECONOMIC GROWTH

Goal 8 : Decent Work and Economic Growth
Goal 9: Industry, Innovation and Infrastructure
Goal 17 : Partnerships for the Goals

Each Working Committee will be represented by members from the UN agencies, private sector, NGOs, CSOs and academia

Government's Green Building Rating System

Penarafan Hijau (pHJKR) bagi fasiliti bangunan kediaman dan bukan kediaman (JKR/SIRIM 2:2020)

- Perancangan dan pengurusan tapak lestari
- Pengurusan kecekapan tenaga dan penggunaan Tenaga Boleh Baharu
- Pengurusan sumber dan bahan
- Pengurusan kecekapan penggunaan air
- Pengurusan kualiti persekitaran dalaman
- Pengurusan fasiliti lestari
- Inovasi dalam reka bentuk

Government’s Green Building Rating System

- **Infrastructure and sequestration**
- Energy Performance Impact
- Occupant & Health
- Lowering the embodied carbon
- Water Efficiency Factors
- Social and Cultural Responsibility
- Demolition and Disposal Factors
- Waste management & Reduction
- Sustainable Facility Management
- Sustainable and Carbon Initiatives


SDG and Buildings
3 GOOD HEALTH AND WELL-BEING
Air Conditioning & Mechanical Ventilation
11 SUSTAINABLE CITIES AND COMMUNITIES
6 CLEAN WATER AND SANITATION
Cold Water and Sanitary System
Green Procurement
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
7 AFFORDABLE AND CLEAN ENERGY
Renewable Energy and Heat Reclaim
13 CLIMATE ACTION

"Ensure healthy lives and promote well-being for all at all ages"

The Targets

- Target 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other **communicable diseases**.
  - Tuberculosis incidence per 100,000 population.
  - Number of people requiring interventions against neglected tropical diseases.

Mechanical Systems

Deploying ventilation, filtration and air cleaners strategies in buildings to achieve exposure reduction goals subject to constraints that may include comfort, energy and cost.

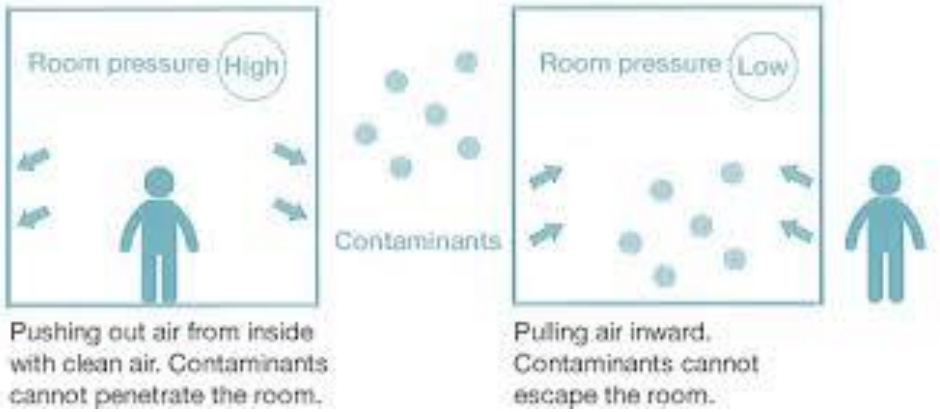
DOSM (2016). *Malaysia's Sustainable Development Goals Indicators, Department of Statistic Malaysia*. Accessible at https://www.dosm.gov.my. Retrieved on: 26 August 2021.

ROLE OF AIR CONDITIONING IN DISEASE PREVENTION AND TREATMENT

- Preventing the spread (Differential pressure control)
- Dilution (by ventilation),
- Air quality (by filtration),
- Exposure time (by air change and pressure differential),
- Temperature,
- Humidity,
- Organism viability (by ultraviolet [UV] treatment), and
- Airflow patterns.

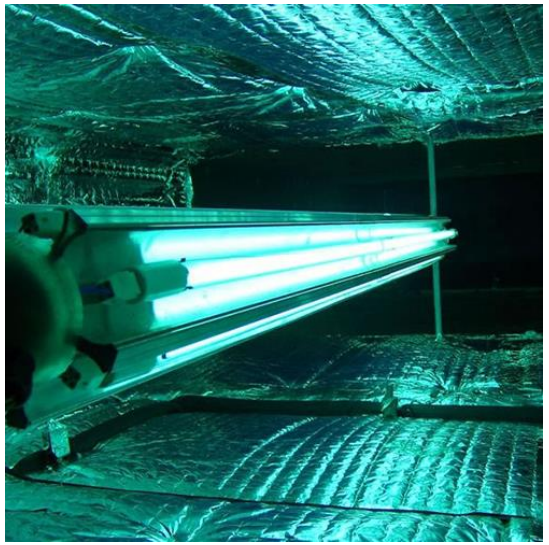
ROLE OF AIR CONDITIONING IN DISEASE PREVENTION AND TREATMENT

Differential Pressure Control



Ventilaton

- Air Change Requirements
- Outside Air Requirements
- Air Filtration Requirements
- Air Diffusion



Ultraviolet Germicidal Irradiation (UVGI)

"Ensure availability and sustainable management of water and sanitation for all"

The Targets

- Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
  - Proportion of population using safely managed drinking water services.
- Target 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.
  - Proportion of domestic and industrial wastewater flows safely treated.

Mechanical Systems

- Water filtration
- Effluent treatment of chemical waste before discharging to public sewerage treatment plant

Water Filtration

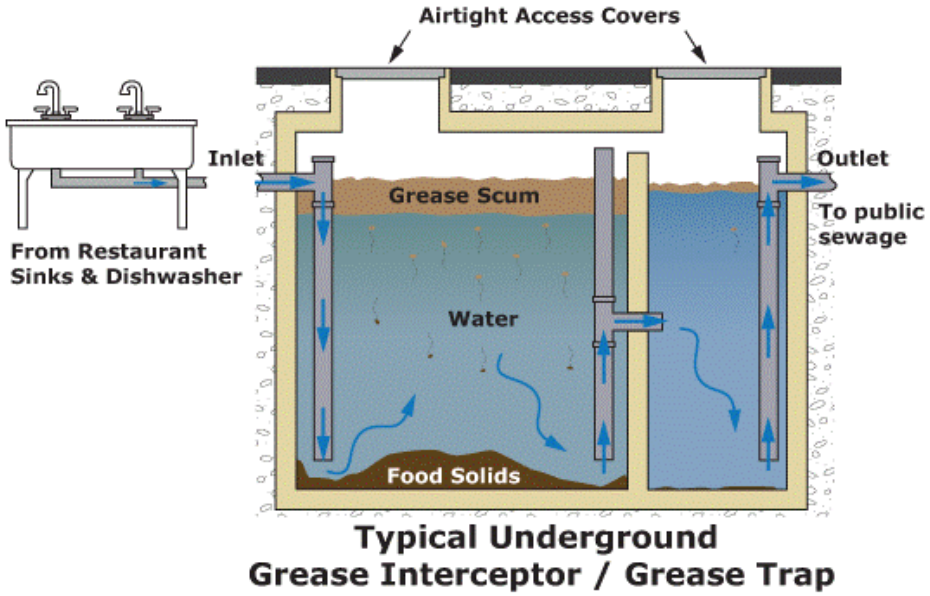
Water Filter

Effluent Treatment

Oil Separator

Neutralizing tank

Receive, dilute and neutralize concentrated corrosive and harmful chemical waste before discharging into the public sewer.



Typical Underground
Grease Interceptor / Grease Trap

Grease Interceptor

Tube Well

Containerized Filtration System

- Extract underground water from tube well and treat to min acceptable drinking water standard.

Parameter	Group	RECOMMENDED RAW WATER QUALITY	DRINKING WATER QUALITY STANDARDS
		Acceptable Value (mg/litre (unless otherwise stated))	Maximum Acceptable Value (mg/litre (unless otherwise stated))
Total Coliform	1	5000 MPN / 100 ml	0 in 100 ml
E.coli	1	5000 MPN / 100 m	0 in 100 m
Turbidity	1	1000 NTU	5 NTU
Color	1	300 TCU	15 TCU
pH	1	5.5 - 9.0	6.5 - 9.0
Free Residual Chlorine	1	-	0.2 - 5.0
Combined Chlorine	1	-	Not Less Than 1.0
Temperature	1	-	-
Clostridium perfringens (including spores)	1	-	Absent
Coliform bacteria	1	-	-
Colony count 22°	1	-	-
Conductivity	1	-	-
Enterococci	1	-	-
Odour	1	-	-
Taste	1	-	-
Oxidisability	1	-	-
Total Dissolved Solids	2	1500	1000
Chloride	2	250	250
Ammonia	2	1.5	1.5
Nitrat	2	10	10
Ferum/Iron	2	1.0	0.3
Fluoride	2	1.5	0.4 - 0.6
Hardness	2	500	500
Aluminium	2	-	0.2
Manganese	2	0.2	0.1
Chemical Oxygen Demand	2	10	-

6 CLEAN WATER AND SANITATION

The Targets

- Target 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

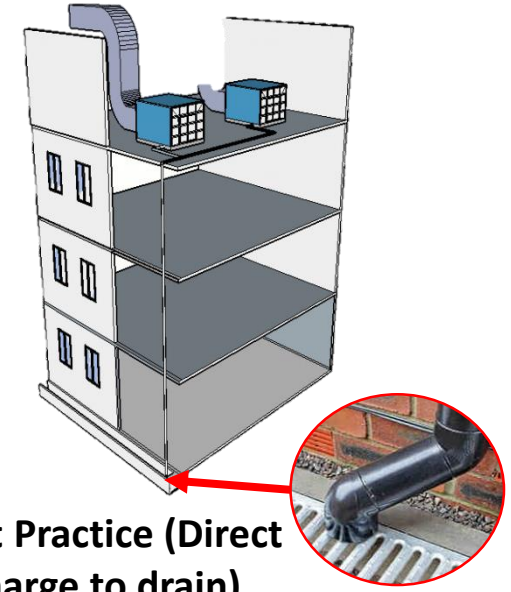
    - Change in water-use efficiency over time.
    - Level of water stress: freshwater withdrawal as a proportion of available freshwater resources.

Mechanical Systems

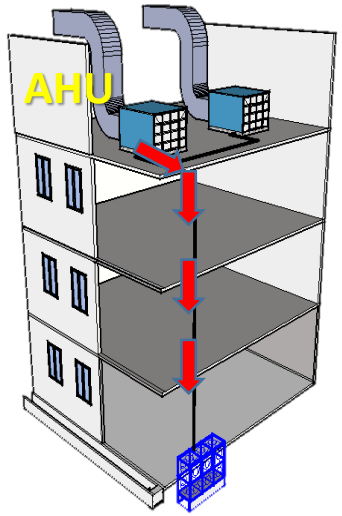
- Recycling Water i.e condensate water reclaim, fire water recycling
- Water efficiency

Condensate Water Reclaim

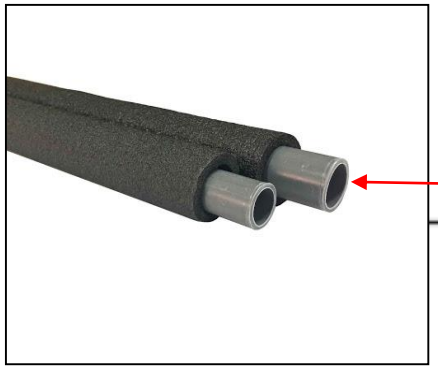
6 CLEAN WATER AND SANITATION

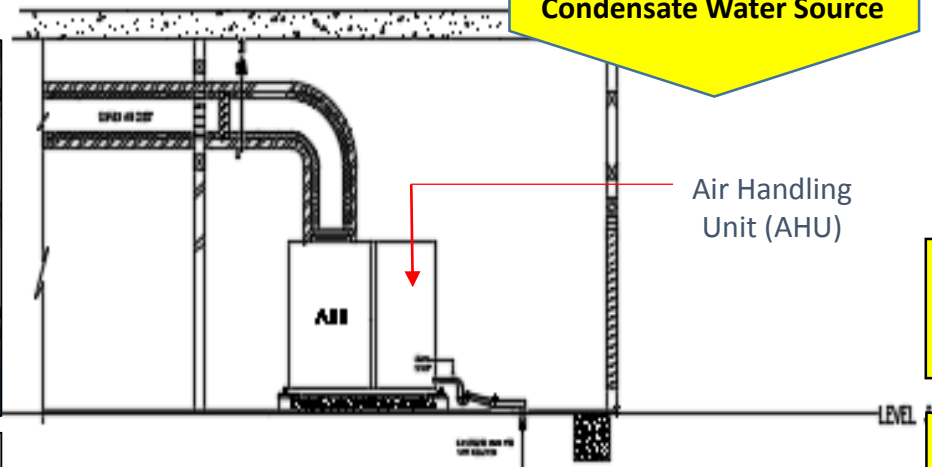


Current Practice (Direct discharge to drain)



Condensate Water Source





PVC Drain Pipe

Condensate Water Storage Tank

1 **Condensate Water Collection**

2 **Feeder pipe**

3 **Condensate Water Storage**

Water Efficient Fittings

- WEPLS is a voluntary Water Efficient Product Labelling Scheme initiated by SPAN to register and label water efficient products according to the guidelines set by SPAN.

- Five (5) types of products are covered under WEPLS, namely water taps which include basin tap, sink tap, shower tap and ablution tap, water closet, urinal equipment, shower heads and clothes washing machine.

Basin taps and mixers

Water Consumption *nominal flow rates* (*ƒ*) (l/min)	**Water Efficiency Grade**	**Rating**	**Symbol on Label**
6.0 < *ƒ* ≤ 8.0	Efficient	1	★
4.0 < *ƒ* ≤ 6.0	Highly Efficient	2	★ ★
1.5 < *ƒ* ≤ 4.0	Most Efficient	3	★ ★ ★

Score included in MyCREST and GBI

Use of most efficient fittings can reduce up to 58% of water and carbon emission

"Ensure access to affordable, reliable, sustainable and modern energy for all"

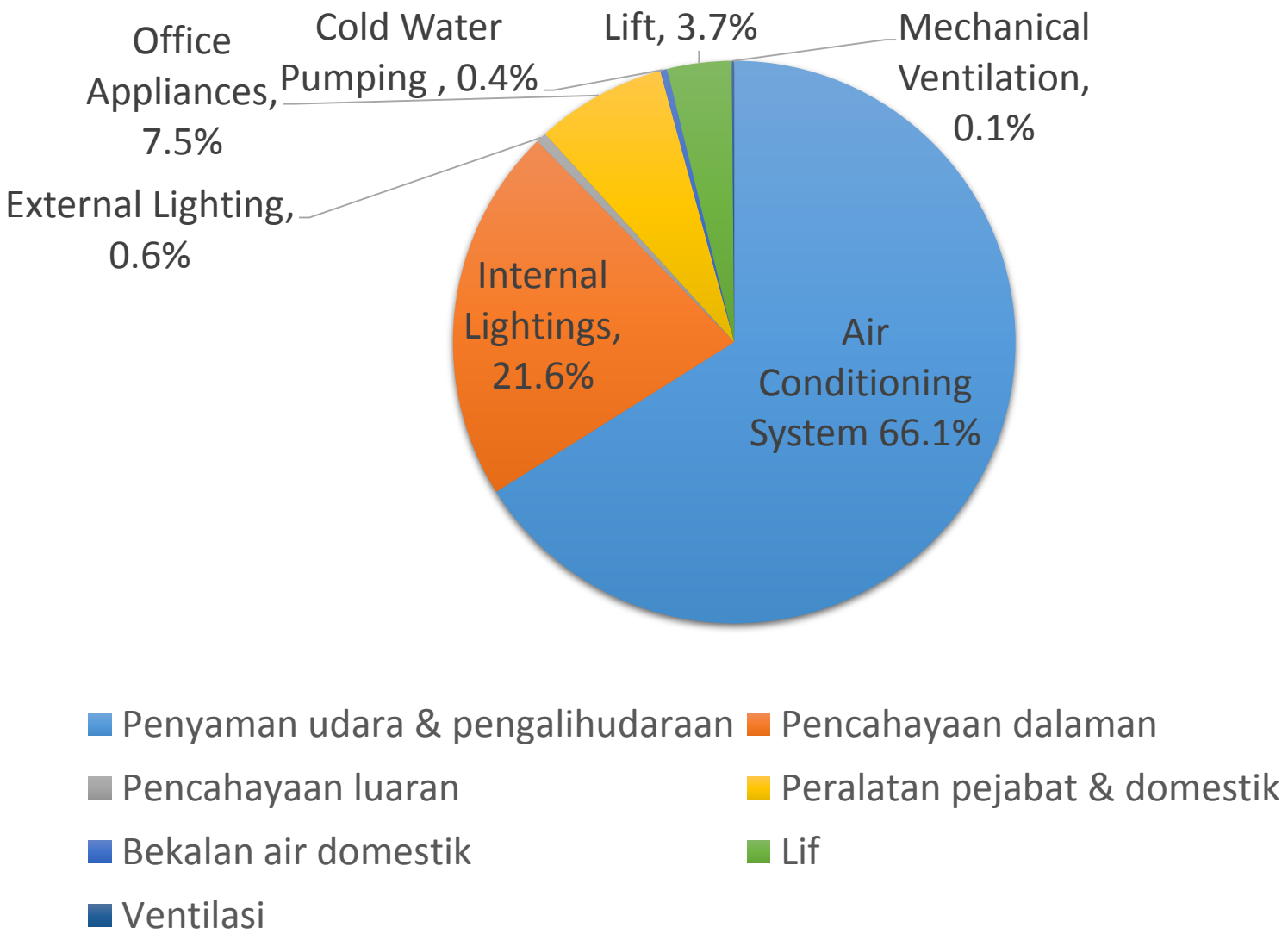
The Targets

- Target 7.1: By 2030, ensure universal access to affordable, reliable and modern energy services.
  - Proportion of population with primary reliance on clean fuels and technology.
- Target 7.2: By 2030, increase substantially the share of renewable energy in the global energy mix.
  - Renewable energy share in the total final energy consumption
- Target 7.3: By 2030, double the global rate of improvement in energy efficiency
  - Energy intensity measured in terms of primary energy and GDP

Mechanical Systems

- Solar Hot Water Collector
- Thermal Chiller
- Waste Heat Reclaim
- Energy Efficient Design and technologies

Building Typical Energy Apportioning



Source: JKR Block F, Energy Audit Report

Energy Efficient Design Principles

- Improve efficiency (energy conversion)
- Conserve energy (usage)
- Utilize renewable energy
- Within boundaries of reasonable economics, safety and health

Use energy only WHEN required at RIGHT amount and with the most efficient equipment

Solar Energy Utilization

- Collect solar heat from solar radiation up to 90^0C.
- Use for hot water heating or solar air conditioning.

Absorption chiller

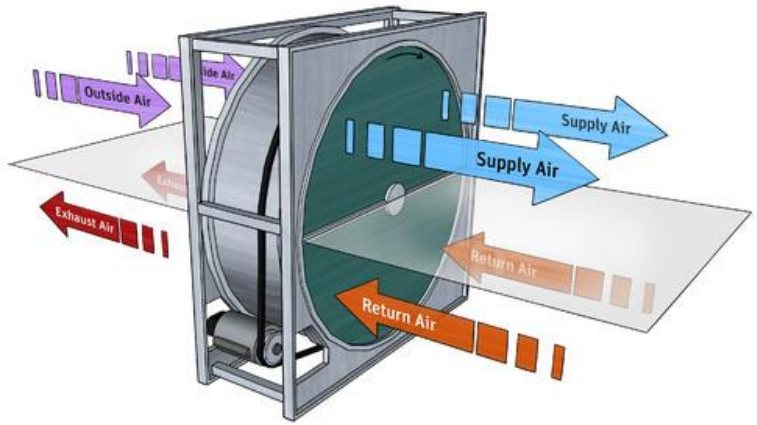
Solar evacuated tube

Single-stage chillers need heat with a minimum temperature of 80°C. Double-stage absorption chillers are more efficient, but need a higher-grade heat, generally above 140°C. The sources of heat can be various; for example: Hot water (80-100°C)

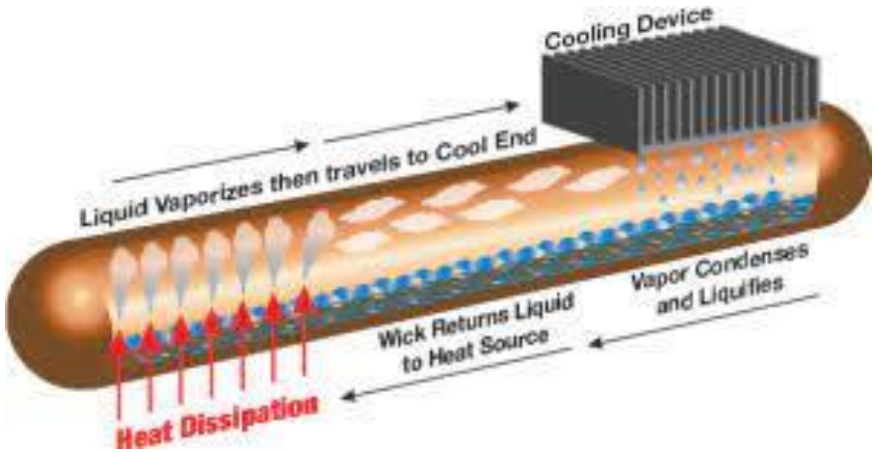
Waste Heat Reclaim

7 AFFORDABLE AND CLEAN ENERGY

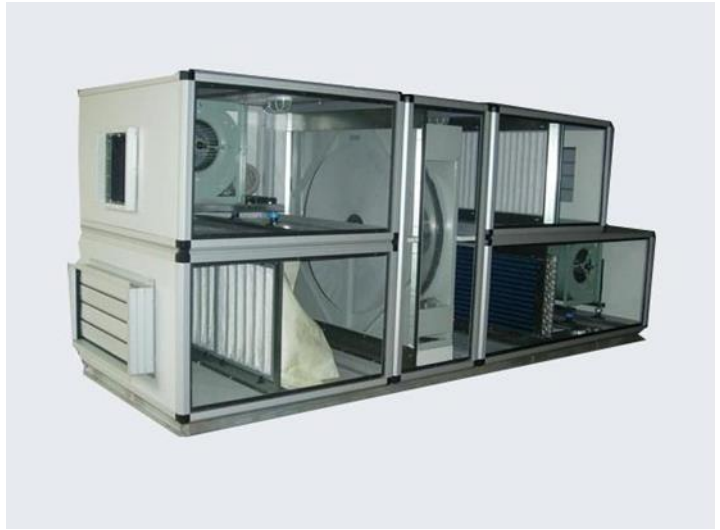
Enthalpy Wheel (sensible and latent)



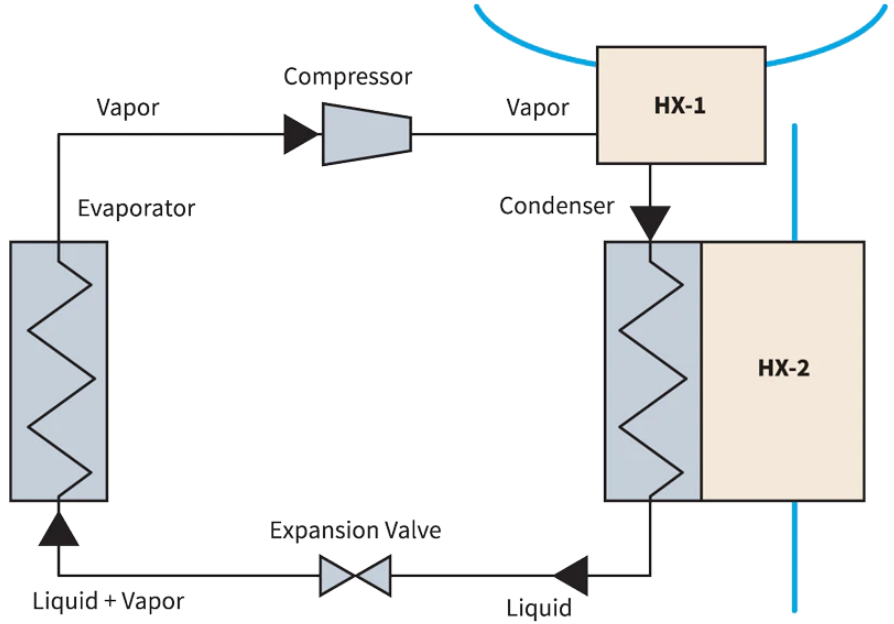
Capacity reduction of AHU up to 65%



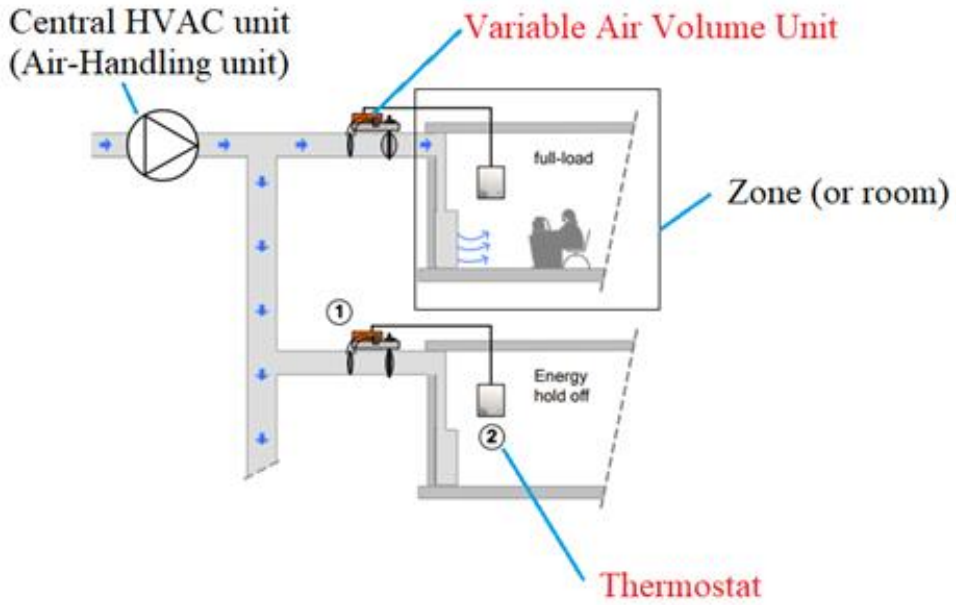
Heat Pipe system (sensible only)



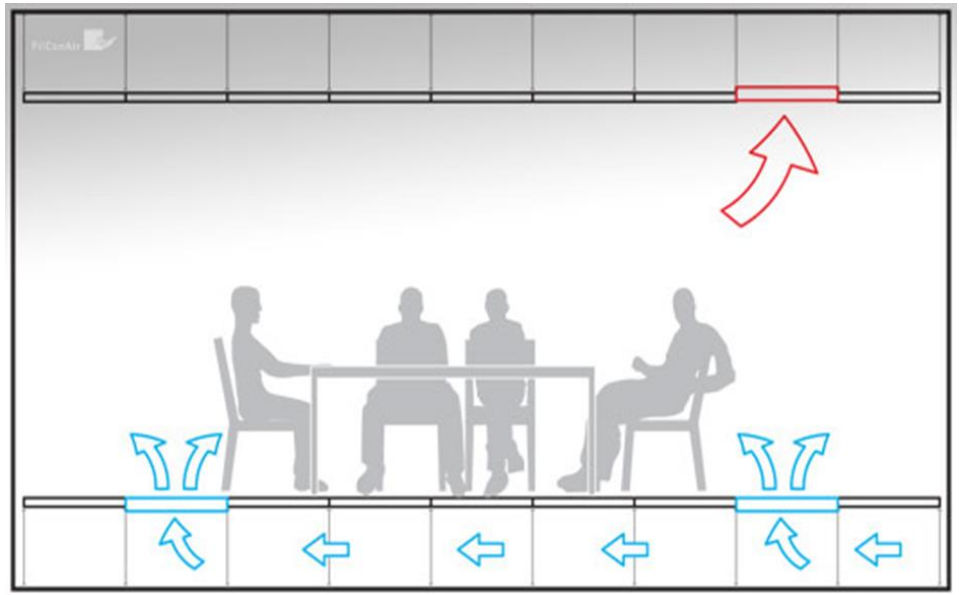
Condenser Heat Reclaim



Energy Efficient Design and Technologies



Variable Air Volume System



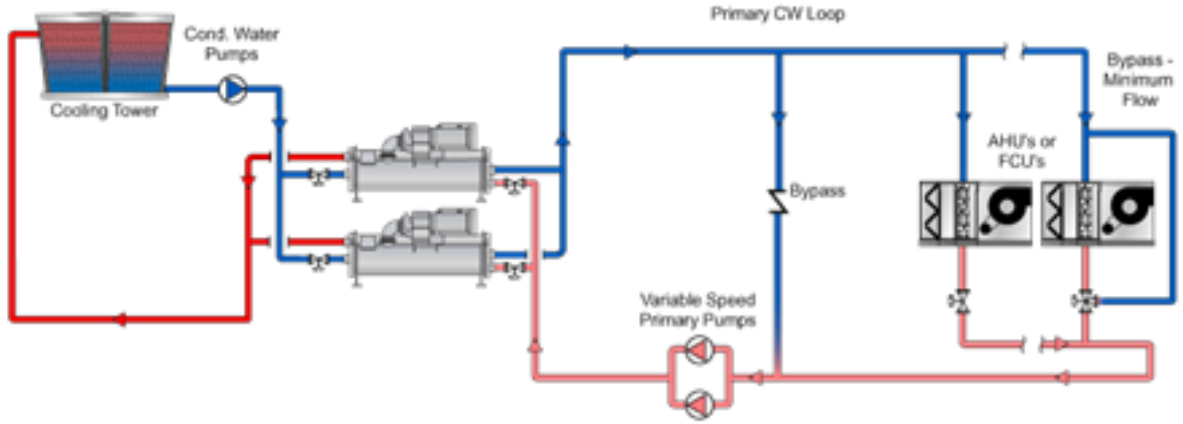
Underfloor Air Distribution System

Energy Efficient Design and Technologies

Energy saving up to 20% compared to typical centrifugal fan

More reduction of chilled water pumping power

Water Cooled Chilled Water Plant
-Variable Primary Flow



Variable Primary Flow System

EC Plug fan

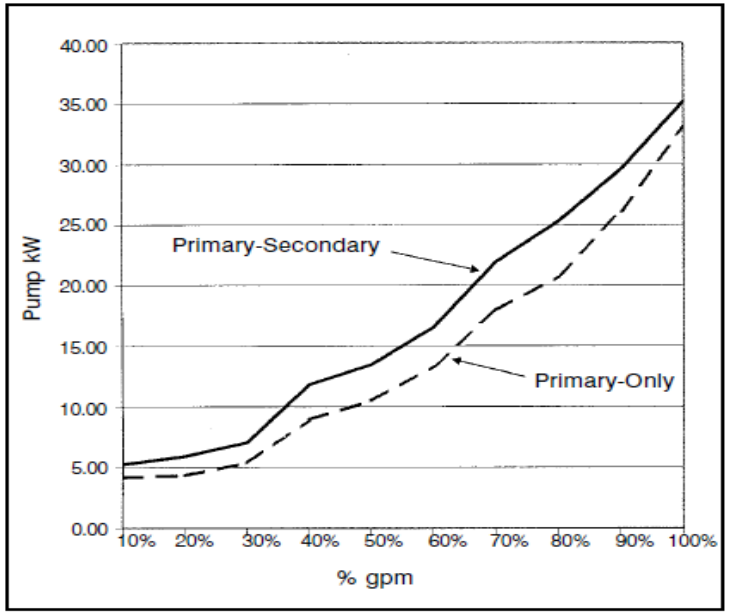


Figure 3: Pump energy for primary-only and primary-secondary systems in three chiller plants.†

"Ensure sustainable consumption and production patterns"

The Targets

- Target 12.7: Promote public procurement practices that are sustainable, in accordance with national policies and priorities.
  - Degree of sustainable public procurement policies and action plan implementation

Mechanical Systems

- Green Specification
  - MS 1525:2019
  - Motor Efficiency (IEC 60034-30-1:2014 for)

MS 1525:2019

Table 25. Water chilling packages, electrically driven: Chiller energy performance rating

Equipment	Size	aCOP @ 100% Load at Malaysian test condition		cMPLV at Malaysian standard condition		bCOP at 100% Load at Standard AHRI test conditions		dIPLV at AHRI standard conditions	
		Min COP	Max kWe/RT	Min COP	Max kWe/RT	Min COP	Max kWe/RT	Min COP	Max kWe/RT
Air cooled, with condenser	< 105 kWr (30RT)	2.93	1.20	3.36	1.05	2.93	1.20	3.84	0.92
	≥ 105 kWr and < 530 kWr (150RT)	2.93	1.20	3.36	1.05	2.93	1.20	3.84	0.92
	≥ 530 kWr and < 1060 kWr (300RT)	2.93	1.20	3.52	1.00	2.93	1.20	3.93	0.90
	≥ 1060 kWr (300RT)	2.93	1.20	3.52	1.00	2.93	1.20	3.93	0.90
Water cooled, positive displacement (reciprocating, scroll, rotary and screw)	< 260 kWr (75RT)	4.56	0.77	4.35	0.81	4.74	0.74	5.86	0.60
	≥ 260 kWr and < 530 kWr (150RT)	4.56	0.77	4.35	0.81	4.74	0.74	5.95	0.59
	≥ 530 kWr and < 1060 kWr (300RT)	5.20	0.68	4.67	0.75	5.43	0.65	6.36	0.55
	≥ 1060 kWr (300RT)	5.68	0.62	5.06	0.69	5.95	0.59	6.84	0.51
Water cooled, centrifugal	< 1060 kWr (300RT)	5.60	0.63	5.27	0.67	5.86	0.60	6.15	0.57
	≥ 1060 kWr and < 2110 kWr (600RT)	6.15	0.57	5.68	0.62	6.36	0.55	6.71	0.52
	≥ 2110 kWr (600RT)	6.26	0.56	5.86	0.60	6.48	0.54	6.84	0.51

Footnotes

[a] Tested at Malaysian chilled water and condenser water temperatures as per Table 25. Chillers without condensers can be rated with matching condensers and comply with the chiller efficiency requirements.

[b] Tested at AHRI leaving chilled water temperature of 44 °F at 2.4 USGPM per tonne, and entering condenser water temperature of 85 °F at 3 USGPM per tonne.

[c] MPLV denotes Malaysia Part Load Value which is a single part load efficiency figure of merit calculated per method described in MS 2449 at Malaysia Standard Rating Conditions, where for part-load Entering Condenser Water Temperatures (ECWT), the temperature should vary linearly from the selected ECWT at 100 % load to 26.67 °C (80 °F) at 50 % load and fixed at 26.67 °C (80 °F) for 50 % to 0 % load, and is defined by the following formula:

(For part-load entering air dry bulb temperatures, the temperature should vary linearly from selected EDB at 100 % load to 25.55 °C (78 °F) at 33 % load and fixed at 25.55 °C (78 °F) for 33 % to 0 % loads).

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Incorporated in Standard CKM Specification

Extracted from MS1525:2019

Motor Efficiency

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Annex B
(informative)

Minimum efficiency values defined in IEC 60034-30-1:2014 for 50 Hz motors (based on test methods specified in IEC 60034-2-1:2014)

Table B1. Minimum efficiency values defined in IEC 60034-30-1:2014 for 50 Hz motors

P_N	2 pole				4 pole				6 pole				8 pole			
(kW)	IE1	IE2	IE3	IE4	IE1	IE2	IE3	IE4	IE1	IE2	IE3	IE4	IE1	IE2	IE3	IE4
0.12	45.0	53.6	60.8	66.5	50.0	59.1	64.8	69.8	38.3	59.1	57.7	64.9	31.0	39.8	50.7	62.3
0.18	52.8	60.4	65.9	70.8	57.0	64.7	69.9	74.7	45.5	64.7	63.9	70.1	38.0	45.9	58.7	67.2
0.20	54.6	61.9	67.2	71.9	58.5	65.9	71.1	75.8	47.6	65.9	65.4	71.4	39.7	47.4	60.6	68.4
0.25	58.2	64.8	69.7	74.3	61.5	68.5	73.5	77.9	52.1	68.5	68.6	74.1	43.4	50.6	64.1	70.8
0.37	63.9	69.5	73.8	79.1	66.0	72.7	77.3	81.1	59.7	72.7	73.5	78.0	49.7	56.1	69.3	74.3
0.40	64.9	70.4	74.6	78.9	66.8	73.5	78.0	81.7	61.1	73.5	74.4	78.7	50.9	57.2	70.1	74.9
0.55	69.0	74.1	77.8	81.5	70.0	77.1	80.8	83.9	65.8	77.1	77.2	80.9	56.1	61.7	73.0	77.0
0.75	72.1	77.4	80.7	83.5	72.1	79.6	82.5	85.7	70.0	79.6	78.9	82.7	61.2	66.2	75.0	78.4
1.10	75.0	79.6	82.7	85.2	75.0	81.4	84.1	87.2	72.9	81.4	81.0	84.5	66.5	70.8	77.7	80.8
1.50	77.2	81.3	84.2	86.5	77.2	82.8	85.3	88.2	75.2	82.8	82.5	85.9	70.2	74.1	79.7	82.6
2.20	79.7	83.2	85.9	88.0	79.7	84.3	86.7	89.5	77.7	84.3	84.3	87.4	74.2	77.6	81.9	84.5

Incorporated in Standard CKM Specification (Min IE3 or IE4 depending on application)

Extracted from MS1525:2019

"Take urgent action to combat climate change and its impacts"

The Targets

- Target 13.2: Integrate climate change measures into national policies, strategies and planning.
  - Total greenhouse gas emissions per year.

Mechanical System

- Use of Renewable Energy
- Energy Efficient Design & Technologies
- Products with low carbon foot print
- Low Global Warming Potential (GWP) and Zero Ozone Depletion Potential (ODP)

Cost effectiveness

- Life cycle cost vs Capital Expenditure

Open vs close technical specification

- New technologies vs common matured technologies.

New technologies reliability issue

- Followers or leaders?

Market Leader

- Opportunity to be market leader given the scale of projects undertaken by JKR.

Conclusion

Mechanical systems in building play an important roles in achieving Global Sustainability Development Goals from health & well being to tackling of climate change.

Abundant of opportunities in sustainable mechanical design for buildings.

Challenges are always there but “smooth seas do not make skillful sailors”.

Regards, Ir. Dr Mohamed Azly Abdul Aziz, Cawangan Kejuruteraan Mekanikal