MEP DESIGN APPROACH FOR HEALTHCARE FACILITIES

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MEP DESIGN FOR HEALTHCARE FACILITIES

AGENDA

1. Design Approach
2. Redundancy and Reliability
3. Sustainability
4. Case Studies

1. Design Approach

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1. Design Approach

a. MEP Design Guide for Healthcare Facilities

b. MEP Design Guide for the Development of Nursing Homes

c. MEP Design Guide for the Development of Polyclinics

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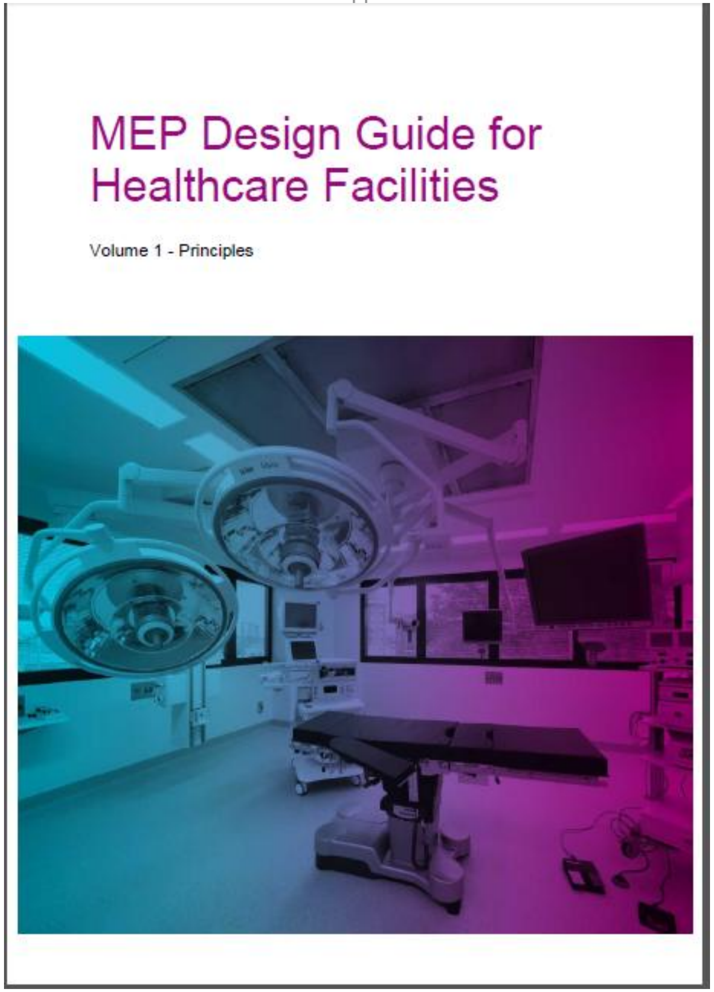
MEP DESIGN FOR HEALTHCARE FACILITIES

1. Design Approach

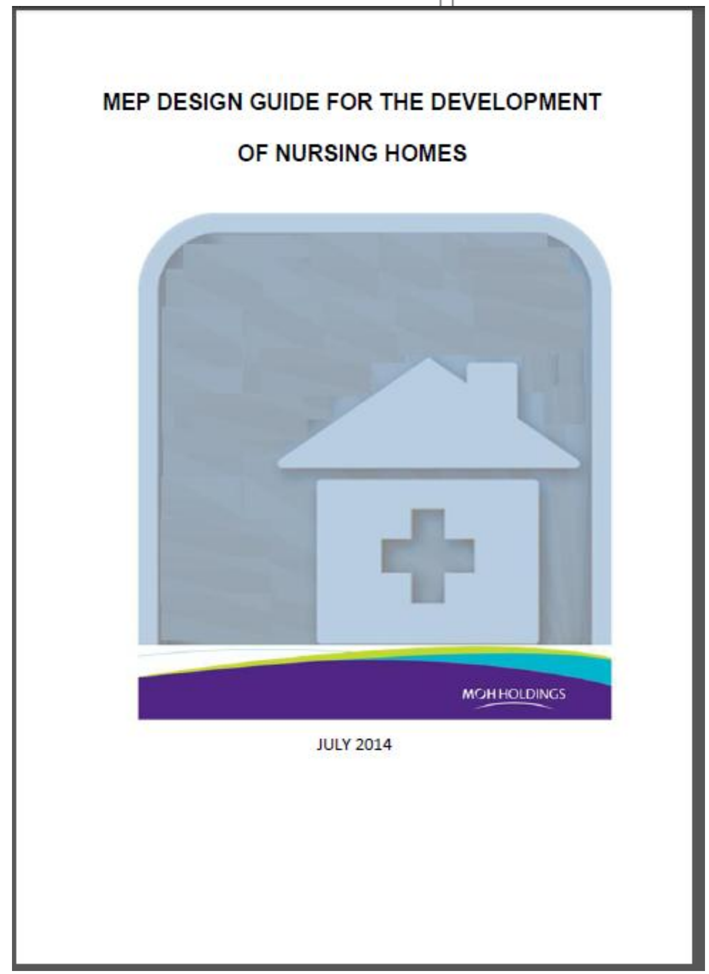
a. MEP Design Guide for Healthcare Facilities



MEP DESIGN FOR HEALTHCARE FACILITIES

1. Design Approach

b. MEP Design Guide for the Development of Nursing Homes


MEP DESIGN GUIDE FOR THE DEVELOPMENT OF NURSING HOMES

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MEP DESIGN FOR HEALTHCARE FACILITIES

1. Design Approach

c. MEP Design Guide for the Development of Polyclinics

MEP DESIGN GUIDE FOR THE DEVELOPMENT OF POLYCLINICS

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1. Design Approach

1.1. DESIGN INPUTS

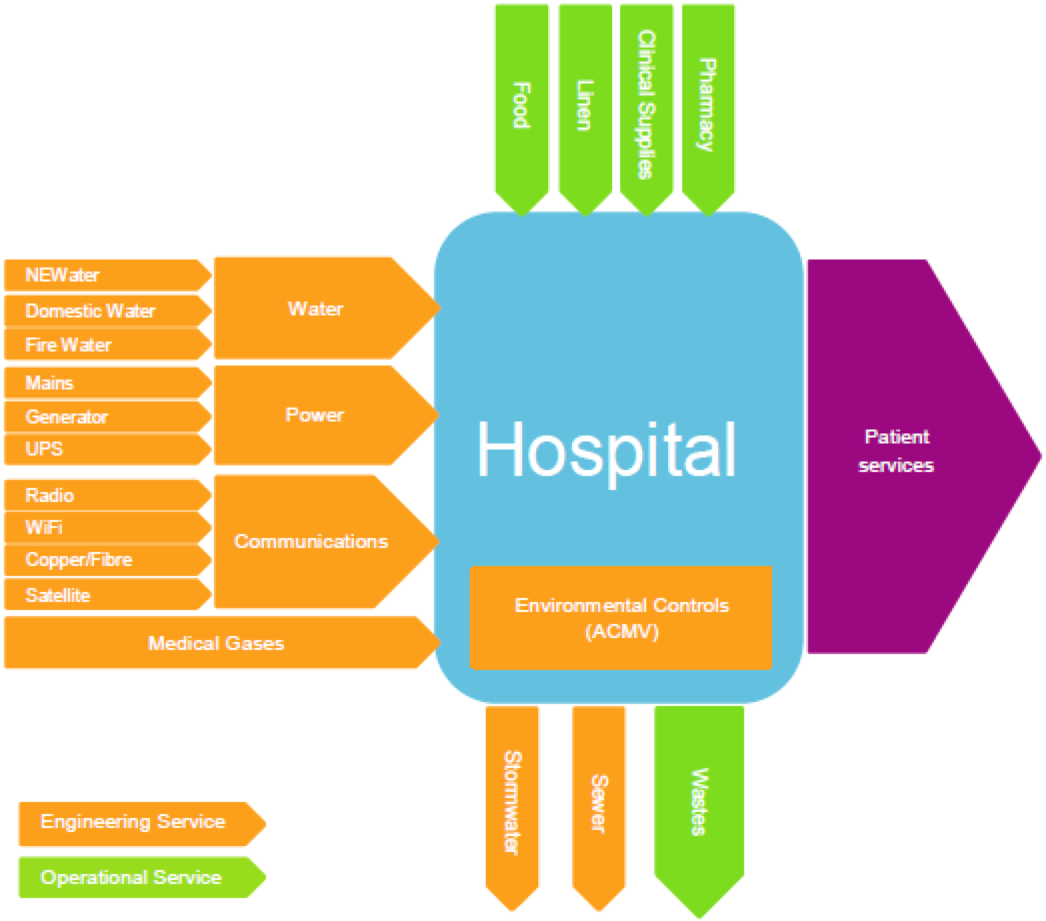
- Project Size
- Facility Risk Profile
- Civil Emergency and National Emergency Operation & Recovery Roles
- Redundancy and Reliability
- Sustainability

MEP DESIGN FOR HEALTHCARE FACILITIES

1. Design Approach

1.2. Design Integrations

Communications between all stake holders ; designers, users and operators are critical for a successful and effective development



Develop INTERFACE CONTROL DATA DOCUMENT (ICDD)

MEP DESIGN FOR HEALTHCARE FACILITIES

1. Design Approach

1.2. Design Integrations

Develop INTERFACE CONTROL DATA DOCUMENT (ICDD)

System	ACMV	Fire Protection	Plumbing & Sanitary	Medical Gas	Lift & Escalator	Power	Lighting	Earthing	Communication	Security	Audio Visual	Carparking	Architectural -SAA/PW/ID	C&S - TYLin	CSSD - I+O	Kitchen - I+O	Auto Guided Veh - I+O	Pneumatic Tube - I+O	Pneumatic Chute - I+O	Landscape/Irrigation - ICN	Facade -Arup	Signages/Wayfind -UDS	MSI - IHIS
ACMV		o	o	o	o	o	x	o	o	x	o	x	o	o	o	o	o	o	o	x	o	x	o
Fire Protection	o		o	o	o	o	x	o	o	o	o	x	o	o	o	o	x	o	o	x	x	x	x
Plumbing & Sanitary	o	o		x	x	o	x	o	x	x	x	x	o	o	o	o	x	x	x	o	x	x	x
Medical Gas	o	o	x		x	o	x	o	x	x	x	x	o	o	x	x	x	x	x	x	x	x	x
Lift & Escalator	o	o	x	x		o	o	o	o	x	x	x	o	o	x	x	o	x	x	x	x	x	x
Power	o	o	o	o	o		o	o	o	o	o	o	o	o	o	o	o	o	o	x	x	o	x
Lighting	x	x	x	x	o	o		o	x	x	x	x	o	o	x	x	x	x	x	o	o	x	x
Earthing	o	o	o	o	o	o	o		o	o	o	o	o	o	o	o	o	o	o	x	o	o	x
Communication	o	o	x	x	o	o	x	o		x	x	x	o	o	x	x	x	x	x	x	x	x	x
Security	x	o	x	x	x	o	x	o	x		x	o	o	o	x	x	x	x	x	x	x	x	x
Audio Visual	o	o	x	x	x	o	x	o	x	x		x	o	o	x	x	x	x	x	x	x	x	x
Carparking	x	x	x	x	x	o	x	o	x	o	x		o	o	x	x	x	x	x	x	x	x	x
Architectural -SAA/PW/ID	o	o	o	o	o	o	o	o	o	o	o	o		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C&S - TYLin	o	o	o	o	o	o	o	o	o	o	o	o	NS		NS	NS	NS	NS	NS	NS	NS	NS	NS
CSSD - I+O	o	o	o	x	x	o	x	o	x	x	x	x	NS	NS		NS	NS	NS	NS	NS	NS	NS	NS
Kitchen - I+O	o	o	o	x	x	o	x	o	x	x	x	x	NS	NS	NS		NS	NS	NS	NS	NS	NS	NS
Auto Guided Veh - I+O	o	x	x	x	o	o	x	o	x	x	x	x	NS	NS	NS	NS		NS	NS	NS	NS	NS	NS
Pneumatic Tube - I+O	o	o	x	x	x	o	x	o	x	x	x	x	NS	NS	NS	NS	NS		NS	NS	NS	NS	NS
Pneumatic Chute - I+O	o	o	x	x	x	o	x	o	x	x	x	x	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS
Landscape/Irrigation - ICN	x	x	o	x	x	x	o	x	x	x	x	x	NS	NS	NS	NS	NS	NS	NS		NS	NS	NS
Facade -Arup	o	x	x	x	x	x	o	o	x	x	x	x	NS	NS	NS	NS	NS	NS	NS	NS		NS	NS
Signages/Wayfind -UDS	x	x	x	x	x	o	x	o	x	x	x	x	NS	NS	NS	NS	NS	NS	NS	NS	NS		NS
MSI - IHIS	o	x	x	x	x	x	x	x	x	x	x	x	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	

Note :

0 – Interface Required

x – Interface Not Required

NS – Not within scope of this IMP

1. Design Approach

1.3. Facility Risk Profile

- The importance of operation for the facility from a clinical and service delivery perspective

- The role of the facility during national emergencies

1. Design Approach

1.4. Civil Emergency and National Emergency Operation & Recovery Role

- Civil Emergency – Natural Disasters, Chemical, Biological and Radiological events (e.g. infectious disease outbreaks)
- National Emergency – War time operations

2. Redundancy and Reliability

2. Redundancy and Reliability

Redundancy levels are defined as:

N	Plant sufficient to meet maximum demand
N+R	Plant capable of continuing to meet maximum demand with R number of plant failures or maintenance activities. Ie. Components (N) with at least one independent backup component are said to be in an 'N+1' configuration.
N+N or 1+1	Fully independent duplicated systems, normally operating concurrently such that a failure event does not result in any interruption of service.

Consideration should be given for critical systems, and particularly infrastructure connected services, to the provision of N+N redundancy, giving fully redundant infrastructure connections. This includes services such as mains power, water, sewer and gas services. The loss of any one of these services has a very significant, potentially crippling, impact on the operation of the hospital. Redundant infrastructure connections and a risk analysis of the network redundancy of the infrastructure should be provided.

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2. Redundancy and Reliability

- Evaluate how the hospital engineering department response to an INTERNAL FAILURE event
- Redundancy components shall be determined based on risk assessments on major infrastructure systems, and would be based on the respective criticality of each system.

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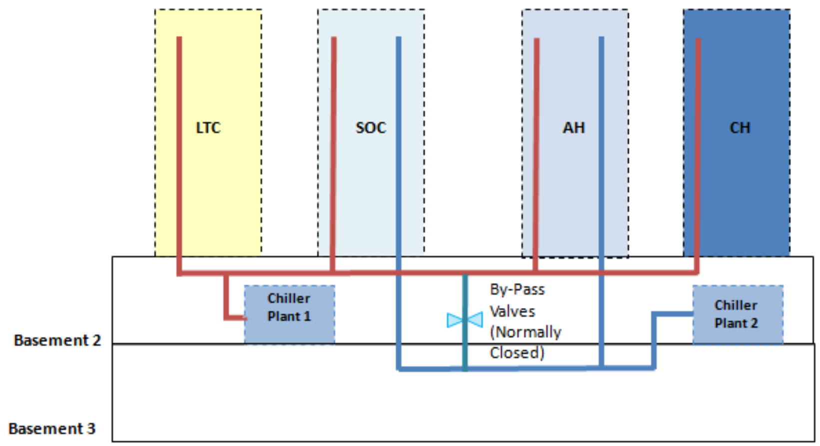
2. Redundancy and Reliability

- Criteria for Evaluation for “R’ component
    - Criticality of the Systems
    - Operation Regime of the Systems

2. Redundancy and Reliability



→ **Backup Provided for both Systems & Infrastructure**

- ✓ Resilience against unforeseen critical risks (e.g. air-conditioning or power failure) to better enhance healthcare **reliability and continuity**
- ✓ **Reduce** the **risk of losses** from service interruptions or operation failure
- ✓ **Reduce** the **need for major retrofits** in the event of system failure

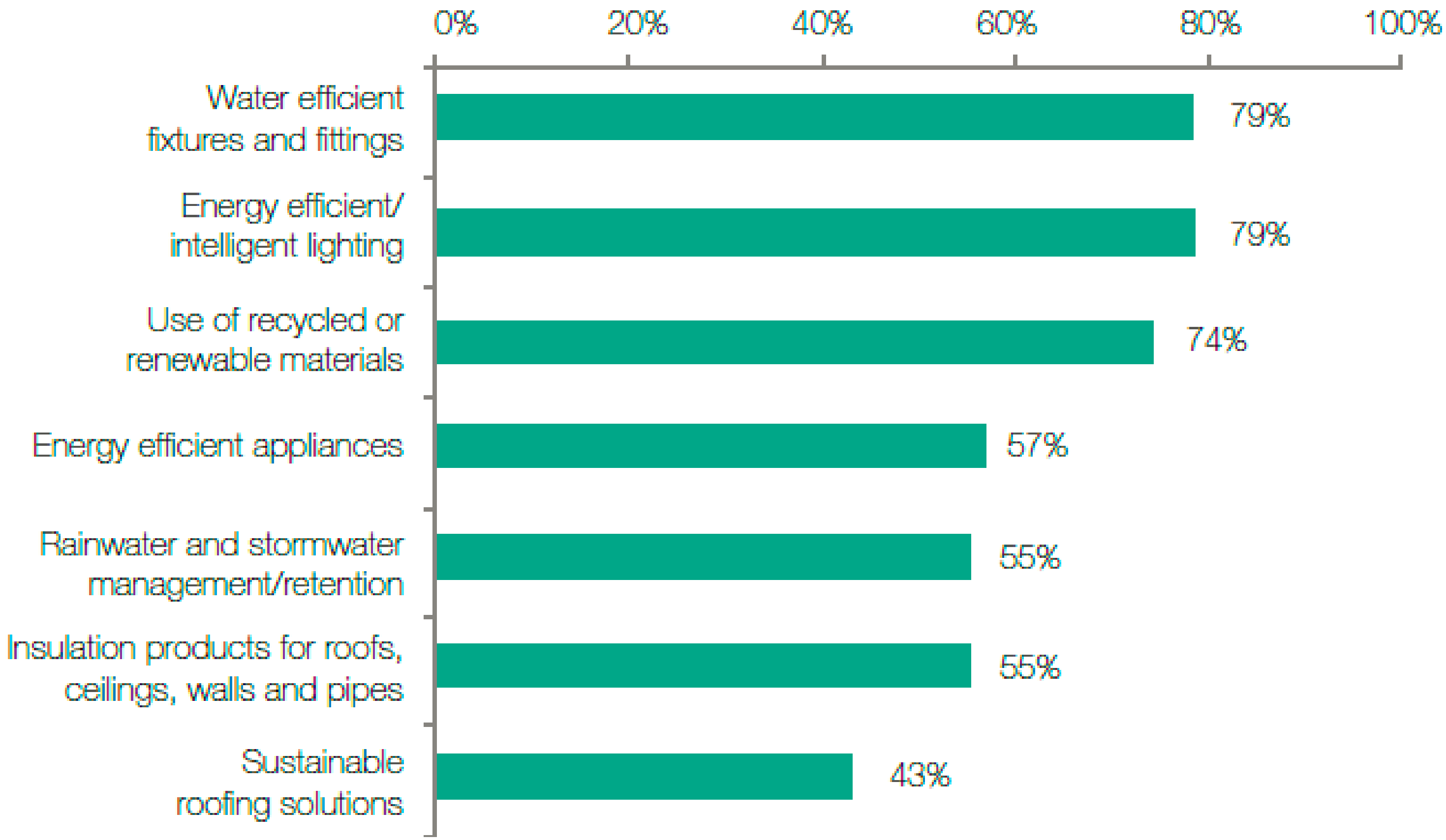
3. Sustainability

3. Sustainability

- BCA Greenmark Compliance
- Energy Performance – benchmarking against SS530, international standards; ASHRAE, LEED
- Water Consumption – efficient fixtures and fittings, flow restriction devices, design to minimise active water usage
- Building Construction – building orientations, shading, thermal mass, etc.

3. Sustainability

3.1. Survey on Technologies Employed in Green Building Projects (Singapore)



Source: BCI Economics, a division of BCI Media Group

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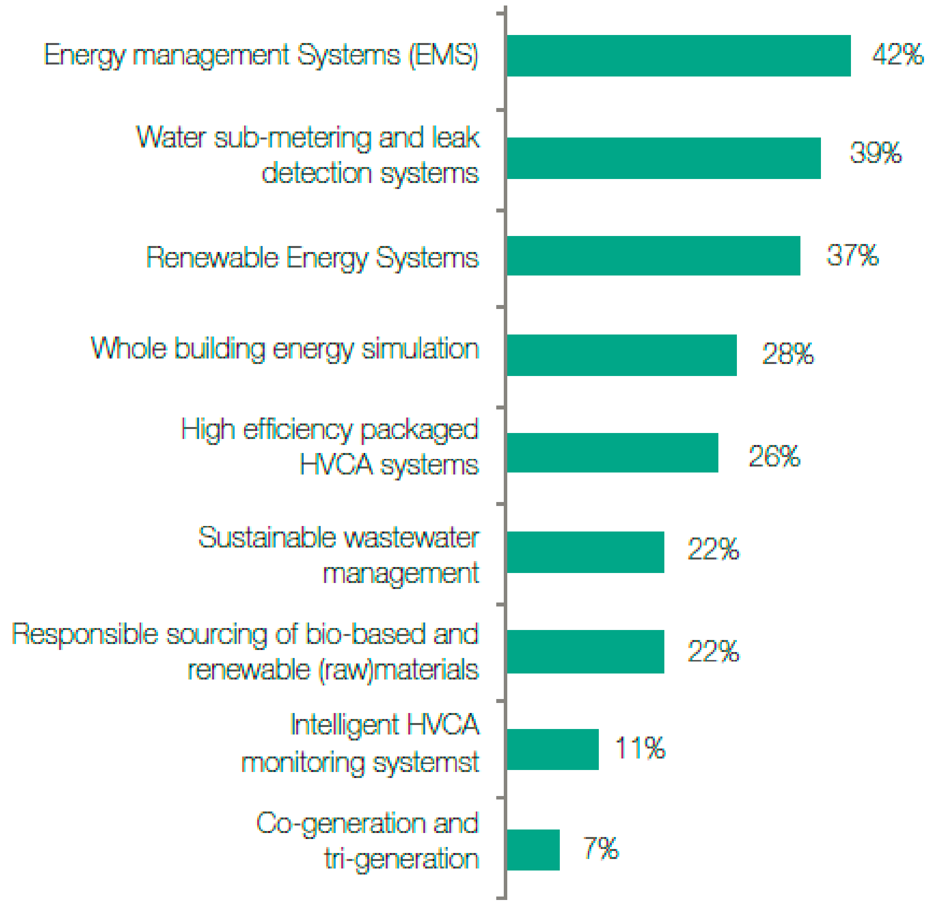
3. Sustainability

3.1. Survey on Technologies Employed in Green Building Projects (Singapore)



Source: BCI Economics, a division of BCI Media Group

3. Sustainability

3.1. Survey on Technologies Employed in Green Building Projects (Singapore)

	Non Residential Buildings - % of Green Cost Premium by Element (average)		
ELEMENT	Gold	Gold Plus	Platinum
Façade	24% of total Premium	30% of total Premium	30% of total Premium
Air-conditioning	16% of total Premium	17% of total Premium	20% of total Premium
Lighting	10% of total Premium	12% of total Premium	10% of total Premium
Landscape	1% of total Premium	4% of total Premium	10% of total Premium
Others (service enhancements)	50% of total Premium	37% of total Premium	30% of total Premium

Source: BCA BuildGreen Issue 04/2013

Source: BCI Economics, a division of BCI Media Group

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3. Sustainability - Examples

3.2. Survey on Green Features in Healthcare Facilities in Singapore – Project N (General Hospital)

- GFA = 180,597m2
- Overall Construction Cost (Builder + M&E) = $766 M
- No of Beds – 1100
- Total GM Cost = $28.1M ($28.3M)
- % GM cost = 3.67% (3.69)

Elements	Project Cost	BCA's published reference
Facade	46 % of premium	**30%**
Air-conditioning	29 % of premium	**20%**
Landscape	6 % of premium	**10%**
Lighting	0.4 % of premium	**10%**
Others(Service Enhancements)	18.6 % of premium	**30%**

MEP DESIGN FOR HEALTHCARE FACILITIES

3. Sustainability - Examples

3.2. Survey on Green Features in Healthcare Facilities in Singapore – Project Y (Community Hospital)

- GFA = 56,247 m2
- Overall Construction Cost (Builder+ M&E) = $205.5 M
- No. of Beds = 428
- Total GM cost = $ 2.14 M (*$ 3.6 M)
- % GM Cost = 1 % (*1.8 %)

Elements	Project Cost	**BCA's published reference**
Facade	- % of premium	**30%**
Air-conditioning	5 % of premium	**20%**
Landscape	- % of premium	**10%**
Lighting	- % of premium	**10%**
Others(Service Enhancements)	95 % of premium	**30%**

3. Sustainability

3.2. Survey on Green Features in Healthcare Facilities in Singapore – Project S (General Hospital)

- GFA = 288,000 m2
- Overall Construction Cost (Builder + M&E) = $1,620 M
- No. of Beds = 1400
- Total GM Cost = $3.72 M (*$14.2 M)
- % GM Cost = 0.23 % (*0.88 %)

Elements	Project Cost	BCA's reference cost
Facade	3 %of premium	**30%**
Air-conditioning	32 % of premium	**20%**
Landscape	- % of premium	**10%**
Lighting	8 % of premium	**10%**
Others(Service Enhancements)	57% of premium	**30%**

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3. Sustainability

3.2. Survey on Green Features in Healthcare Facilities in Singapore – Project NC (Specialist Hospital)

- GFA: 106,522.98 m2
- CFA: 192,812 m2
- Overall Construction Cost (Builder + M&E) = $603.75 M
- No. of beds = 330
- Total GM Cost = $5.26M ($ 8.06M)
- % GM Cost = 0.87% (1.3 %)

Elements	Project Cost	BCA's reference cost
Facade	47 %of premium	**30%**
Air-conditioning	16 % of premium	**20%**
Landscape	- % of premium	**10%**
Lighting	9 % of premium	**10%**
Others(Service Enhancements)	28 % of premium	**30%**

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3. Sustainability

3.2. Survey on Green Features in Healthcare Facilities in Singapore – Project O (Community Hospital)

- GFA: 148,000 m2
- Overall Construction Cost (Builder + M&E) = $ 721 M
- No. of Bed = 746
- Total GM Cost = $13.5 M ($18.5 M)
- % GM Cost = 1.9 % (2.6%)

Elements	Project Cost	**BCA's reference cost**
Facade	33 %of premium	**30%**
Air-conditioning	14 % of premium	**20%**
Landscape	- % of premium	**10%**
Lighting	34 % of premium	**10%**
Others(Service Enhancements)	19 % of premium	**30%**

3.3. OT Ventilation

INTEGRATED DEVELOPMENT OF GENERAL AND COMMUNITY HOSPITALS AND SPECIALIST OUTPATIENT CLINICS

Comparison of Energy Consumption between Re-circulation and 100% FA

	Normal Mode				Night Setback Mode			
	Total Cooling Load [A]	Energy Recovery [B]	Nett Cooling Load [A-B]	Fan Power	Total Cooling Load [C]	Energy Recovery [D]	Nett Cooling Load [C-D]	Fan Power
	(RT)	(RT)	(RT)	(KW)	(RT)	(RT)	(RT)	(KW)
100% Fresh Air Mode with heat recovery unit	48.3	27.3	21.0	9.05	22.5	11.0	11.5	9.05
Re-circulation Mode with heat recovery unit	24.1	13.1	11.0	9.05	22.5	11.0	11.5	9.05
100% Fresh Air w/o heat recovery unit	48.3	-	48.3	6.0	22.5	-	22.5	6.0

Note:
1. Chiller efficiency based on 0.63kW/ton.
2. Electricity consumption consists chiller load + fan load
3. Electrical tarrif for OT AHU based on 30days per month
4. Electrical tarrif based on 21cents per kWh.

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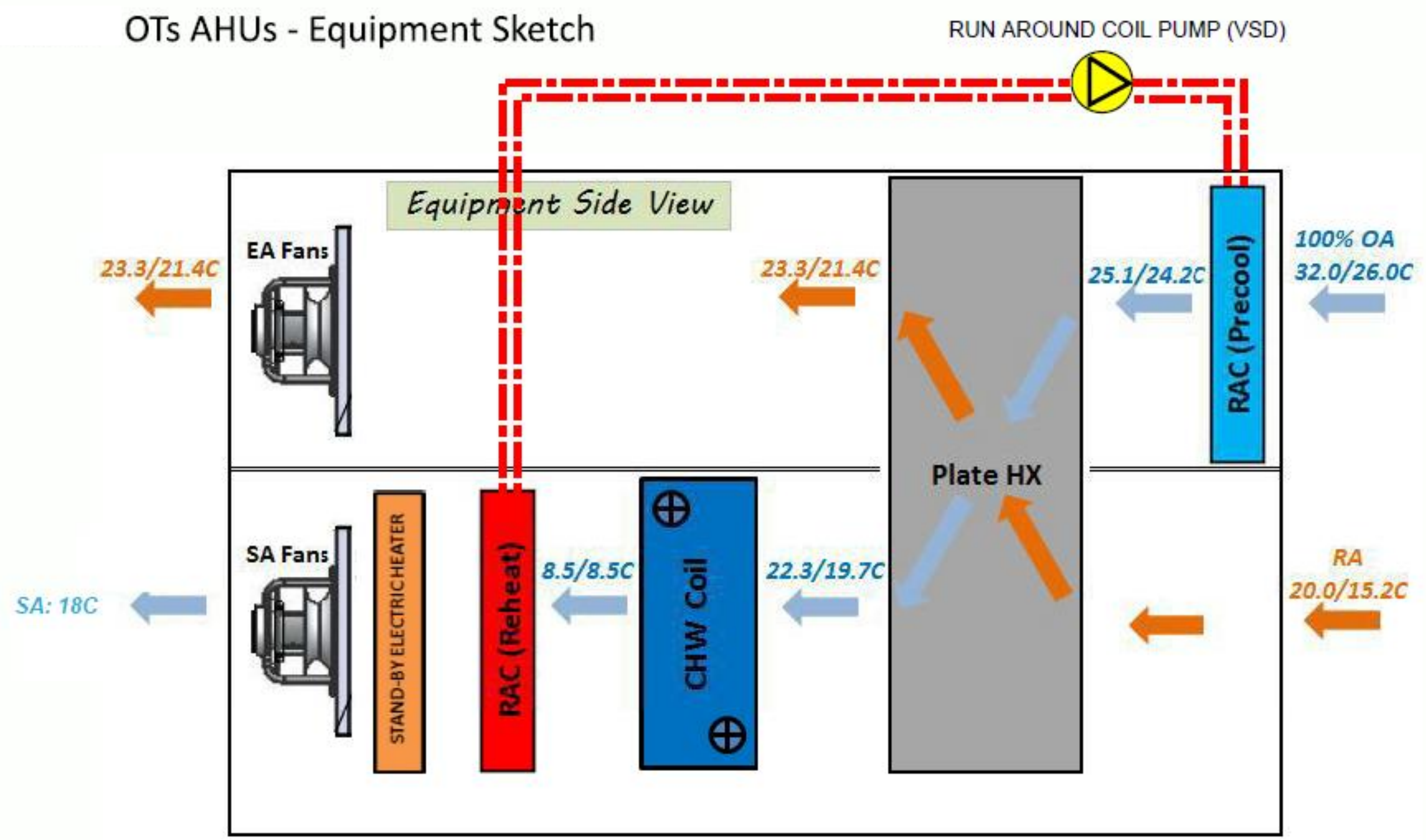
3.3. OT Ventilation



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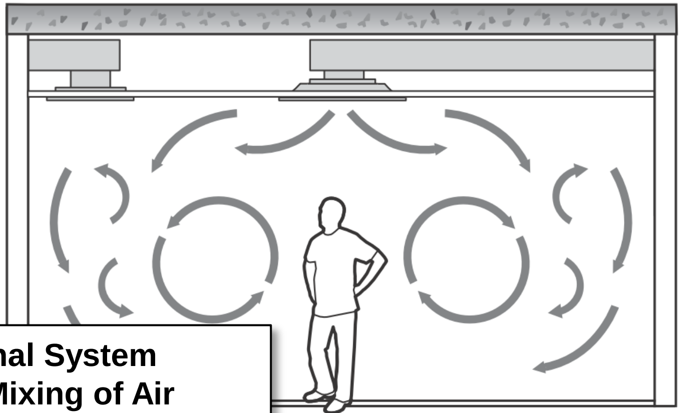
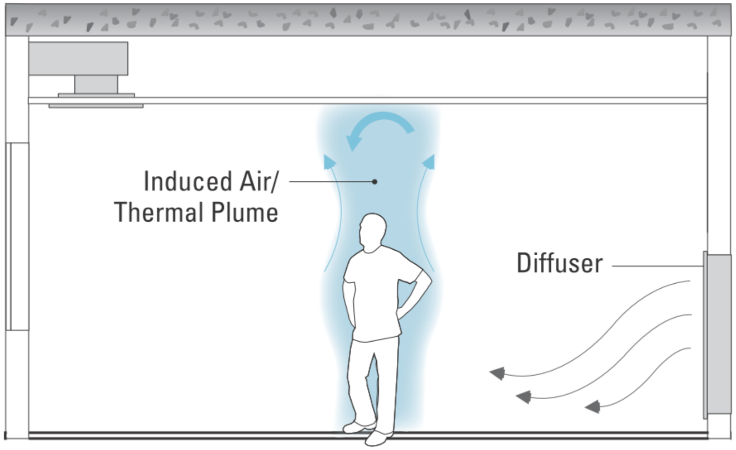
3.4. Displacement AC System



Conventional System
→ General Mixing of Air



→ Proposed Displacement Ventilation implantation in Training Rooms and Seminars Rooms

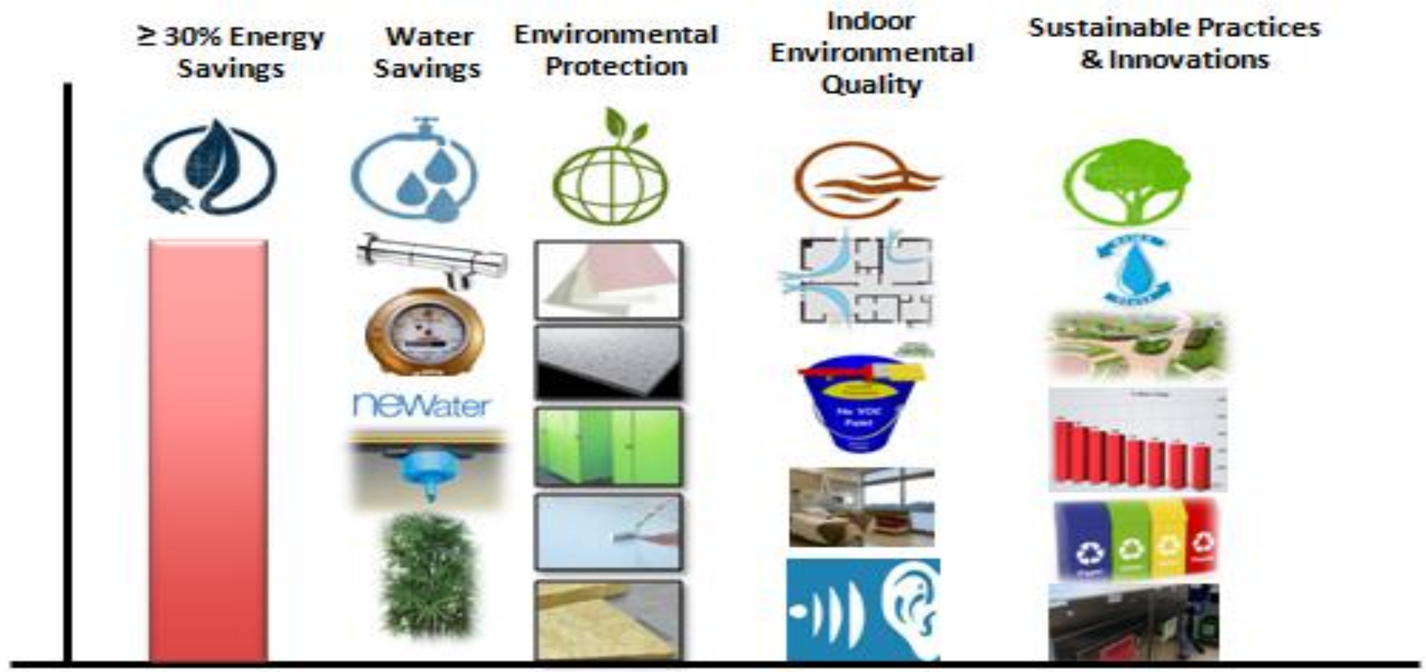
- ✓ Reduce Energy Consumption
- ✓ Lower maintenance due to lesser moving parts
- ✓ Quiet Operation

MEP DESIGN FOR HEALTHCARE FACILITIES

3.5. Design For Sustainability

BCA GREEN MARK

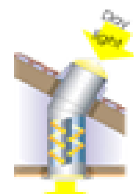
ASSIST TO FORM A HOLISTIC BASELINE REFERENCE FOR SUSTAINABLE HEALTHCARE FACILITIES



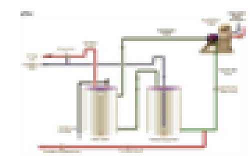
3.5. Design For Sustainability

TYPICAL HEALTHCARE OPERATION		POTENTIAL GREEN INITIATIVES/ INNOVATIVE FEATURES
ENERGY	• 24 hours operation • High Energy Consumption (e.g. steam and hot water demand for steam sterilization and cart washer)	Solar Photovoltaic System; Sunpipes; Heat Recovery from chilled water system
WATER	• 24 hours operation • High Water Consumption (e.g. sterilization, medical processes, washing etc)	Rainwater Harvesting for non-potable use.
WASTE	• High volume of solid waste generated (e.g. food waste etc)	Food Waste Recycling System

Solar Photovoltaic System

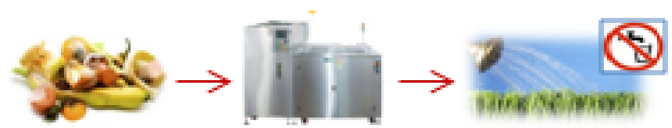


Sunpipes



Heat Recovery from chilled water system

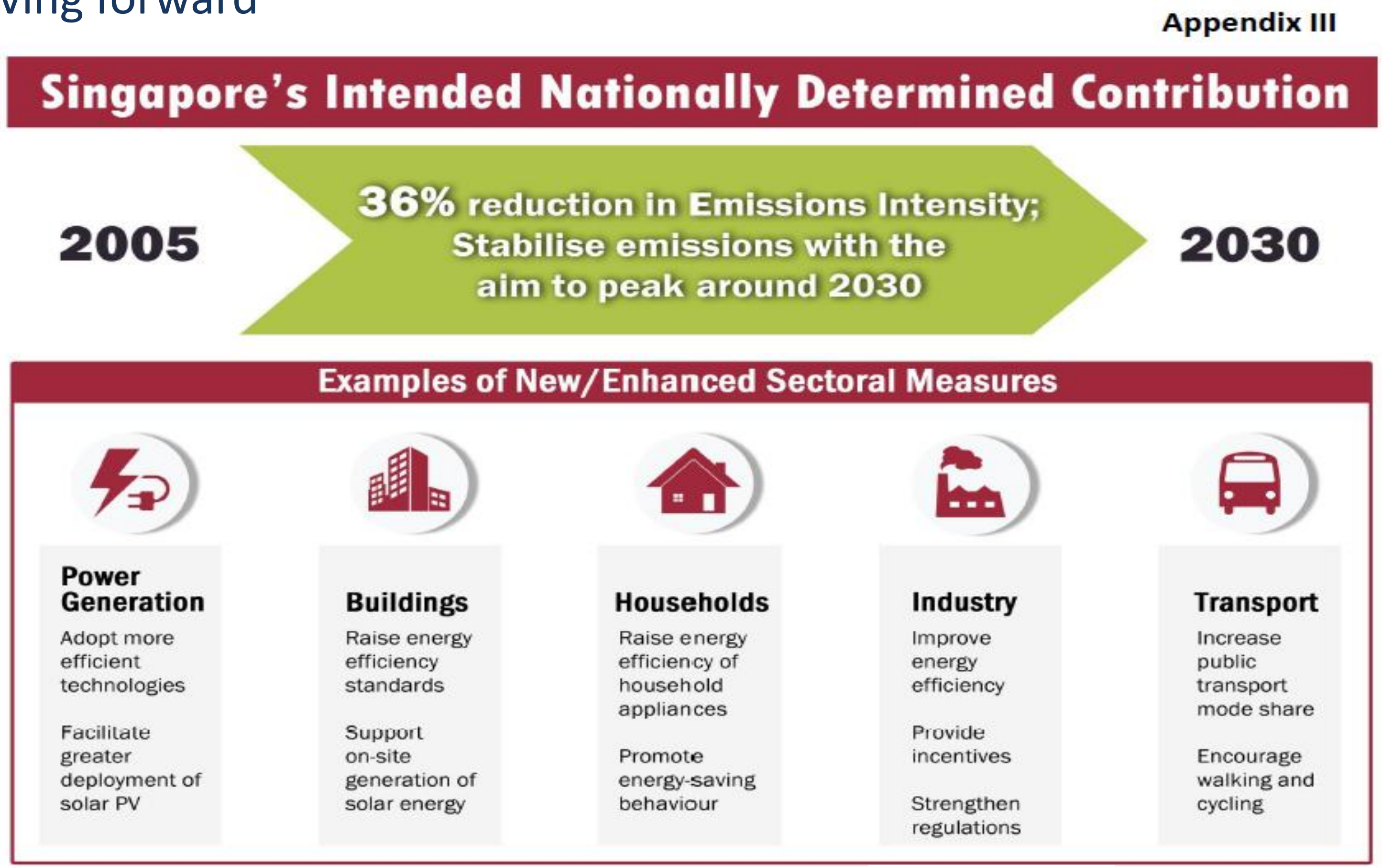
Rainwater Harvesting for non-potable use.



Food Waste Recycling System

3. Sustainability

3.6. Moving forward

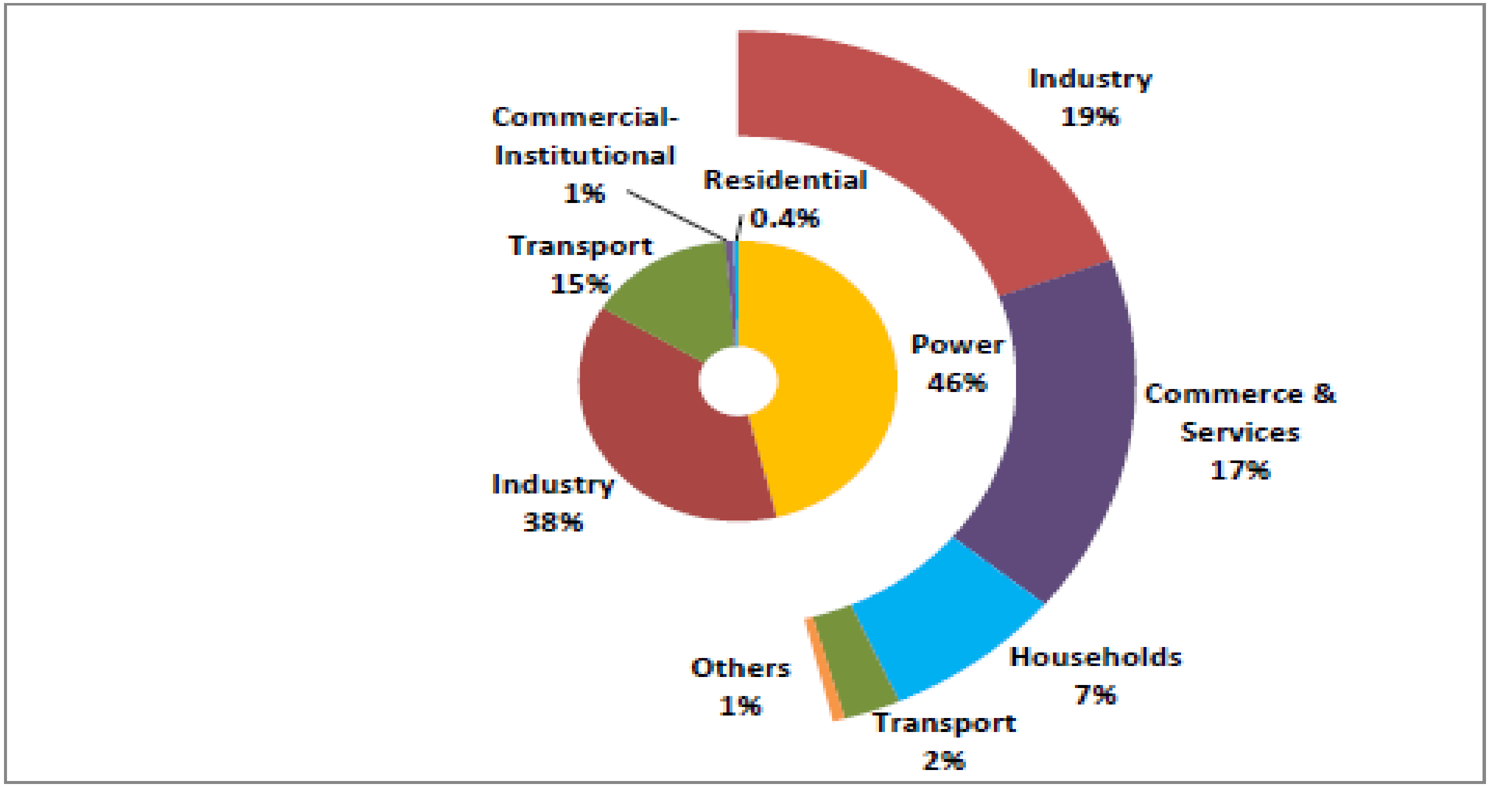


Source : National Climate Change Secretariat Prime Minister Office Singapore

3. Sustainability

3.6. Moving forward

Figure 1: Sectoral Breakdown of Singapore's CO_2 Emissions from Fuel Combustion[1]



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3. Sustainability

3.6. Moving forward

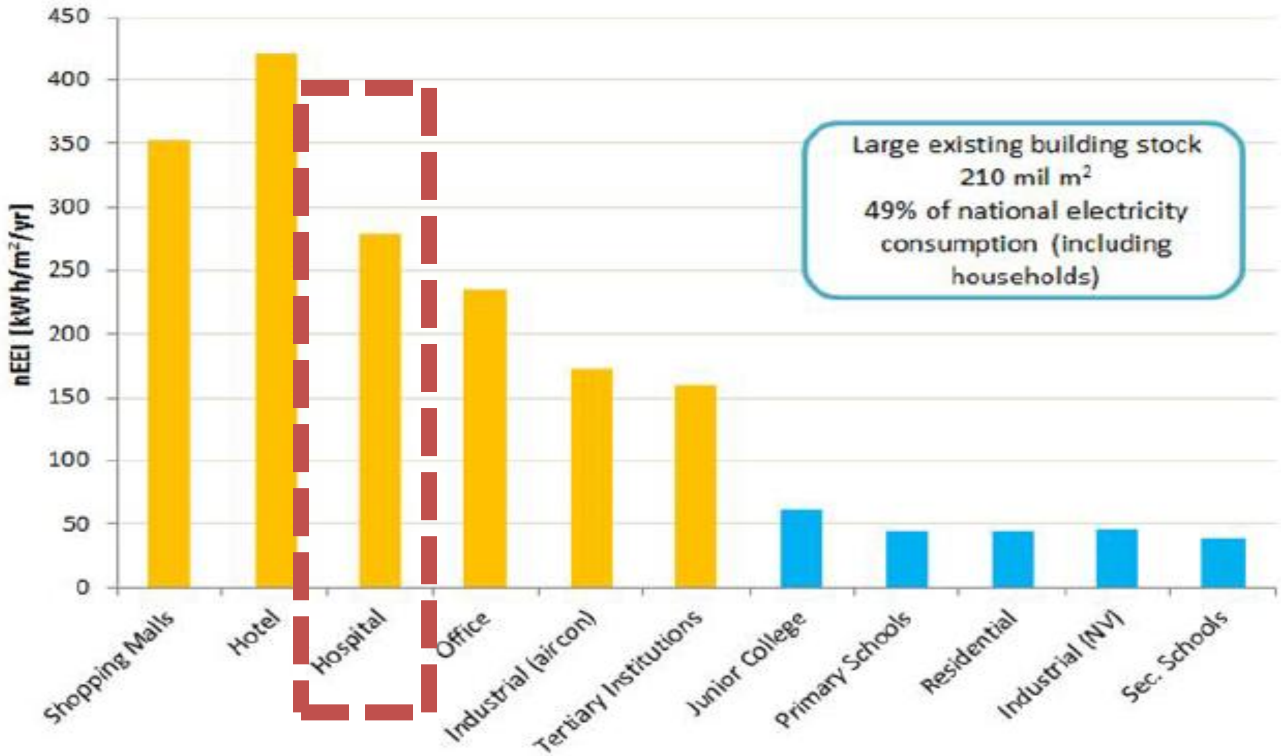

Figure 1.2: Energy consumption in existing building types (BCA, 2012a)

Source : National Climate Change Secretariat Prime Minister Office Singapore

MEP DESIGN FOR HEALTHCARE FACILITIES

3. Sustainability

3.6. Moving forward

1) Develop a strategy for Sustainability for Healthcare Infrastructures (SHI) to contribute to the GOS Intended Nationally Determined Contributions (INDC) commitment to reduce the country's overall carbon emissions intensity (EI) by 36% by 2030

2) Develop a roadmap for SHI 2020 for new and existing healthcare facilities to achieve the EI reduction

Activities:

1) To establish an energy benchmark(Energy Efficiency Index EEI, kWhr/m2/year) for healthcare facilities:
   a) micro-targets for four elements: air-conditioning, façade, lighting and other service enhancements

2) To identify innovations and technologies to achieve the energy benchmark for healthcare facilities

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4. Case Studies

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4. Case Studies

4.1. Type of General MEP Systems within a Healthcare Facility

- Air Conditioning, Mechanical Ventilation and Smoke Control Systems
- Plumbing (Cold & Hot Water), Sanitary, Drainage and Irrigation Systems
- Fire Protection Systems
  - Automatic Fire Sprinkler System
  - Automatic Fire Detection and Alarm System
  - Wet / Dry Riser Installation
  - Fire Hose Reel Installation
  - Clean Gas Fire Suppression System
- Town Gas / LPG Supply Installation
- Vertical Transportation Systems

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4. Case Studies

4.1. Type of General MEP Systems within a Healthcare Facility

- Electrical Power and Lighting Installation
  - Normal HT and LT Power Supply Installation
  - Emergency Power Supply (Uninterruptible power supply & diesel generators and underground fuel tank)
  - Lighting Installation
- Lightning Protection System
- Intelligent Building Management System
  - Building Automation System
  - Building Energy Management System
- Communications / Security / Car Park Systems
- Audio & Visual System

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4. Case Studies

4.2. Type of Special MEP Systems within a Healthcare Facility

- Compressed Air and Medical Gases Systems
  - Compressed Air System
  - Oxygen System
  - Nitrous Oxide System
  - Carbon Dioxide System
  - Nitrogen System / Surgical Air (11 bar)
  - Medical Air (4 bar)
  - Vacuum System
  - Anaesthetic Gas Scavenging System (AGSS)
- Earthing System (clean earth)

4. Case Studies

4.2. Type of Special MEP Systems within a Healthcare Facility

- Automatic Material Handling Systems
  - Automated Guided Vehicle (AGV) System
  - Pneumatic Tube Conveying System
  - Pneumatic Chute Solid Waste Conveying System
  - Pneumatic Chute Soiled Linen Conveying System
  - Pneumatic Kitchen Waste Conveying System
  - CSSD / TSSU Conveyor System

4. Case Studies

4.3. Basic Project Information

Description	Project A	Project B	Project C
GFA	150,000 m^2	58,000 m^2	268,000 m^2
Purpose	Community Hospital, Logistic Centre, Admin Services	Department of Emergency Medicine, Admin Services	Acute Hospital, Community Hospital, Nursing Home
No. of Beds (approx.)	550	230	1,800

4. Case Studies

4.4. Air Conditioning System

Description	Project A	Project B	Project C
Amount of Air Conditioned space	50 %	80%	60%
Chiller Plant Configuration	6 x 800 RT	4 x 1000 RT	2 separate interconnected plant room each with 4 x 1000 RT
Redundancy Level	N+1 (N+2 if do not consider Admin)	N+2	N+1 in each plant room (shared redundancy)

4. Case Studies

4.5. Water Supply Installation

Description	Project A	Project B	Project C
Potable Water	Yes	Yes	Yes
NEWater	Yes – air con make up water and toilet flushing	Yes – air con make up water and toilet flushing	Yes – air con make up water and toilet flushing
Water Supply Redundancy	1 day with breeching inlet for top up	1 day with breeching inlet for top up	1 day with top up breeching inlet being considered
Storage Configuration	Separated HL Tanks for Admin and Clinical use	Centralized HL Tank	Decentralised HL Tanks for individual blocks

4. Case Studies

4.6. Power Supply Installation (Normal Supply)

Description	Project A	Project B	Project C
Ultimate Design Load	24 MVA	9 MVA	27 MVA
Installed Capacity	60 MVA	24 MVA	68 MVA
No. of Feeds	Dual feed	Dual feed	Dual feed
No. of Transformers	2N (for Critical Load)	2N (for Critical Load)	2N

4. Case Studies

4.7. Power Supply Installation (Essential / Critical Supply)

Description	Project A	Project B	Project C
Total Generator Capacity	50% of Design	75% of Design	33% of Design
Generator Set Configuration	N	N for building, N+1 for Server Room	N+1
UPS	N for Centralised UPS	N for Centralised UPS	N+1 for Centralised UPS N for Decentralised
Critical Supply Back Up	Back up by LV Generator Set	Back up by LV Generator Set	Back up by LV Generator Set

Thank You