International Commerce Centre

2019 ESCI Best Practices Awards Program

Smart Building – Low Energy Buildings Network

No.1 Austin Road West, Hong Kong

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

新鴻基地產
Sun Hung Kai Properties

啟勝管理服務有限公司
KAI SHING MANAGEMENT SERVICES LIMITED

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Content

ICC
- Background Information

Strategy
- Innovativeness
- Inspiration
- Clearness

Measure
- Practicability
- Replicability
- Cost-effectiveness
- Consistency

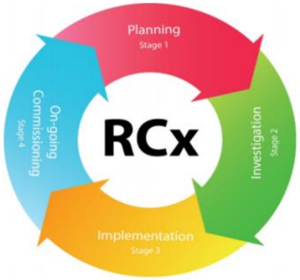
Performance
- Completeness
- Verifiability
- Impact

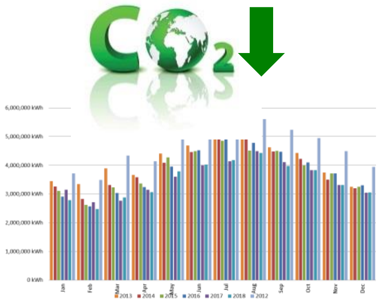
新鴻基地產
Sun Hung Kai Properties

啟勝管理服務有限公司
KAI SHING MANAGEMENT SERVICES LIMITED

PLATINUM 鉑金級 EB 既有建築 V2.0 2017
HKGBC BEAM Plus 綠建環評

CERTIFIED COMPANY HKQAA
ISO 50001 : 2011
Certificate No.: CC5375
Limited Sites





Section 1 Introduction

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Sun Hung Kai Properties Limited

Sun Hung Kai Properties Limited ("SHKP") was publicly listed in **1972** and is now one of the largest **property** companies in Hong Kong.

The Group also has complementary operations in the following property related fields: **Hotels, Construction, Insurance and Mortgage services.**

SHKP embraces corporate social responsibility by respecting its staff, the environment and society at large. It has clear green policies for sustainable development in its operations to conserve resources for future generations.

Kai Shing Management Services Limited

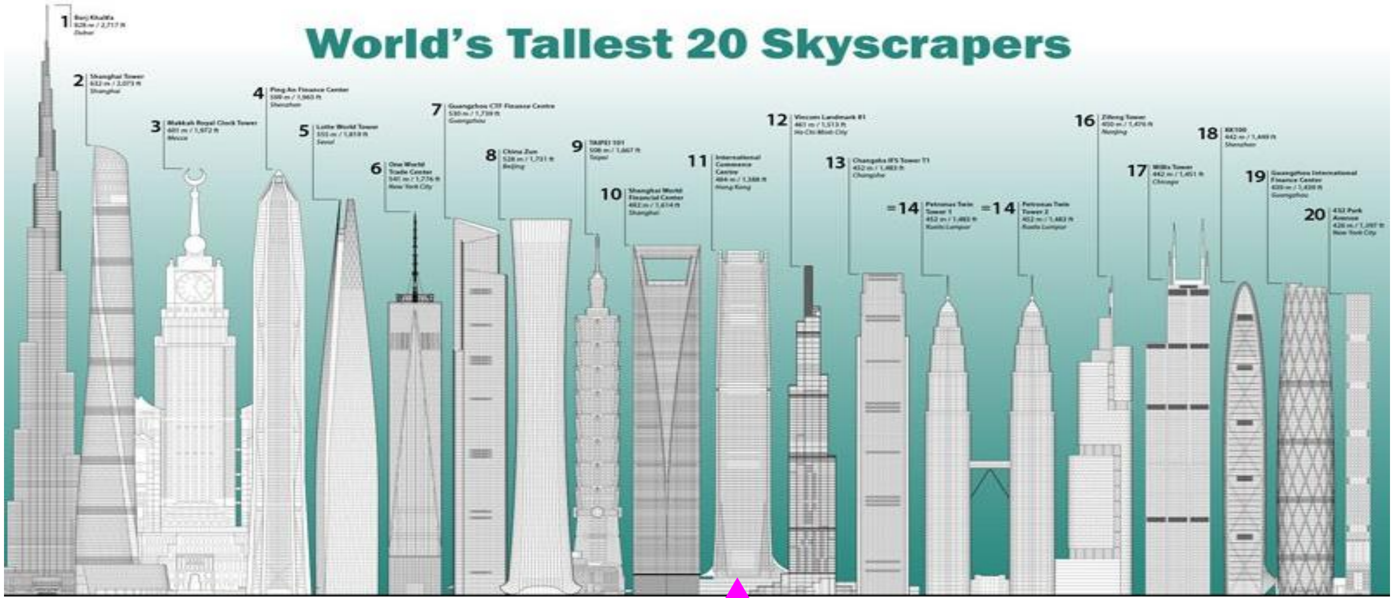
Kai Shing Management Services Limited (Kai Shing), a member of Sun Hung Kai Properties, was established in 1978. It currently manages over a hundred million square feet of properties including A-grade commercial buildings, large-scale shopping malls, premium residences, large-scale residence estates, commerce and trade buildings, HOS estates, and clubhouse and leisure facilities management across Hong Kong, Kowloon and the New Territories. Kai Shing is one of the largest property management organizations in Hong Kong.

International Commerce Centre

Vision: Harbour Gateway   Location: Central's extension

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

International Commerce Centre



1st in Hong Kong, 11th tallest in the world

2.5 million square feet of office space, 98% occupied

Source: CTBUH

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Connectivity – Union Square

Key Information

- Two MTR Stations Nearby:
  - ➢ Austin Station
  - ➢ Kowloon Station
- Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL)
  - ➢ West Kowloon Station

*All are within **15 minutes** walking distance from ICC*

Connectivity –
Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL)

Key Information

- Service commencement date: 23 September 2018
- Estimated daily traffic: 109,200 passengers
- Route Length: Approximately 26 km in Hong Kong
- Direct Links offered: 44 mainland cities

Connectivity - West Kowloon Cultural District (WKCD)

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

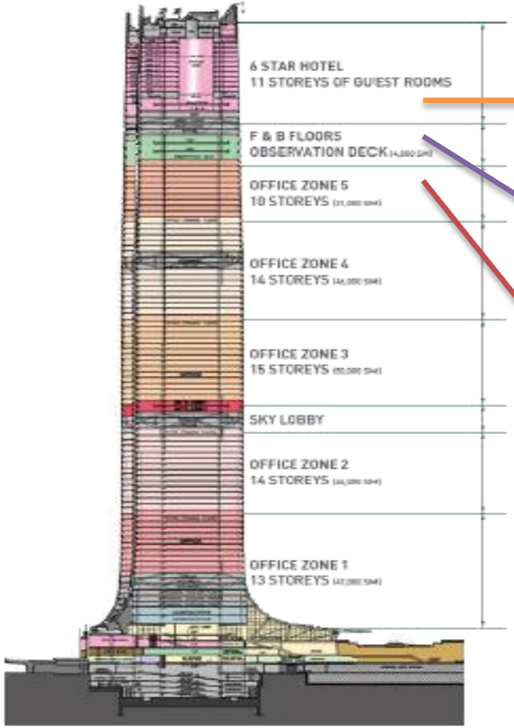
5 minutes walking distance from ICC

Building Information

- Location: 1 Austin Road West, Kowloon, HK
- Floors: 118-storey
- Height: 490m (1st in Hong Kong)
- Construction period: 2002-2011
- Phases of occupation:
  Zone 1& 2 - 2008
  Zone 3 & 4 - 2010
  Zone 5 - 2011
  Hotel - 2011
- No. of Staff :170

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Building Information



The Ritz-Carlton
Hong Kong
(Level 102 – 118)

天際100
香 港 觀 景 台
(Level 100)

Office floors (Level 10 – 99)

Key Information

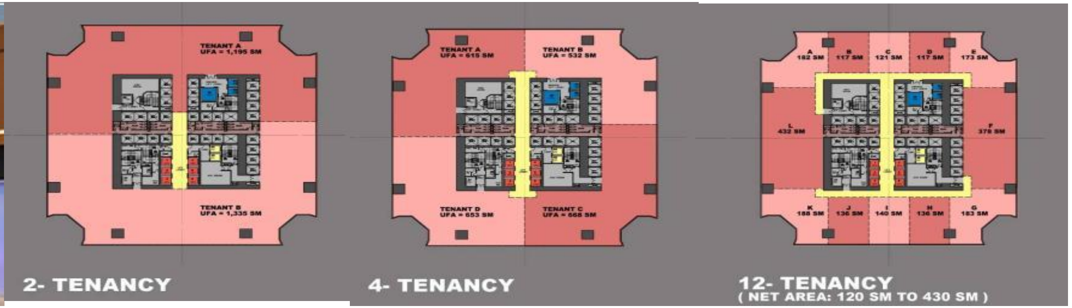
ICC is a multi-function building totaling 3 million s.f.:

- **Office: 2.5 million s.f.**
- **Hotel:0.38 million s.f.**
- **Observation Deck + Restaurants: 0.06 million s.f.**

Building Information

Highly Efficient Large Floor Plates

- The size of the ICC footprint and the efficiency of the structure produce a highly efficient plan for tenants, each floor can accommodate 1.5 times more population that normal commercial building in Central Business District
- A number of tenant occupation could be easily adopted with uninterrupted panoramic views.
- Span depth varies from 12.6 to 16m to cater for different tenants requirement
- The structural floor system facilitate the multiform tenants to built internal staircases to reduce the reliance on lift system. All the major tenants had subsequently built their internal staircases.

Building Information

Shingled façade design: cut down glare and solar gain while maintaining views out of the tower; brings the sculptural form of the building to life and significantly reduces unwanted reflections.

Curtain Wall Design: The curtain wall design utilizes specially selected glass to cut down glare and solar gain while maintaining views out of the tower. The unique shingled design of the façade brings the sculptural form of the building to life and significantly reduces unwanted reflections.

Building Information

- 95% of the building's tenants are international investment banks that operate 24 hours by 7 days.
- The combined market capitalization of the tenants' businesses amounts to multi-billion dollars.

Section 2
Strategy

Kai Shing Missions and Visions

The backbone of the company

CERTIFIED COMPANY HKQAA
ISO 9001 : 2015
Certificate No.: CC 521
Limited Sites

CERTIFIED COMPANY HKQAA
ISO 10002 : 2014
Certificate No.: CC3043
Limited Sites

CERTIFIED COMPANY HKQAA
ISO 14001 : 2015
Certificate No.: CC 1096
Limited Sites

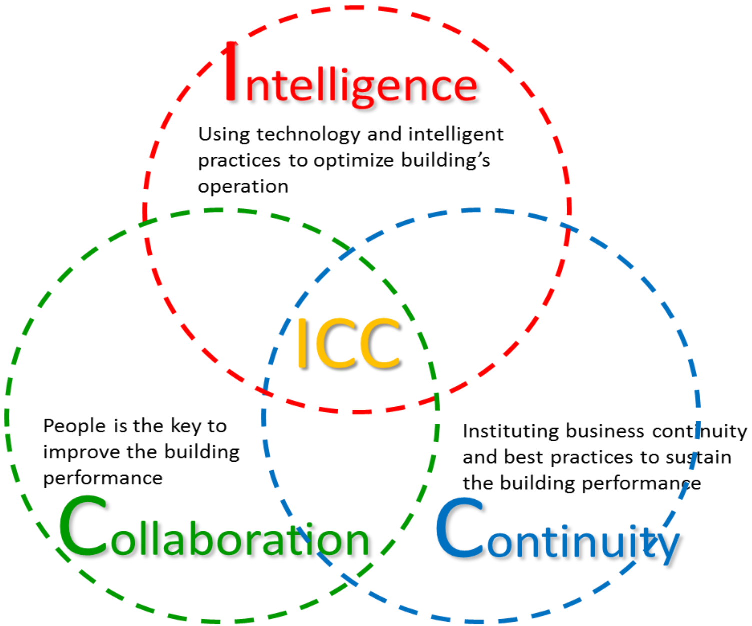
CERTIFIED COMPANY HKQAA
ISO 50001 : 2011
Certificate No.: CC5375
Limited Sites

CERTIFIED COMPANY HKQAA
OHSAS 18001 : 2007
Certificate No.: CC2459
Limited Sites

BCM CERTIFIED COMPANY HKQAA
ISO 22301 : 2012
Certificate No.: CC 5709
Limited Sites

Objectives and Operation Model

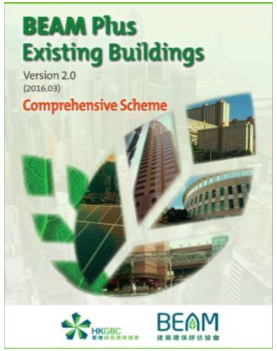
The building management team has incorporated the ***three-element management*** framework: ***Intelligence, Collaboration and Continuity*** in operating ICC for green management, smart building development and support of government.



- Contain a wide variety different kinds of **sensors** to track **operational data**
- Different systems are **connected together** to form a holistic operational view of the building
- Tracked data is analyzed with **automatic response** mechanism to **optimize operation**

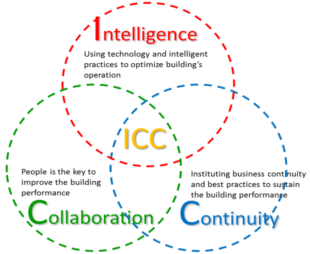
The 3-Sphere Framework - Intelligence

Intelligence - integration of people, place, process and technology



- Intelligence
  - Process Intelligence
    - Training & Development
    - Process such as ISO 14001 & 50001
  - Machine Intelligence
    - Feedback & Alarm
    - Collection & Analysis

- Building management system (BMS)
- Power monitoring system (PMS)
- Etc.



The 3-Sphere Framework - Collaboration

Collaboration - Vitalizing the trade experts and recognizing the contributions from stakeholders from within and outside the building environment

3rd Tier – Societal Level

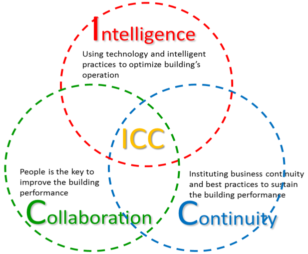
Government, Non-Government Organizations, Green Groups

2nd Tier – Community Level

Other buildings, institutions, Community partners

1st Tier - Building Level

Building owners, property and facility managers, building users, suppliers



The 3-Sphere Framework - Continuity

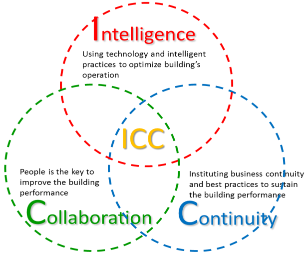
Continuity - Working towards a common goal of reducing environmental impacts

- ✓ **BEAM Plus Existing Building V2.0**
- ✓ **Annual Energy Audit**
- ✓ **IoT application**

Medium to long term plan with Management System in place to gauge on building performance

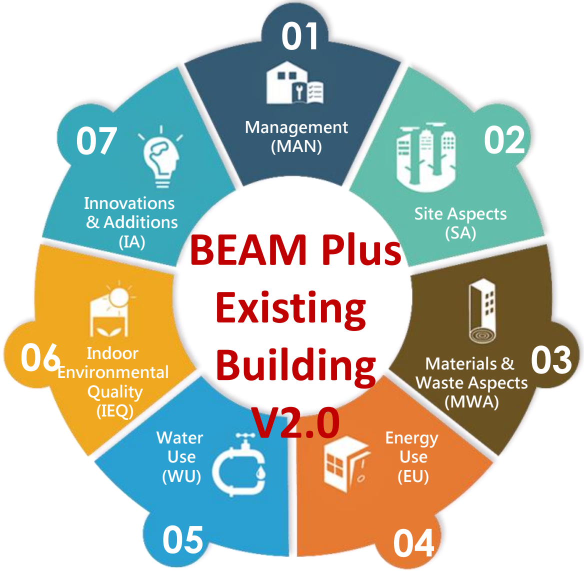
Benchmarking with similar types of properties

Year-on-Year tracking of operating data and adjusting of strategy



BEAM Plus Existing Building 2.0

ICC is the first HK building received "BEAM Plus Existing Buildings V2.0" Platinum certificate

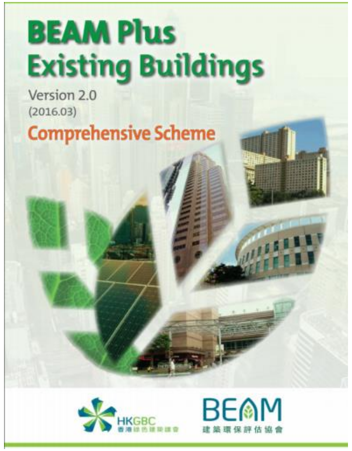


Existing Buildings V2.0

Final Platinum

Total Score:

79.1



Category	Applicable Credits	Achieved Credits	Achieved Bonus Credits	% of Achieved Credit	Category Weighting	Weighted Achieved Credits	Category Grade
MAN	23.0	16.0	3.0	82.6%	24%	19.8	Platinum
SA	22.0	17.0	0.0	77.3%	10%	7.7	Platinum
MWA	17.0	10.0	1.0	64.7%	14%	9.1	Platinum
EU	39.0	28.0	2.0	76.9%	24%	18.5	Platinum
WU	23.0	11.0	3.0	60.9%	14%	8.5	Platinum
IEQ	26.0	11.0	3.0	53.8%	14%	7.5	Platinum
IA	Max. 10 Bonus		8.0		100%	8.0	
					Overall Score:	79.1	Platinum

Indoor Environmental Qualities & LEED Offices

Air
- Fresh air intake; riser provision for local exhaust
- CO_2 sensor at office for user comfort settings

Lighting
- High frequency electronic ballasts are adopted for ICC office lightings

Acoustics
- Vibration isolators in all water and concrete pumping pipes
- AC system is designed to NC40 level

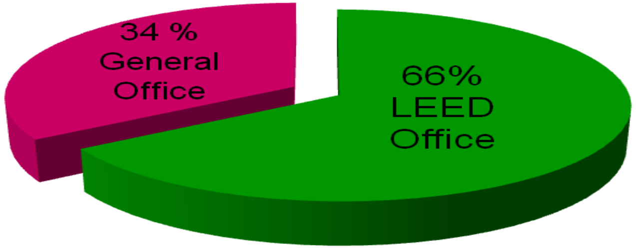
View
- Curtain wall system with enhanced visual accessibility, open view to all sides

Daylight Provisions
- Central building core and curtain wall design maximize daylight penetration to all sides of building

Thermal Comfort
- Low E IGU to reduce solar heat gains and cooling loads

LEED VS General Office
Approx. **40%** Energy Saving

For 66% LEED Offices
Approx.**1,750,000sq.ft**
Approx.↓ **395,000 kg** CO_2



Higher Rent and Occupancy Rate in Certified Green Buildings

Commercial Property Executive 2016

LEED-certified vs. non-certified buildings in US

3.7%↑ Rent

4%↑ Occupancy Rate

LEED-certified vs. non-certified buildings in Canada

10.2%↑ Rent

8.5%↑ Occupancy Rate

China Green Building Report 2017

LEED-certified vs. non-certified buildings in China

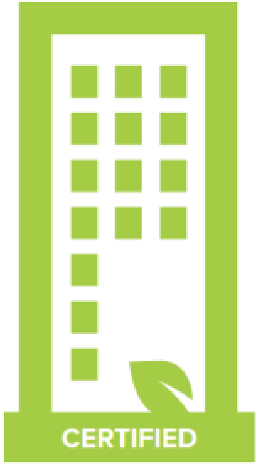
25%↑ Rent

1.5%↑ Occupancy Rate

LEED Platinum vs. Certification below LEED Platinum in China

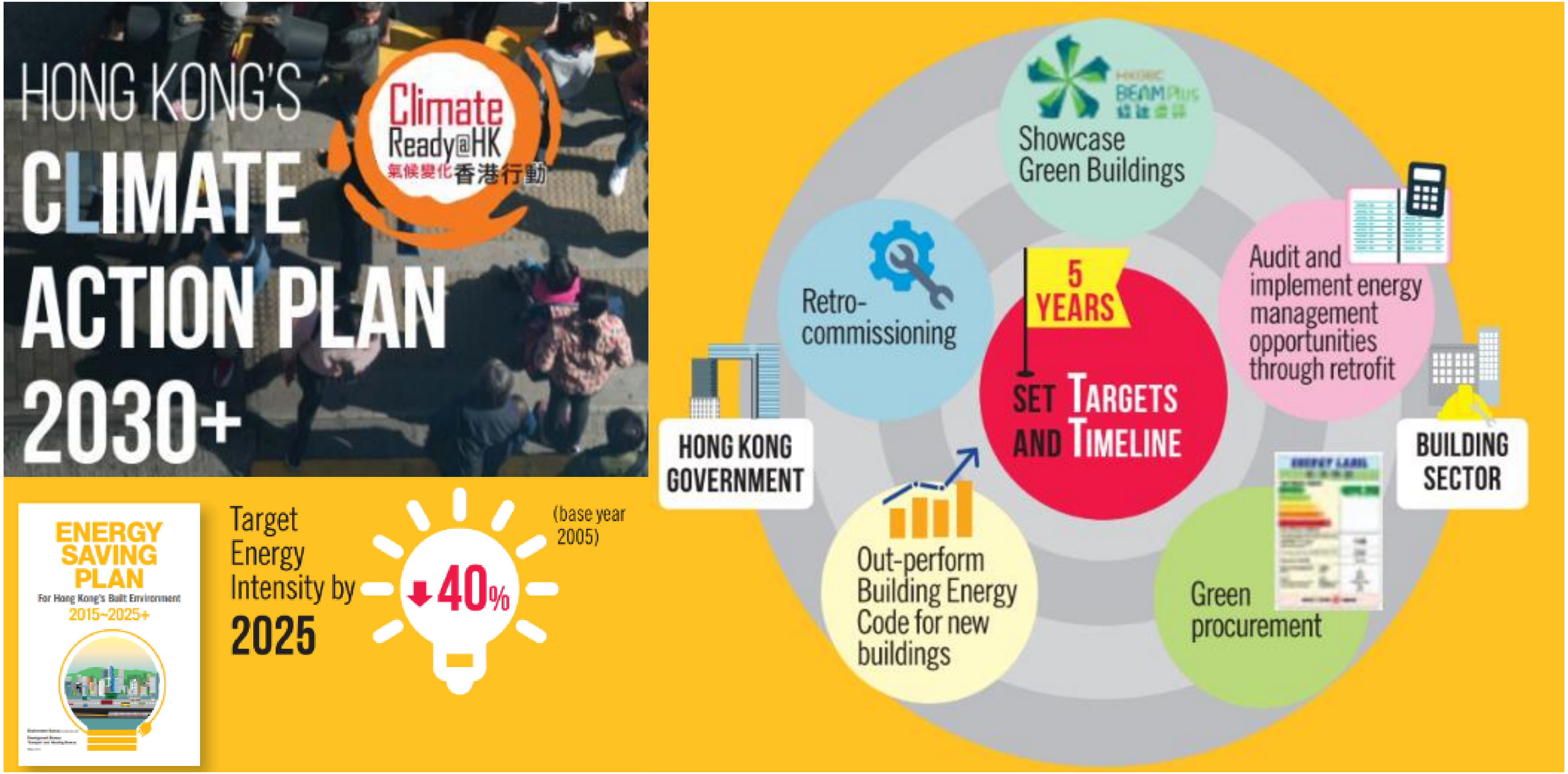
10%↑ Rent

3.5%↑ Occupancy Rate

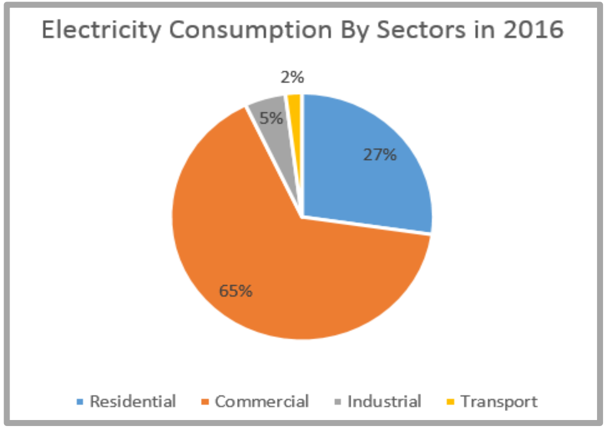


Source: Commercial Property Executive; CBRE and U.S. Green Building Council

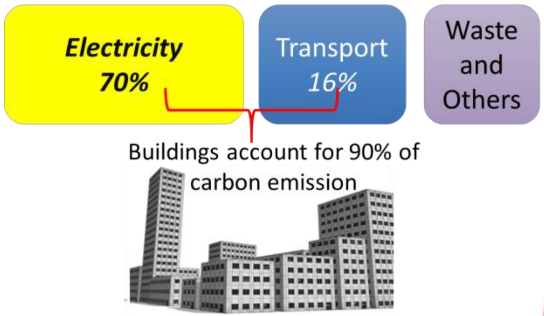
HK Climate Action Plan 2030+



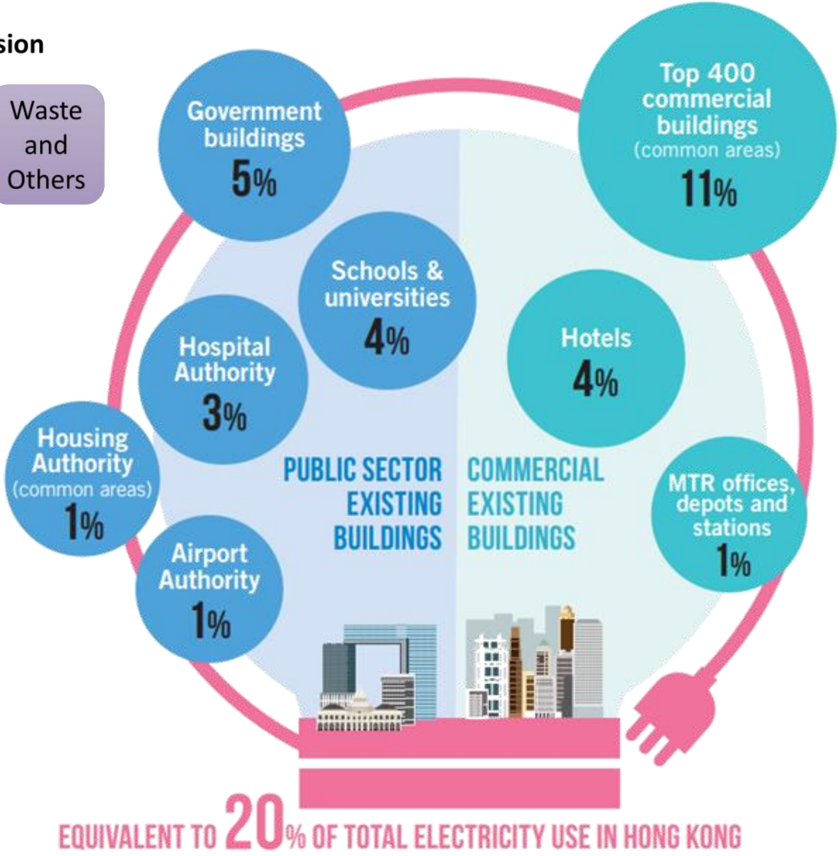
Energy End Use in Hong Kong



Largest Source of Carbon Emission



Source: Hong Kong Energy End Use Data 2018

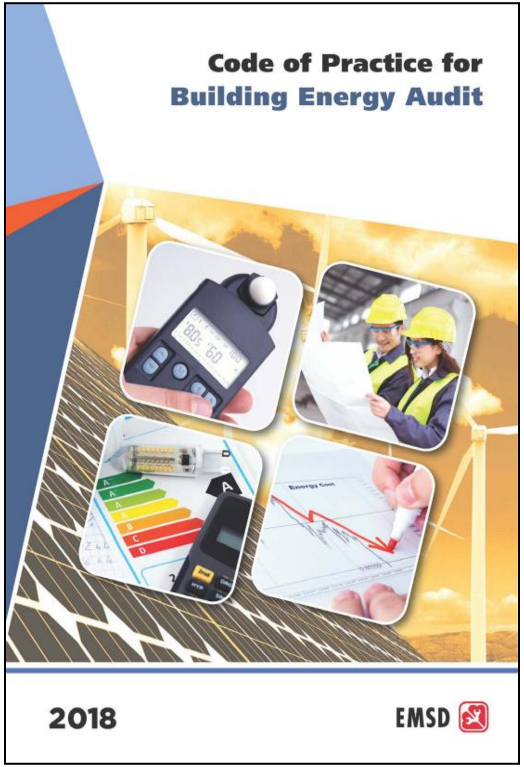


New Buildings vs Existing Buildings

- Over ***42,000*** existing buildings in Hong Kong
- Potential reduction of ***52%*** in absolute electricity consumption compared to a Business-As-Usual (BAU) scenario

Source: HK3030 Market Drivers for Transformation of Green Buildings in Hong Kong (Executive Summary)

Energy Audit by Registered Energy Assessor (REA)



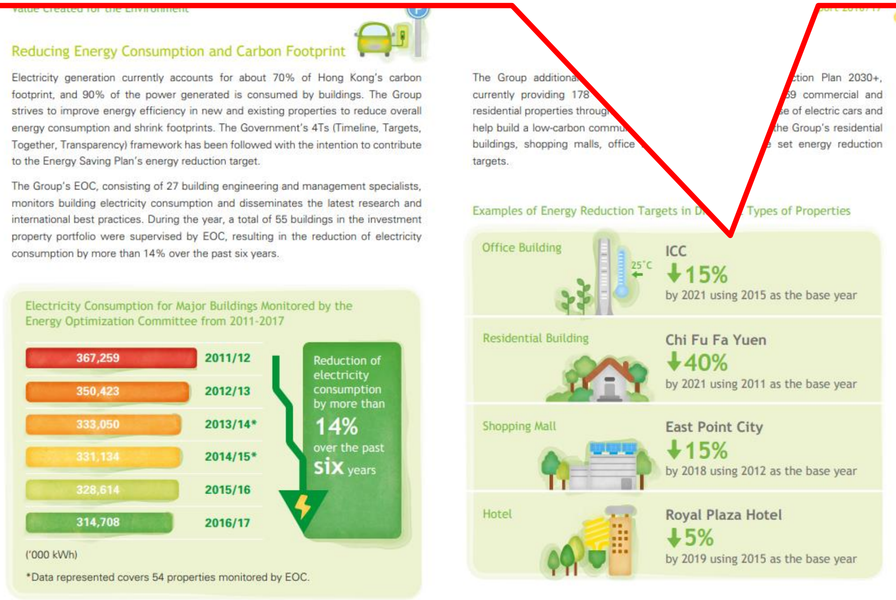
Energy Management Opportunity (EMO)	Energy Management Approach
EMO I	Housekeeping practice for saving energy
EMO II	Replacement of less energy efficient apparatus with the more energy efficient one with a reasonable outlay
EMO III	Substantial savings over a long term with capital investment

Energy audit is an effective way to examine the energy use and performance of a building. The annual energy audit conducted in ICC is based on the Building Energy Efficiency Ordinance (BEEO) of Hong Kong Legislation Chapter 610 (Cap.610) which enacted by HKSAR. Through continuously optimizing the energy consumption facilities, the annual audit of ICC showed the *reduction of Energy Utilization Index (EUI)* of ICC.

Source : Electrical and Mechanical Services Department (EMSD), HKSAR Government

ICC Energy Reduction Target

As stated in SHKP Sustainability Report, the *energy reduction target of ICC is 15% by 2021* with 2015 as base year.



Reducing Energy Consumption and Carbon Footprint

Electricity generation currently accounts for about 70% of Hong Kong's carbon footprint, and 90% of the power generated is consumed by buildings. The Group strives to improve energy efficiency in new and existing properties to reduce overall energy consumption and shrink footprints. The Government's 4Ts (Timeline, Targets, Together, Transparency) framework has been followed with the intention to contribute to the Energy Saving Plan's energy reduction target.

The Group's EOC, consisting of 27 building engineering and management specialists, monitors building electricity consumption and disseminates the latest research and international best practices. During the year, a total of 55 buildings in the investment property portfolio were supervised by EOC, resulting in the reduction of electricity consumption by more than 14% over the past six years.

Electricity Consumption for Major Buildings Monitored by the Energy Optimization Committee from 2011-2017

367,259	2011/12
350,423	2012/13
333,050	2013/14*
331,134	2014/15*
328,614	2015/16
314,708	2016/17

Reduction of electricity consumption by more than 14% over the past six years

('000 kWh)

*Data represented covers 54 properties monitored by EOC.

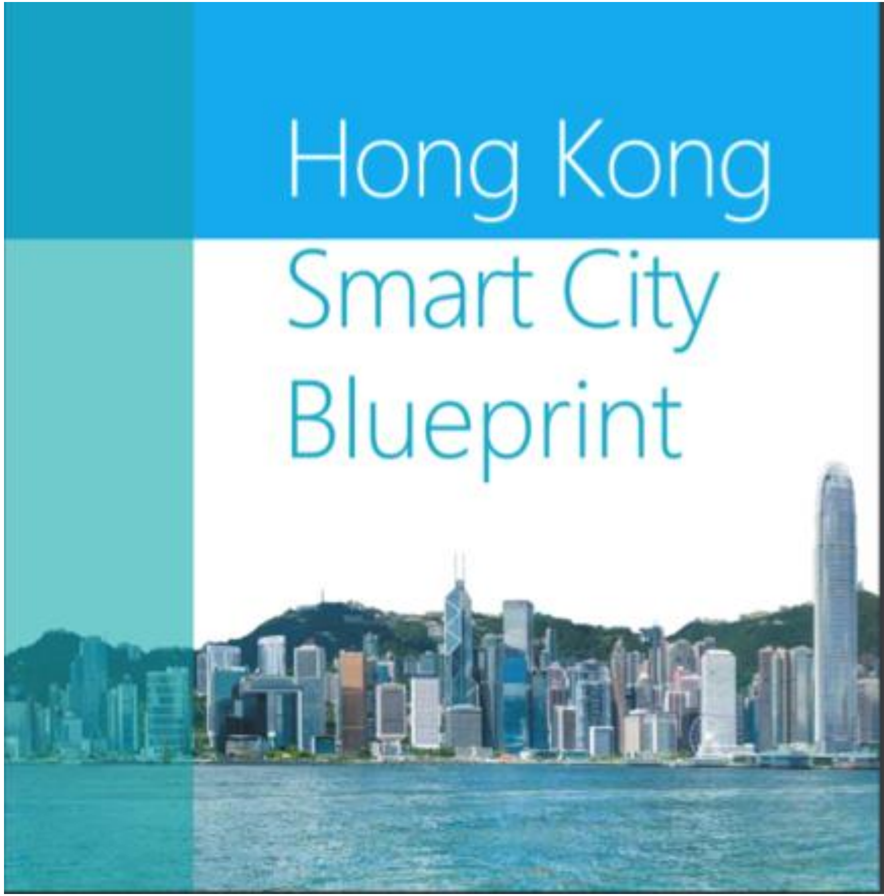
The Group additiona… currently providing 178… residential properties throug… help build a low-carbon commu… buildings, shopping malls, office… targets. …ction Plan 2030+, …59 commercial and …e of electric cars and …the Group's residential …e set energy reduction

Examples of Energy Reduction Targets in D… Types of Properties

Office Building	ICC	↓15% by 2021 using 2015 as the base year
Residential Building	Chi Fu Fa Yuen	↓40% by 2021 using 2011 as the base year
Shopping Mall	East Point City	↓15% by 2018 using 2012 as the base year
Hotel	Royal Plaza Hotel	↓5% by 2019 using 2015 as the base year

HK Roadmap in Smart City Development

- In HKSAR, Hong Kong Smart City Blueprint was released in Dec 2017.
- Making use of innovation and technology (I&T) continues to be a trend
- One of the initiatives is the use of the "Internet of Things" (IoT) in buildings.



環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

IoT Initiatives in ICC

Extract of "HK Smart City Blueprint"

Strategy and Initiatives

Climate Action Plan 2030+

- Reduce our carbon intensity by between 65% and 70% by 2030 compared with the 2005 level
- Phase down coal-fired electricity generation gradually and replace with natural gas and non-fossil fuel sources. Coal as a proportion of the fuel mix will be reduced from 47% as of 2016 down to about 25% in 2020
- Apply renewable energy on a wider and larger scale based on mature and commercially available technologies with the public sector taking the lead
- Further promote energy efficiency and conservation in the community with particular focus on buildings
- Implement other measures to achieve carbon emission reduction by phases

Green and Intelligent Buildings, and Energy Efficiency

- Promote retro-commissioning and building-based smart/IT technologies
- Install LED lamps in public lighting systems progressively under the LED Public Lighting Replacement Programme of the Highways Department starting from 2017-18 and encourage retrofitting LED lighting for existing government buildings
- Continue to include requirements, such as green building design, provision of smart water meter system, electric vehicle charging facility and real-time parking vacancy information for new land sale sites in Kowloon East, with a view to developing a green and smart community

SMART ENVIRONMENT

SHKP Sustainability Report

Q Peer companies and suppliers:

Innovative application of technology is a growing trend in property management. It is observed that SHKP has developed smartphone applications, such as the SHKP Malls App and the Intake Easy device, for its customers' convenience. Is the Group also exploring other innovative technological solutions to enhance resource efficiency of its operations?

SHKP is committed to investing in the effective use of innovation and technology. Specifically, the Group sees the potential of the commercial application of IoT (Internet-of-Things) technology as a means to improve operational efficiency and quality. We have been supporting our subsidiaries on the introduction of technologies in property management and across other commercial aspects, such as construction, healthcare, event management and smart city development. During the year, Kai Shing and SmarTone collectively launched a smart management solution in ICC with IoT applied, allowing ICC to meet or exceed the energy-saving target set by the Government for commercial buildings. We believe this innovative system will help to set a new industry standard in smart and eco-friendly property management in Hong Kong. More information on the management solution implemented in ICC can be found in the Value Created for Customers section in this report.

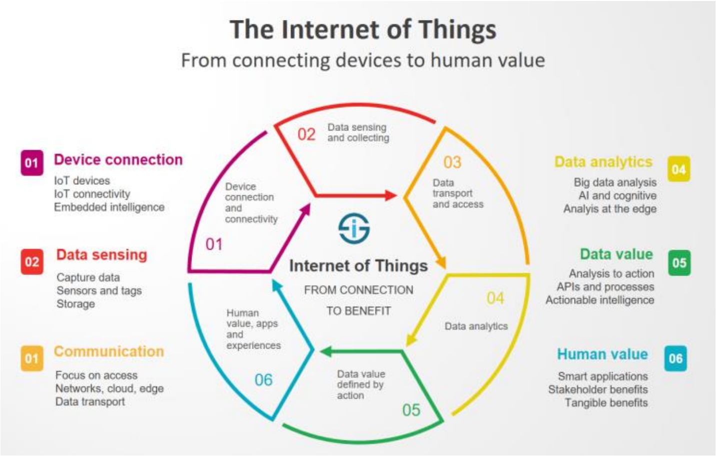
SMART BUILDING MANAGEMENT

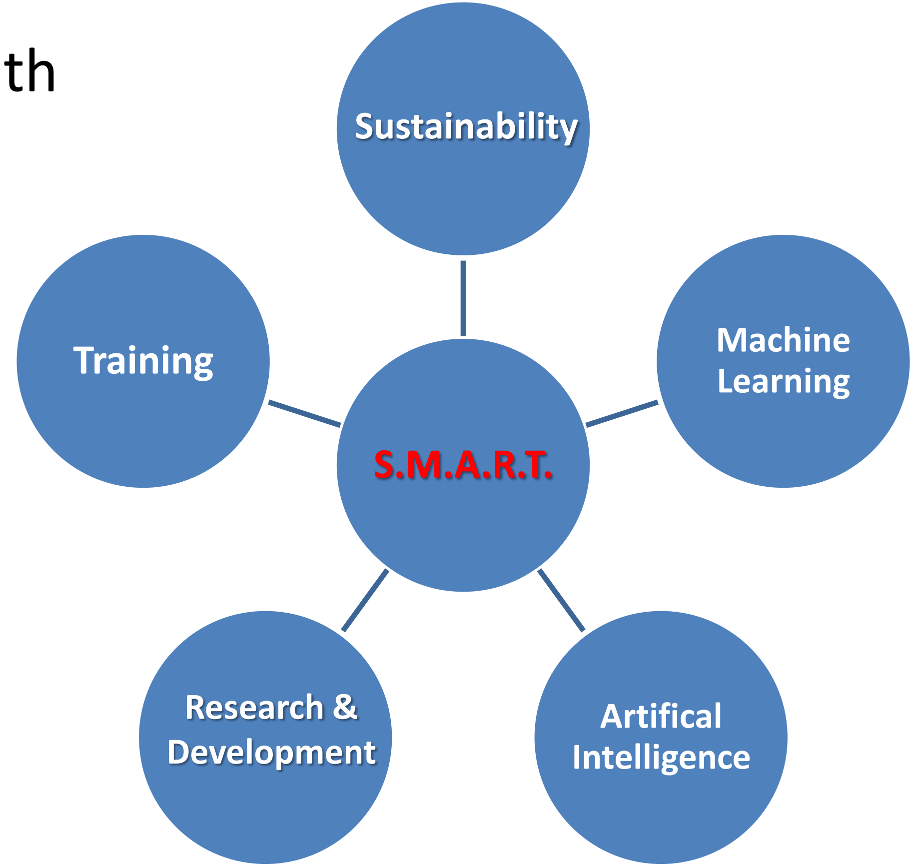
Smart Building Development

Improve efficiency and comfort with

IoT for Smart Buildings

S.M.A.R.T ICC





環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Support of IoT Development

新鴻基地產
Sun Hung Kai Properties

Home Contact

SHKP e-News | Site Feedback | RSS | Share

About SHKP | Group Business | Corporate Governance | Corporate Social Responsibility | Investor Relations | Media Centr

MEDIA CENTRE

Home > Media Centre > Press Releases

- Press Releases
- Photo Library
- Executive Speeches
- Media Contact

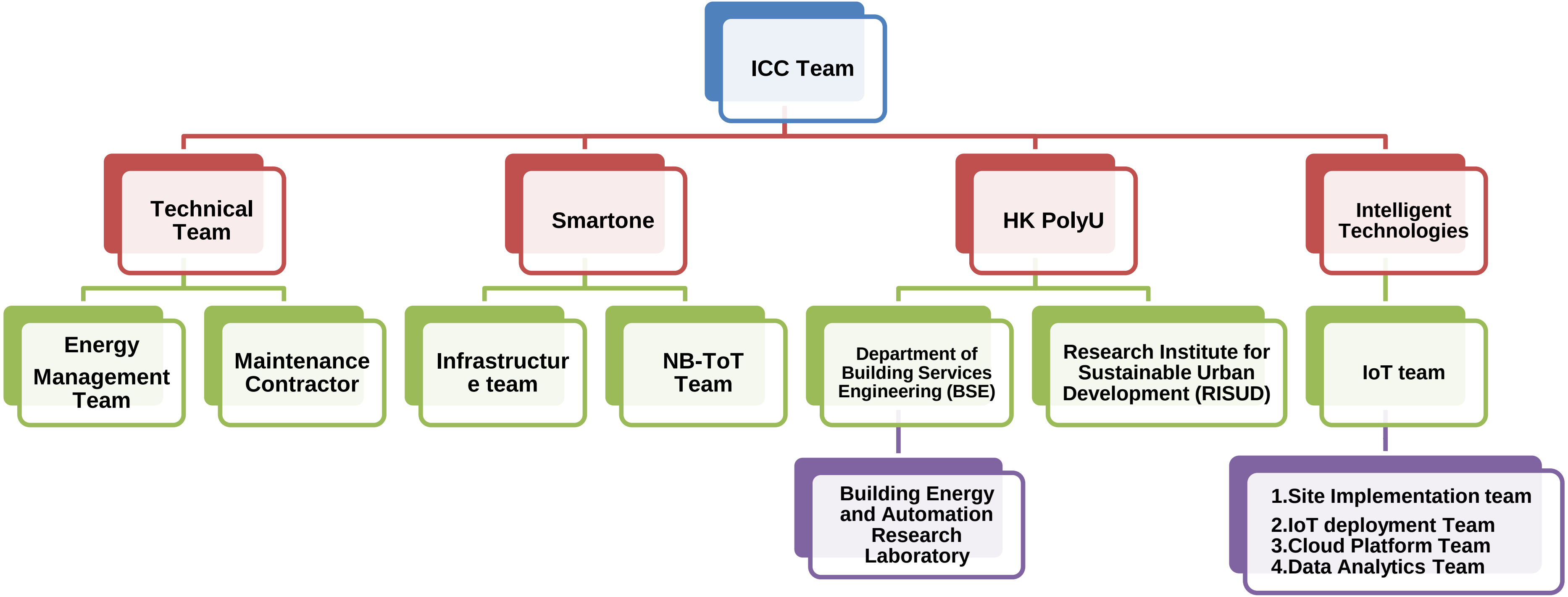
Press Releases

SmarTone and Kai Shing spearhead NB-IoT enabled smart property management solution at Hong Kong's tallest landmark ICC

2018-05-23

SmarTone and Kai Shing Management Services Limited ("Kai Shing") jointly announce today the introduction of a Narrowband Internet-of-Things (NB-IoT) enabled smart property management solution at International Commerce Centre (ICC), bringing property management service level to new heights in this tallest landmark in Hong Kong.

O-chart for IoT Development with Different Partners



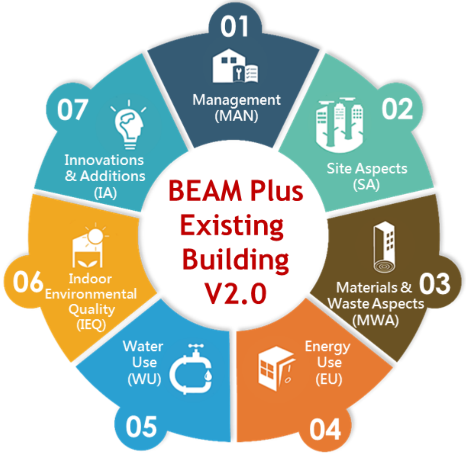
Smart Building Development

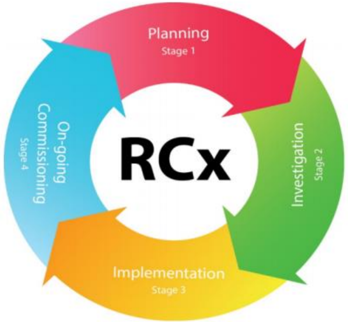
Our Management System

- Assesses the policies, procedures and strategies implemented to ensure buildings operate in a sustainable manner

- ICC Management Systems:
  - **BEAMPLUS Existing building v2.0**
  - **OHSAS 18001, ISO 50001, ISO 22301**
  - **Retro-commissioning (RCx) / Lift cycle commissioning**

- Management Policy & Plans:
  - Building Services Maintenance Plan
  - Energy Management Plan
  - Waste Management Plan
  - Environment Purchasing Plan
  - Water Conservation Plan





OHSAS 18001 : 2007
Certificate No.: CC2459
Limited Sites

ISO 50001 : 2011
Certificate No.: CC5375
Limited Sites

ISO 22301 : 2012
Certificate No.: CC 5709

Smart Building Development

Design & Construction → Cx → Smart on-going Commissioning + Operation

Condition-Based Maintenance

Functional testing

through

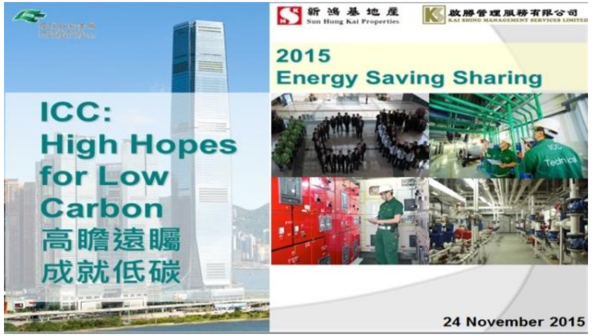
Smart IoT Device

Big Data

Analytics

Public Seminar/ Visit for Best Practices Sharings

- *ICC was invited to share energy saving achievement via the implemented MVAC strategies on* ***Sun Hung Kai Properties (shkp) 's Internal Sharing Session for Kai Shing, Hong Yip and SHK Real Estate Management***



24th Nov, 2015

26th Oct, 2016

26th Oct, 2018

Public Seminar/ Visit for Best Practices Sharings

Seminars / Sharing
Experience sharing of winners of Energy Saving Championship Scheme 2016
Experience Sharing Seminar with winning teams of Energy Saving Championship Scheme 2016
Environmental Forum on Green and Healthy Buildings
Technical Visit to International Commerce Centre – BEAM Plus for Existing Buildings (EB) v2.0 Comprehensive Scheme A – Final Platinum
Energy Saving Sharing Session for Kai Shing, Hong Yip and SHK Real Estate Management Sharing on 9th Oct, 2018
Experience Sharing Session – Energy Saving Championship Scheme 2017
University Visit - HKU, PolyU, City, THEi, Penn State, etc.
Sky-high experience at Sky 100 for primary & secondary schools

Public Seminar/ Visit for Best Practices Sharings

BEAM Pro & BEAM Affiliate
CPD
auto record at Individual Account

HKGBC will upload 2 CPD credits to individual account for BEAM Pro and BEAM Affiliate

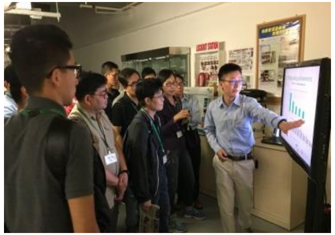
This event is co-organised by the **Hong Kong Green Building Council Limited (HKGBC) and The Open University of Hong Kong (OUHK)**.

Thank you for your support. The event is full house now.

Organised by BEAM Society Limited

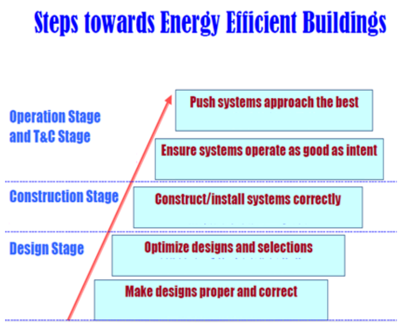
Technical Visit to International Commerce Centre –
BEAM Plus for Existing Buildings (EB) v2.0
Comprehensive Scheme A – Final Platinum

Date:	12 May 2018 (Saturday)
Time:	9:30am – 12:00noon (Registration starts at 9:15am)
Venue:	International Commerce Centre Gathering Point: Level 3, ICC, 1 Austin Road West, Kowloon
Language:	Cantonese supplemented with English as appropriate
Fee:	HK$125 (BEAM Pro & BEAM Affiliate) HK$750 (Others)
CPD Entitlement:	2.5 CPD hours for BEAM Pro and BEAM Affiliate
Enquiry:	Email: beampro.training@beamsociety.org.hk Tel: (852) 3610 5700



Project Extension

ICC has been work with PolyU for *Life Cycle Commissioning* work to optimize the chiller plant system and the collected data & design approach is widely adopted in other buildings for optimize the energy efficiency of chiller plant system and achieve energy saving.



Life Cycle Commissioning for ICC

MTR Station – To Kwa Wan

Hong Kong International Airport office building

New World Centre TST

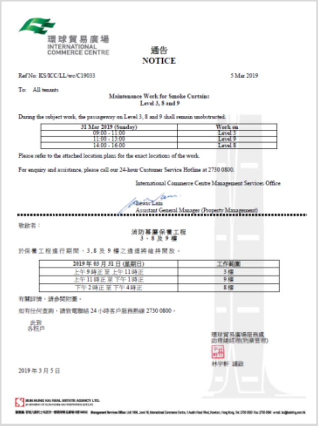
MTR station – Tsing Yi

Sheung Wan Holiday Inn Hotels

Our Communication Chanel (External)

ICC Website

Tenant's Corner


環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

通告
NOTICE

Ref No: KS/ICC/LL/wc/C19033 5 Mar 2019

To: All tenants

Maintenance Work for Smoke Curtains
Level 3, 8 and 9

During the subject work, the passageway on Level 3, 8 and 9 shall remain unobstructed.

31 Mar 2019 (Sunday)	Work on
09:00 - 11:00	Level 3
11:00 - 13:00	Level 9
14:00 - 16:00	Level 8

Please refer to the attached location plans for the exact locations of the work.

For enquiry and assistance, please call our 24-hour Customer Service Hotline at 2730 0800.

International Commerce Centre Management Services Office

Lewis Lam
Assistant General Manager (Property Management)

敬啟者：

消防幕簾保養工程
3、8及9樓

ICC Notice

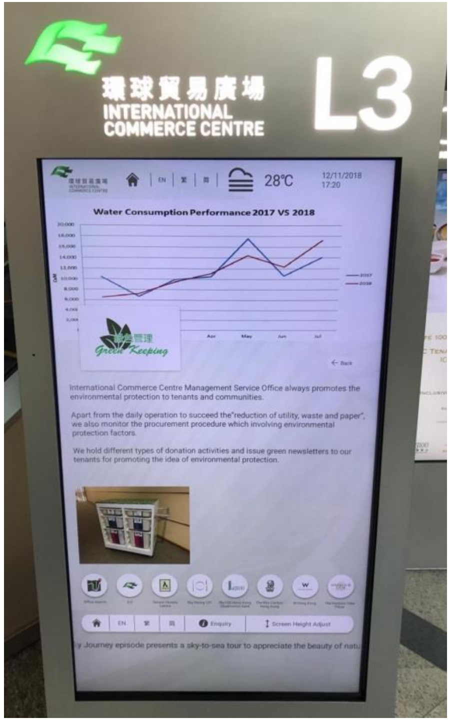
ICC Publications

Our Communication Chanel (External)

Helpdesk System & Customer Relationship Management (CRM) System

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

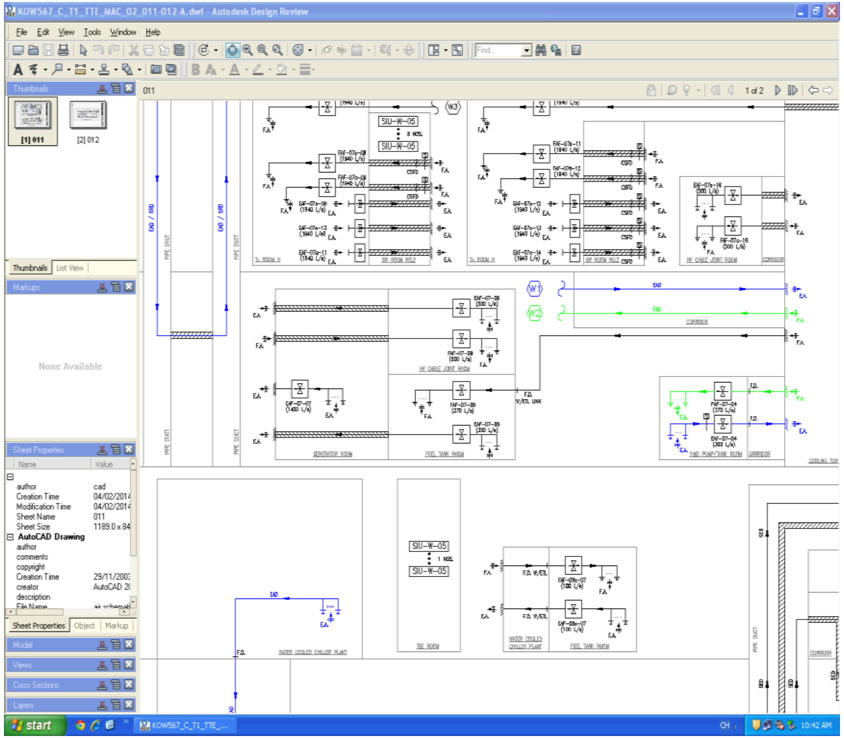
Our Communication Chanel (External)



L3 & L8 e-directories to display building information and performance

Our Communication Chanel (Internal)

SuperE Management System (SEM)



Autodesk Viewer System

Section 3
Measure

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

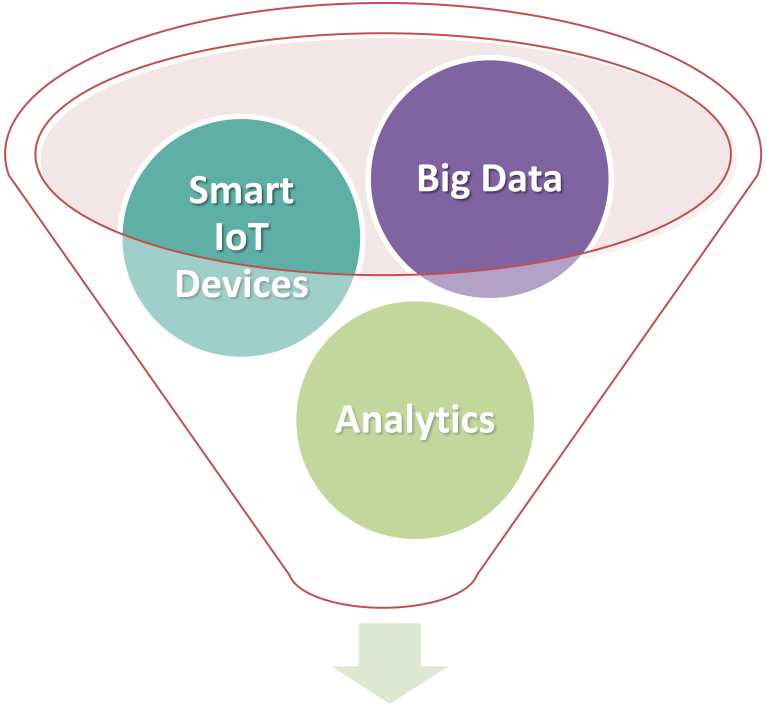
Digital Building for 21st Century

- “a bridge to a greener future”
- “a vehicle to reach occupant health and wellness”
- “an approach to a new business model”

Optimize
Predictive
Informative
Healthy
Adaptive
Virtual
Real-Time
Comfort

Today, Tomorrow & Beyond

- Turn data into information, and information into insight

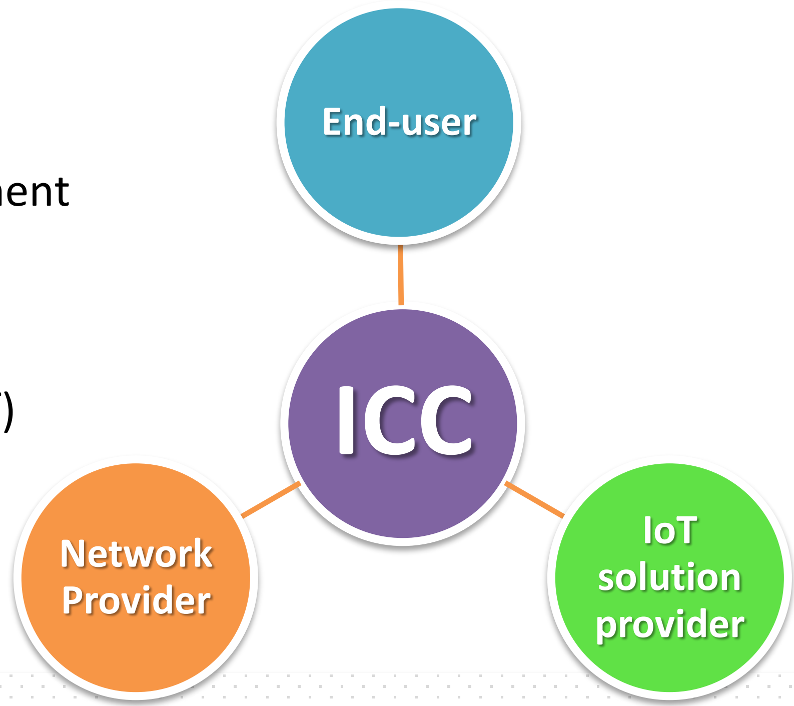


On-going Commissioning
Condition-based Maintenance
Energy Optimization

Smart Buildings Development

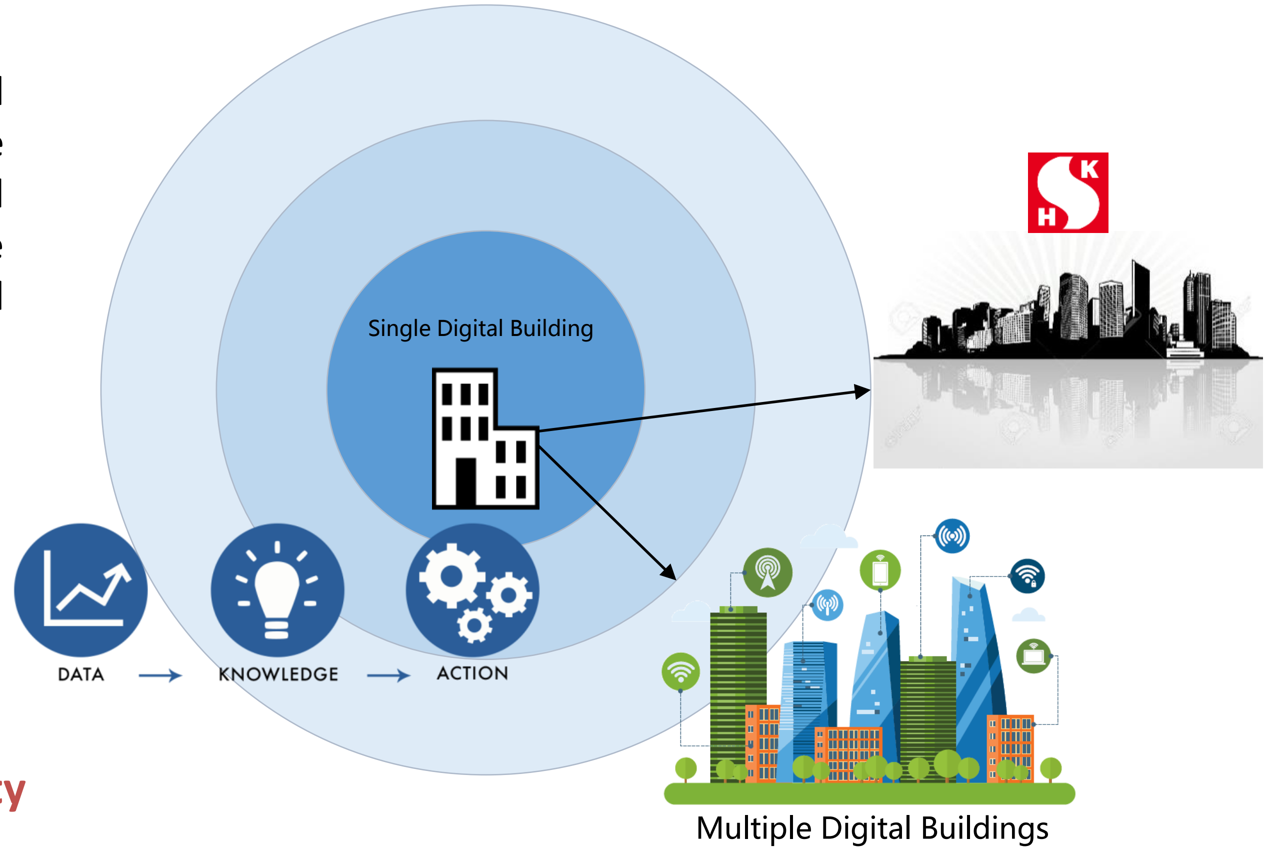
Smart Buildings shall make use of IoT technology to improve energy efficiency and building comfort

- Smart Lighting System
- Smart Lift Control System
- Smart Indoor Air Quality (IAQ) Management
- Optimal Control of Central Cooling & Air Conditioning System
- Air Handler Reborn Project
- Renewable Energy System (Feed-in Tariff)
- Demand Response Programme



Smart Buildings Development

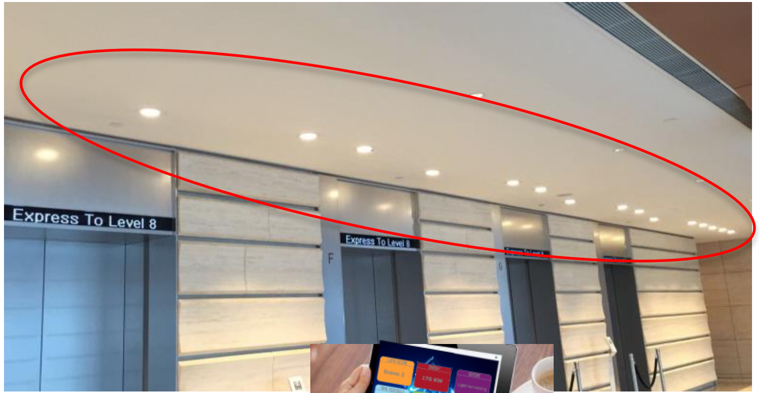
From a single digital building, to multiple digital buildings, and enhance branding of the corporation using digital services

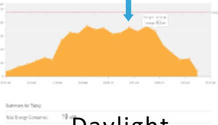


From Smart Buildings transform to Smart City

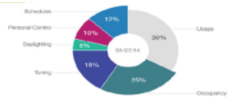
Smart Lighting System

Smart Control for Lighting Pattern & Energy Use Tracing

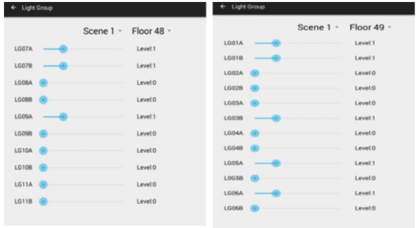




Daylight Harvesting Reprot



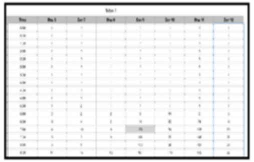
Power Distribution Report



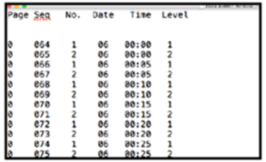
Optimize energy consumption via different lighting sense

Regroup the Date for Analysis

Capture Date, Time & Sensor Level



FTP Raw Data Files



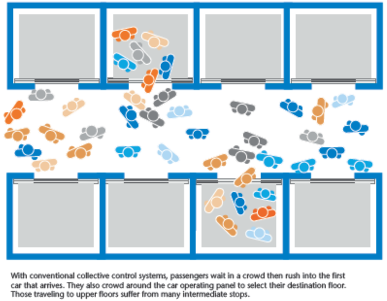
Page	Seq	No.	Date	Time	Level
0	064	1	06	00:00	1
0	065	2	06	00:00	2
0	066	1	06	00:05	1
0	067	2	06	00:05	2
0	068	1	06	00:10	1
0	069	2	06	00:10	2
0	070	1	06	00:15	1
0	071	2	06	00:15	2
0	072	1	06	00:20	1
0	073	2	06	00:20	2
0	074	1	06	00:25	1
0	075	2	06	00:25	2

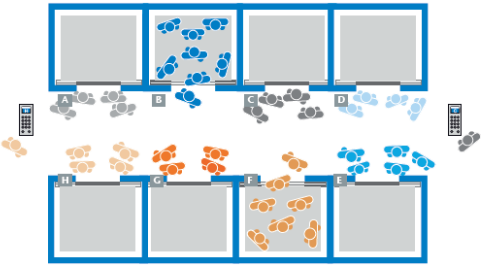
Smart Lift Control System

86 lifts (40 double-deck)

Destination Control System

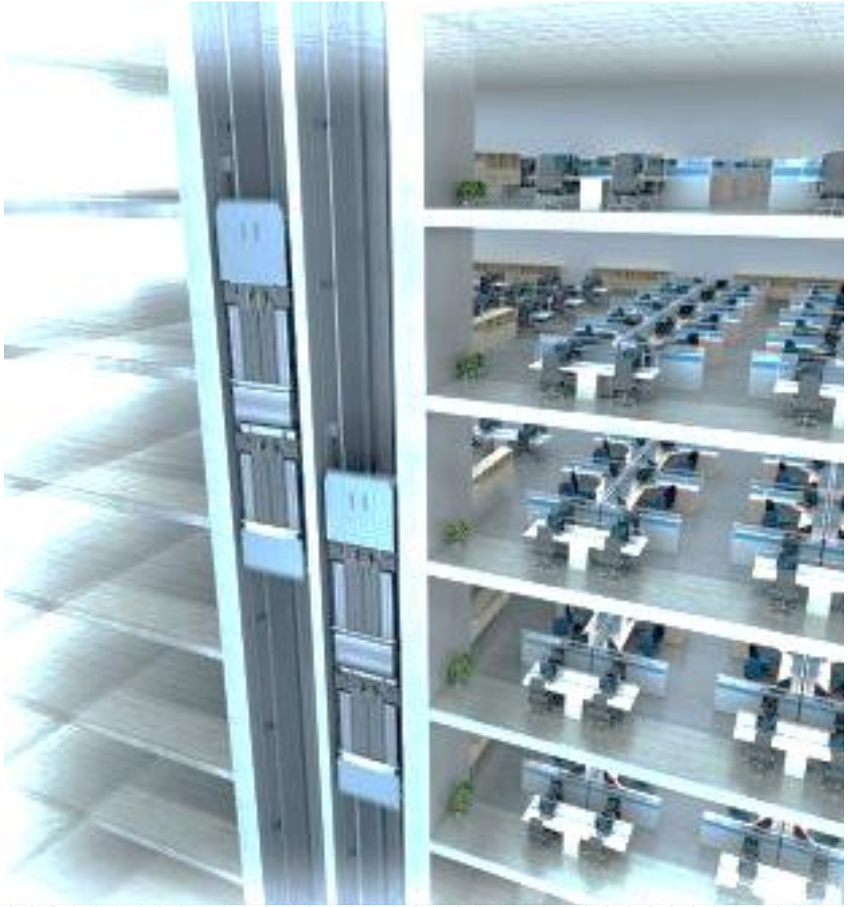
Shorten both travelling and waiting time





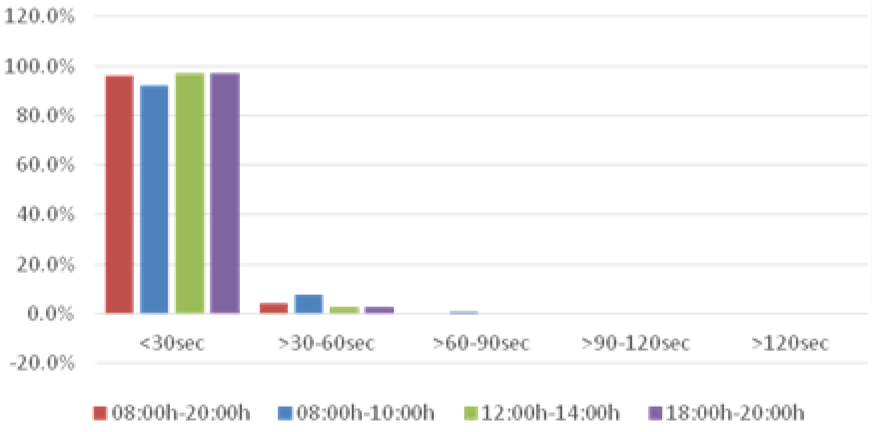
Port

Security for access control & passenger reports by Touch-less system



Smart Lift Control System

Lift Traffic Analysis



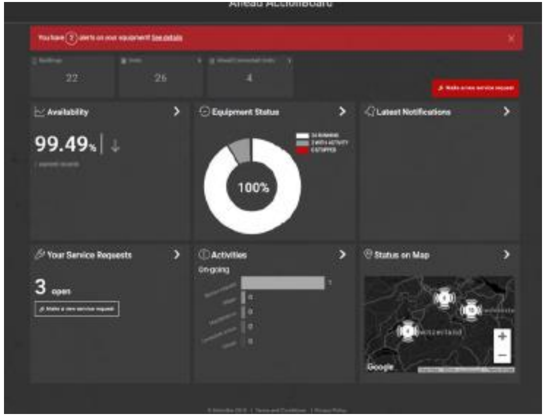
Based on the capability of the lift system to capture key information about traffic patterns of occupants, the availability of lifts will be adjusted to reduce wastage of energy while the facility is idle.

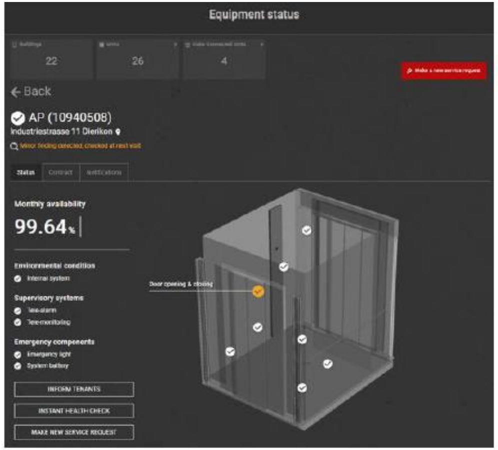
Mon. ~ Fri.		Total. # calls [person]	AWT [sec]	ADT [sec]	Call distribution Waiting Time (in average)				
					<30sec	>30-60sec	>60-90sec	>90-120sec	>120sec
All Day	08:00h-20:00h	31217	5.9	76.9	95.9%	4.1%	0.0%	0.0%	0.0%
Morning peak	08:00h-10:00h	9843	8.5	80.6	92.1%	7.8%	0.1%	0.0%	0.0%
Lunch peak	12:00h-14:00h	7142	5.7	78	97.2%	2.8%	0.0%	0.0%	0.0%
Evening peak	18:00h-20:00h	2901	5.3	76.6	97.3%	2.7%	0.0%	0.0%	0.0%

Smart Lift Control System

Future Development of Internet of Elevators and Escalators (IoEE.) in ICC

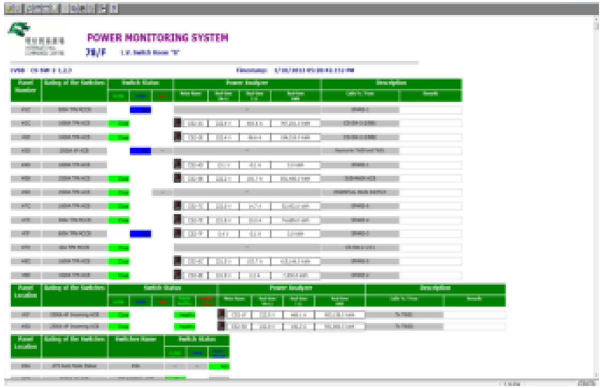
- *Allows proactive on events and to define whom should be informed automatically on equipment status changes*
- *Real-time insights in day-to-day operations and mid-term planning needs, with full transparency on status and maintenance activities notifications.*

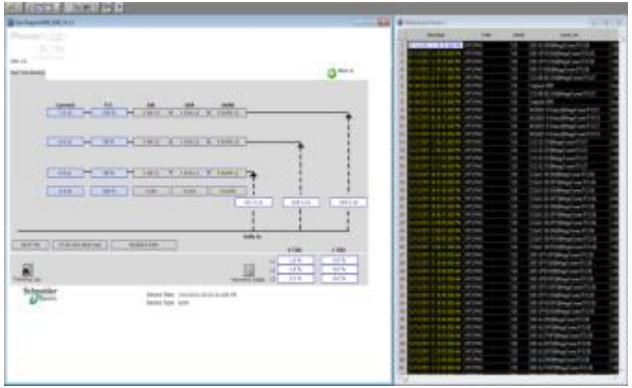


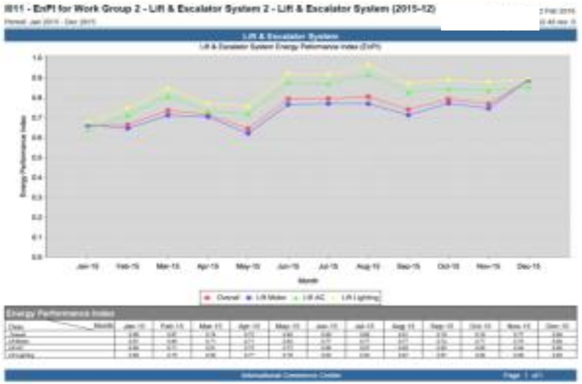


Energy Management System

Use Smart Energy System to record, collect, analyze the power usage data to provide a full picture of each trade, each floor and each time period about energy consumption.

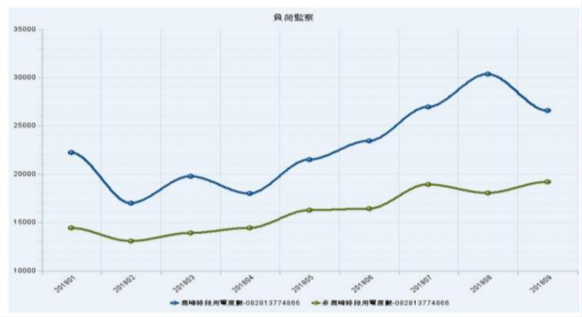


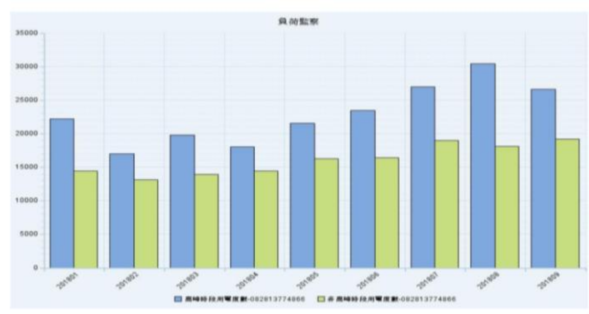




Power Monitoring System (PMS) & Building Energy Management System (BEMS)

- Load Profile
- Load Monitoring
- Energy Analysis
- Forecast Peak Demand





Smart IAQ Management

Whole building of ICC has been awarded "Excellent Class" under Hong Kong IAQ Certification Scheme since 2014.

環境保護署
ENVIRONMENTAL PROTECTION DEPARTMENT

Indoor Air Quality Certificate (Excellent Class)

室內空氣質素檢定證書《卓越級》

Valid period 有效日期: 2 December 2018 to 到 1 December 2019

I hereby certify that the indoor air quality of the following location(s) has fully complied with the Excellent Class of the Indoor Air Quality Objectives.
本人證明下列地點的室內空氣質素完全符合「卓越級」室內空氣質素指標。

Name of building 建築物名稱: International Commerce Centre 環球貿易廣場
Address 地址: 1 Austin Road West, Kowloon 九龍柯士甸道西1號
Certified location(s) 已檢定地點: Whole Office Building 全幢辦公大樓

Approved HKIAS IAQ Signatory
香港認可處核準室內空氣質素簽署人員

Name 姓名: Law Ching Man
IAQ Certificate Issuing Body 室內空氣質素證書簽發機構: Business Environment Council Limited IAQ Solutions Centre
Signature 簽署:
Date of issue 簽發日期: 21 November 2018
Certificate No. 證書編號: 3794024201811(2014)

Organisation Chop 機構印鑑

(This certificate is issued based on the results of the HKIAS endorsed inspection report no. R14-17/18-083)
(此證書是根據香港檢驗機構認可計劃檢驗報告編號 R14-17/18-083 所得之結果發出)

Indoor Air Quality Certification Scheme for Offices and Public Places
辦公室及公眾場所室內空氣質素檢定計劃

Indoor Air Quality Information Centre
室內空氣質素資訊中心

環境保護署
Environmental Protection Department

室內空氣質素資訊中心
INDOOR AIR QUALITY INFORMATION CENTRE

Smart IAQ Management

Needs for Smart IAQ management

- Fit-out works are a fact of life in Hong Kong office buildings, which may induce dust and odour to indoor environment
- The enhanced working environment lowers the absenteeism while boosts the workforce productivity.
- Closely monitor the indoor air quality during fit-out works can minimize impact for occupancies

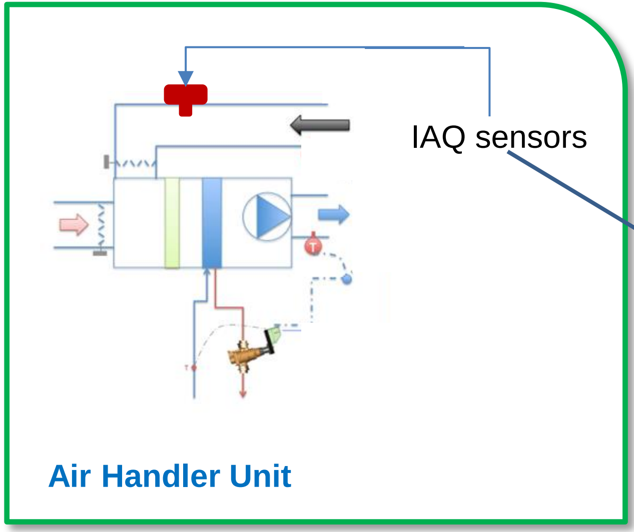
Periodic cleaning of air handling units

Equip with standalone air purifying devices in public areas

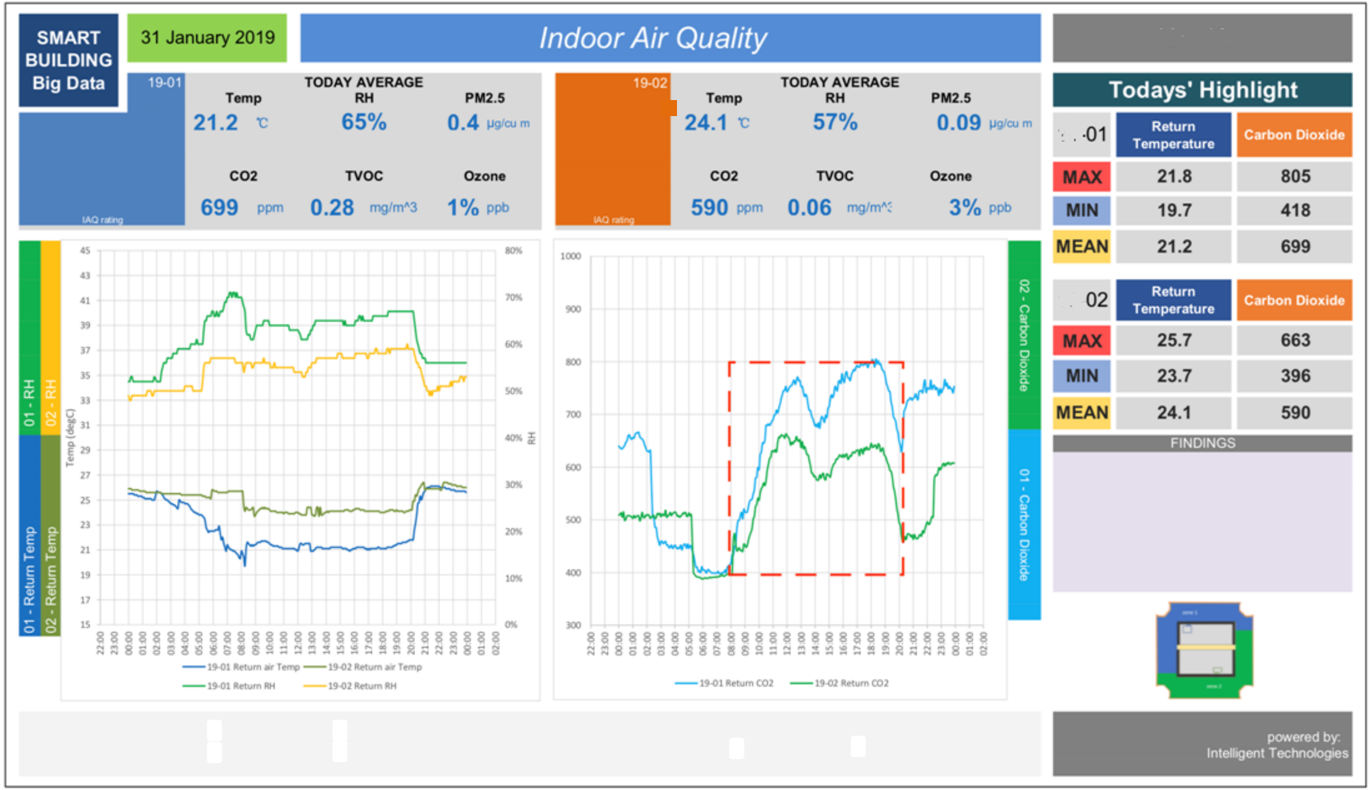
Make use of blowers to enhance air movement during fitting out of premises

Real-time Indoor Air Quality Monitoring System

- With the use of IoT, AHUs are connected for real-time environmental monitoring for **relative humidity, total volatile organic compounds (TVOC), ozone and PM2.5 level**.
- Demand control ventilation is adopted in the office area while IAQ sensors are embedded into the return air duct of AHU.



Real-time Indoor Air Quality Dashboard



Real-time Indoor Air Quality Monitoring System

- IoT connects between occupants, building and building landlord.
- Real-time IAQ monitoring allows heath-focus environment for building occupants. Immediate remedial actions could be taken in case the measured IAQ parameters fall below the acceptable levels.

Building

IAQ sensors are embedded into return air duct of AHU

Occupants

Facility Management Team

DCV is adopted, controlling outdoor air supply based on the **real-time occupancy conditions**

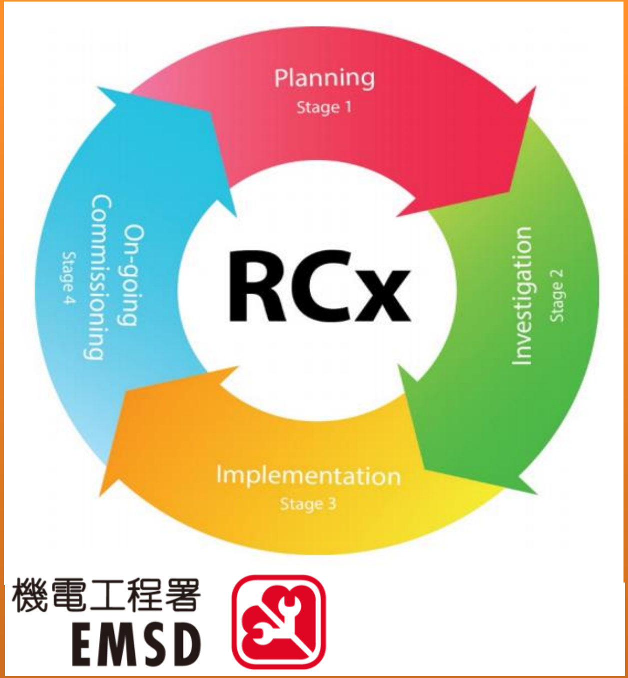
Outdoor air control is **optimized without sacrificing IAQ** while **energy-saving** could be achieved

IoT PROJECT 1
OPTIMAL CONTROL OF CENTRAL COOLING AND AIR CONDITIONING SYSTEM

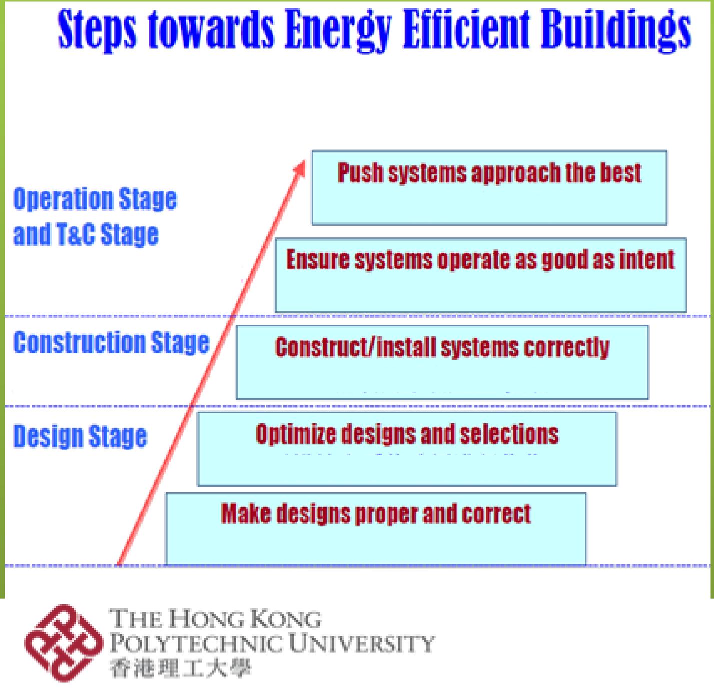
Collaboration with Academia

Life Cycle Commissioning Works

Retro-commissioning



Life Cycle-commissioning

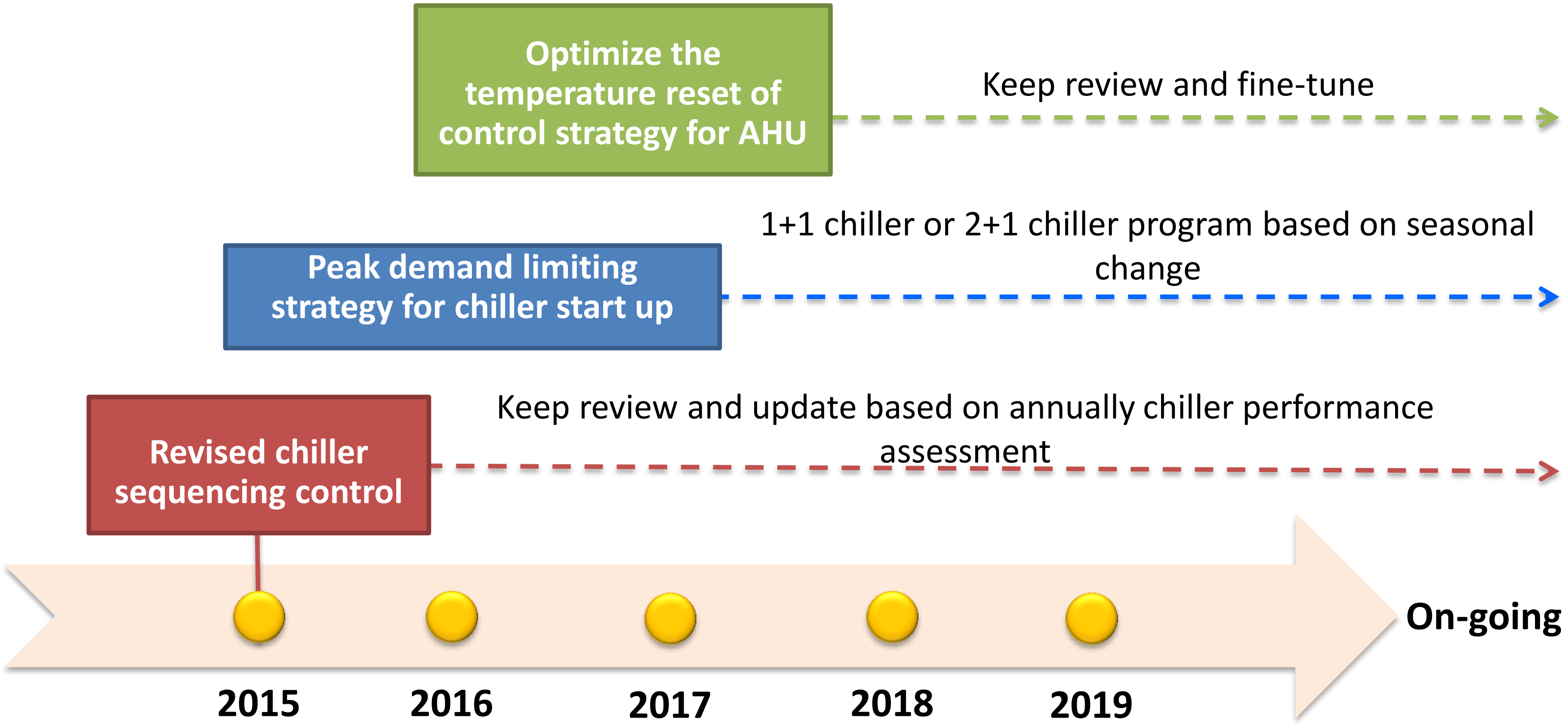


Energy Performance Enhancement Work

Optimal AC Control Strategies

- Revised Chiller Sequencing Control
- Optimized design configuration of PCHWP for HX
- Optimized cooling tower control
- Optimized HX control logic
- Optimized chiller water supply temperature
- Optimized control of secondary pump for AHU
- Peak demand limiting strategy
- Optimized control of AHU supply air static pressure

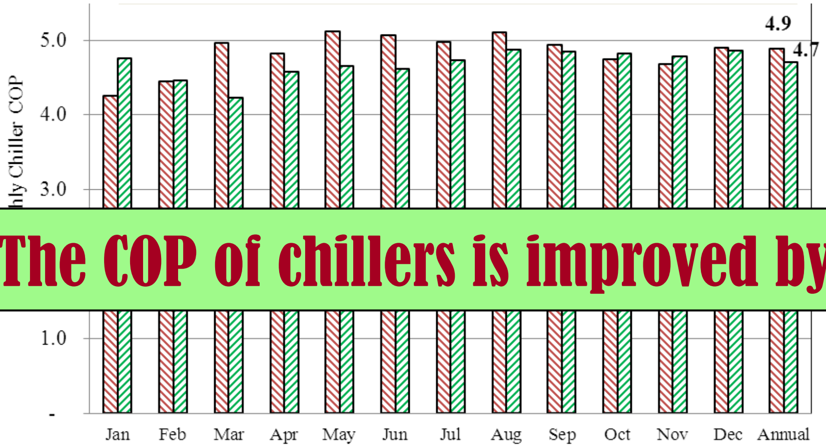
Energy Performance Enhancement Work



Optimize Chiller Sequence Control

Original Control: If cooling load <1000 RT, then operating chiller 2->1

Revised Control: If cooling load <1500 RT, then operating chiller 2->1



The COP of chillers is improved by 3.7%

Revised Chiller Sequencing Control

Big Data Analysis

The multilinear regression model used in the chiller sequencing control also have to be updated using the most recent operation data

$$Q_{ev,\max} = c_0 + c_1 \cdot p_{ev} + c_2 \cdot p_{cd}$$

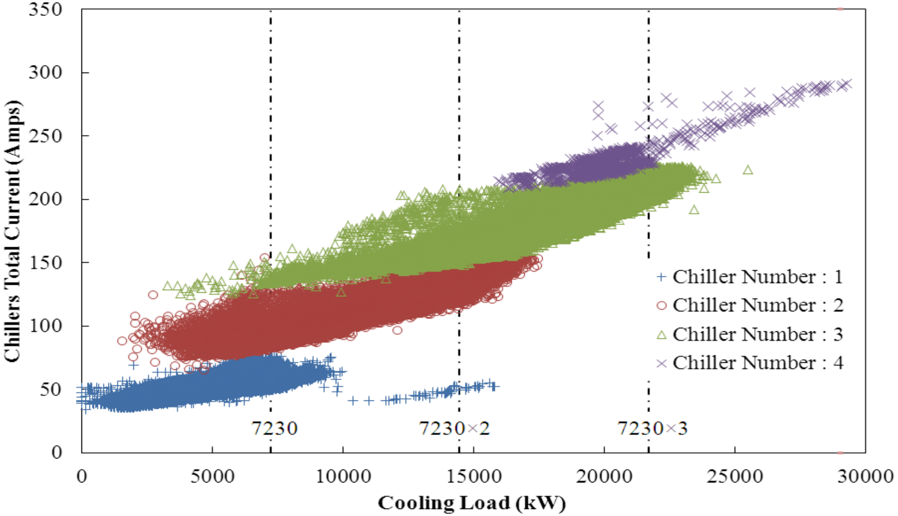
where, *c0*, *c1*, *c2* are regression coefficients based on operating history data. The coefficients shall be updated periodically

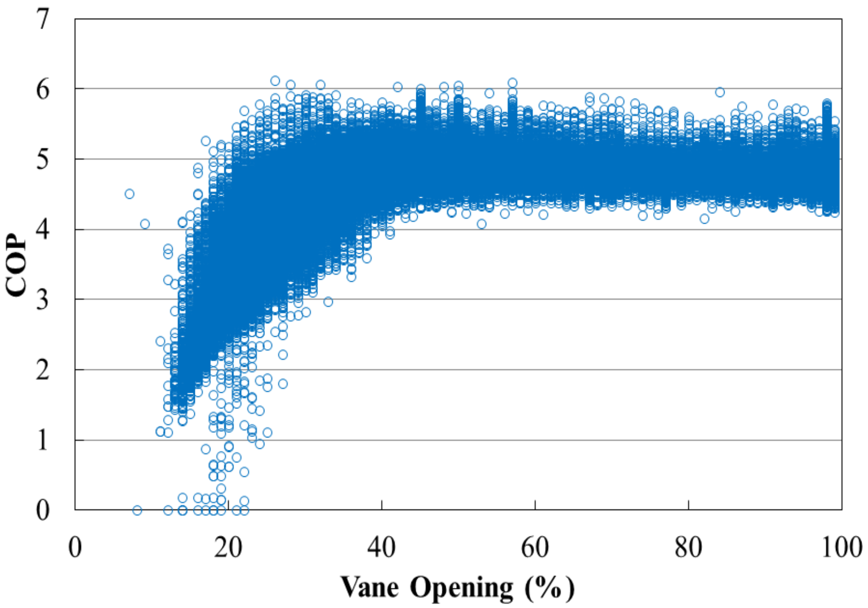
Remove chiller
One running chiller vane opening < **50**%, and $Q_{\max} \cdot 90\% > Q_{tot}$

Chiller #	c_0	c_1	c_2
1	3679.002	25.518	-3.462
2	3632.291	35.282	-5.607
3	2583.231	38.515	-5.073
4	10457.785	6.401	-3.741
5	3582.208	29.722	-4.199
6	4396.750	17.025	-2.367

The estimated saving is about 3%

Further Improved Chiller Sequencing Control

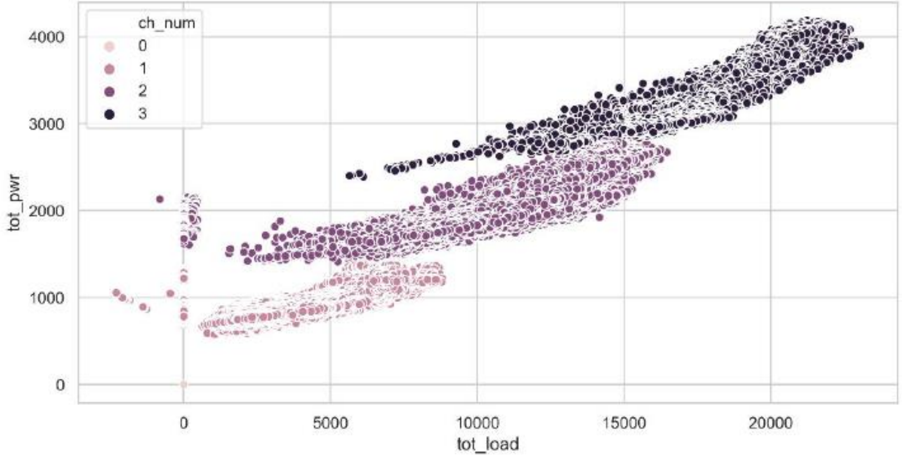




COP is high if chiller vane opening is above 40%

COP is high if chiller vane opening is above 40%

Further Improved Chiller Sequencing Control



Chiller #	c_0	c_1	c_2
1	4192.728	21.588	-2.705
2	3422.679	27.446	-2.988
3	4418.941	37.989	-8.1444
4	9793.504	7.729	-5.222
5	5207.251	16.0198	-1.9788
6	8928.752	1.2137	-3.0327

Table 1 Percentage of time of different chiller number in the two years

Chiller number	0	1	2	3	4
2014	0.10%	59.80%	25.50%	14.40%	0.30%
2015	0.30%	59.50%	26.20%	14.10%	0
2016	0.40%	43.10%	31.70%	12.70%	12.10%
2017	0.10%	66.40%	21.80%	11.70%	0
2018	0.00%	65.50%	22.20%	12.30%	0

$$Q_{ev,\max} = c_0 + c_1 \cdot p_{ev} + c_2 \cdot p_{cd}$$

Coefficients are reviewed regularly and was updated in Feb 2019

Optimize Temperature Reset Control Strategy for AHU

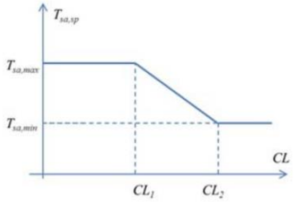
- Find the optimal supply air temp set point
- (Original) By supply air fan speed
- (New) Calculate cooling load of individual AHU by real-time cooling load through air side sensors
- Prevent the downstream effect during low cooling demand season, therefore guarantees indoor thermal comfort.
- Annual energy saving: 250,000 kWh

Original Control

Increase set-point	Decrease set-point
AHU VSD < 60% for 700s (+0.5 DegC)	AHU VSD > 70% for 300s (-0.5 DegC)

constrains
Max: 18 DegC (Summer), 20 DegC (Winter)
Min: 13 DegC (Summer), 16 DegC (Winter)

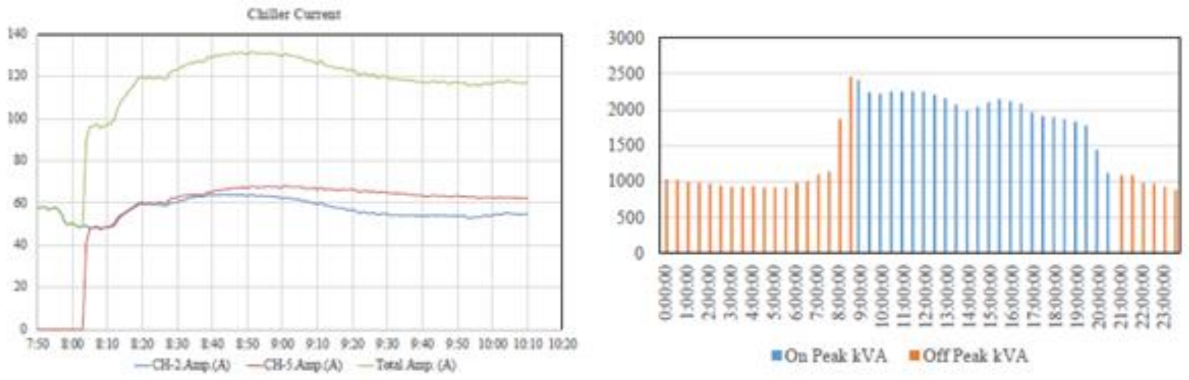
Modified Control



$$CL = M_{sa} \cdot (\rho_{sa} \cdot h_{ra} - \rho_{ra} \cdot h_{sa})$$

Peak Demand Limiting Strategy for Chiller Start Up

- Peak demand affects electricity cost and thus, there is room of electricity cost savings
- Applied area: all AHUs start at 8:00am simultaneously which would result in a peak in demand curve with high probability
- A deep analysis on the impact of morning peak demand was conducted to evaluate the possibility of reducing electricity cost, as well as energy consumption

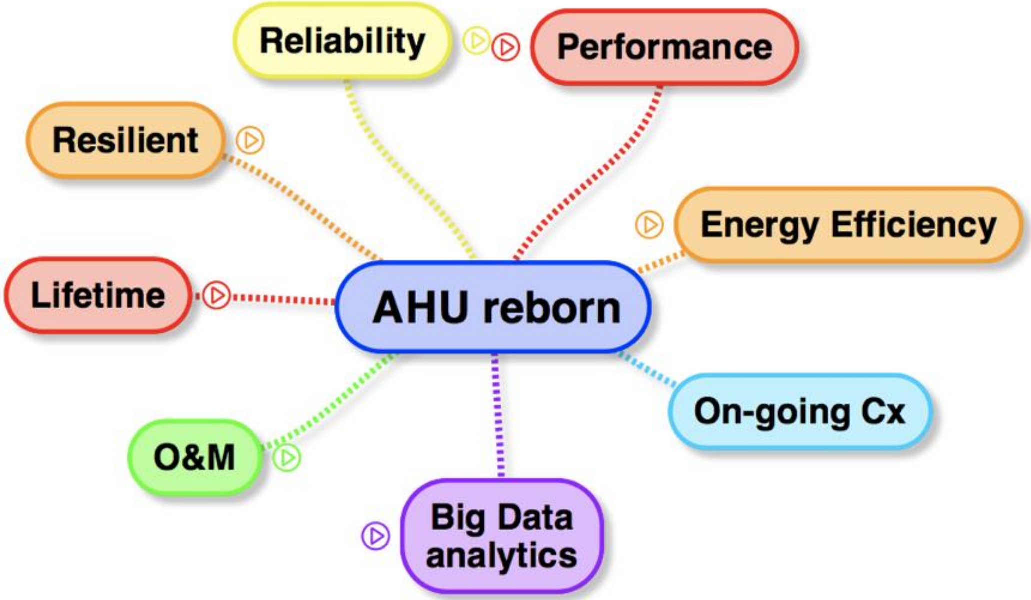


Chiller current and load profile in CLP online meter

IoT PROJECT 2
AIR HANDLER REBORN PROJECT

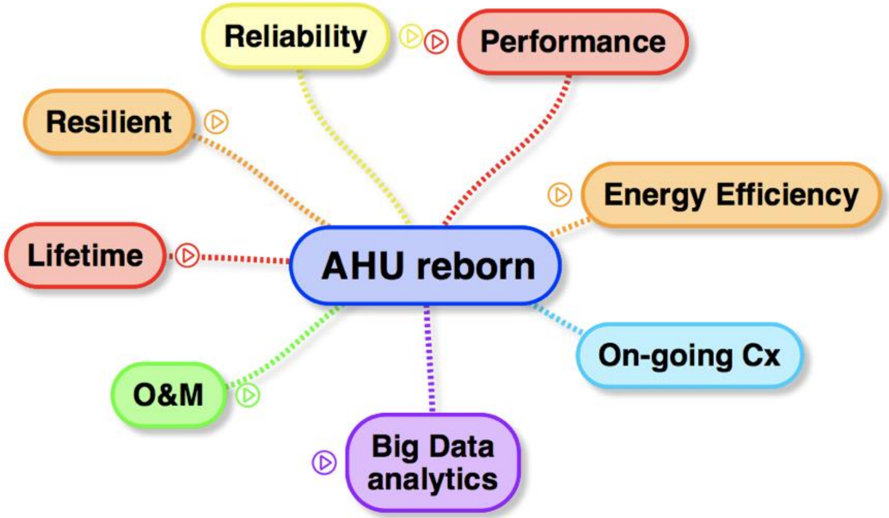
Collaboration with Industrial Partner

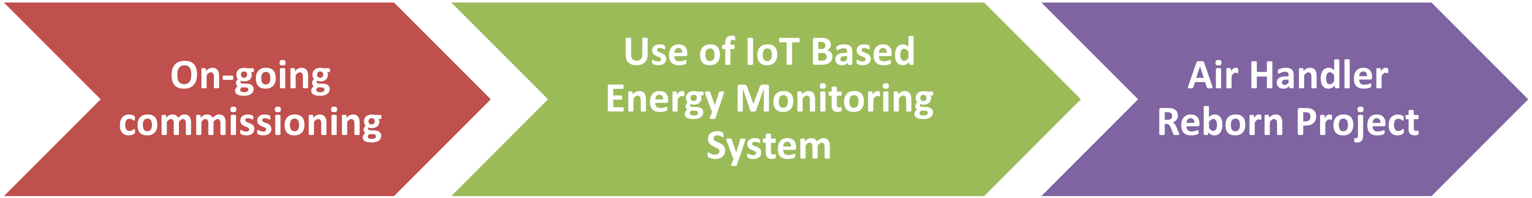
On-going Commissioning Works for AHUs



On-going Commissioning Works for AHUs

- Reliability improvement
- Improve energy efficiency
- Performance improvement
- On-going commissioning
- Predictive maintenance
- Get CONNECTED
- Data analytics
- Lift cycle improvement





環球貿易廣場 INTERNATIONAL COMMERCE CENTRE

Air Handler Reborn Project

IoT Based Energy Monitoring System

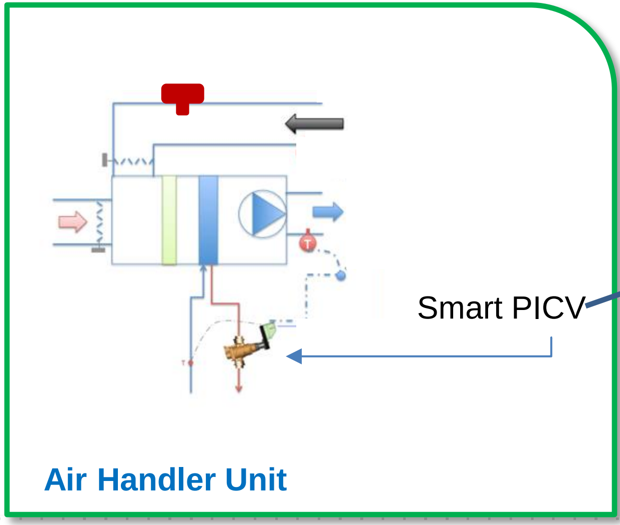
On-going commissioning → Use of IoT Based Energy Monitoring System → Air Handler Reborn Project

- Provide continuous retro-commissioning for the HVAC system
- Better optimization of energy saving and comfort
- Further saving real-time energy costs by weather forecast
- Help condition-based maintenance by machine learning algorithms
- Achieve energy conservation by enhanced operation control strategies based on past operational pattern and real-time data
- Real-time data visualization and big data analysis (trends of cooling load and energy profiles) allow the identification of needs and improvement opportunities across time and seasonal changes.

Air Handler Reborn Project

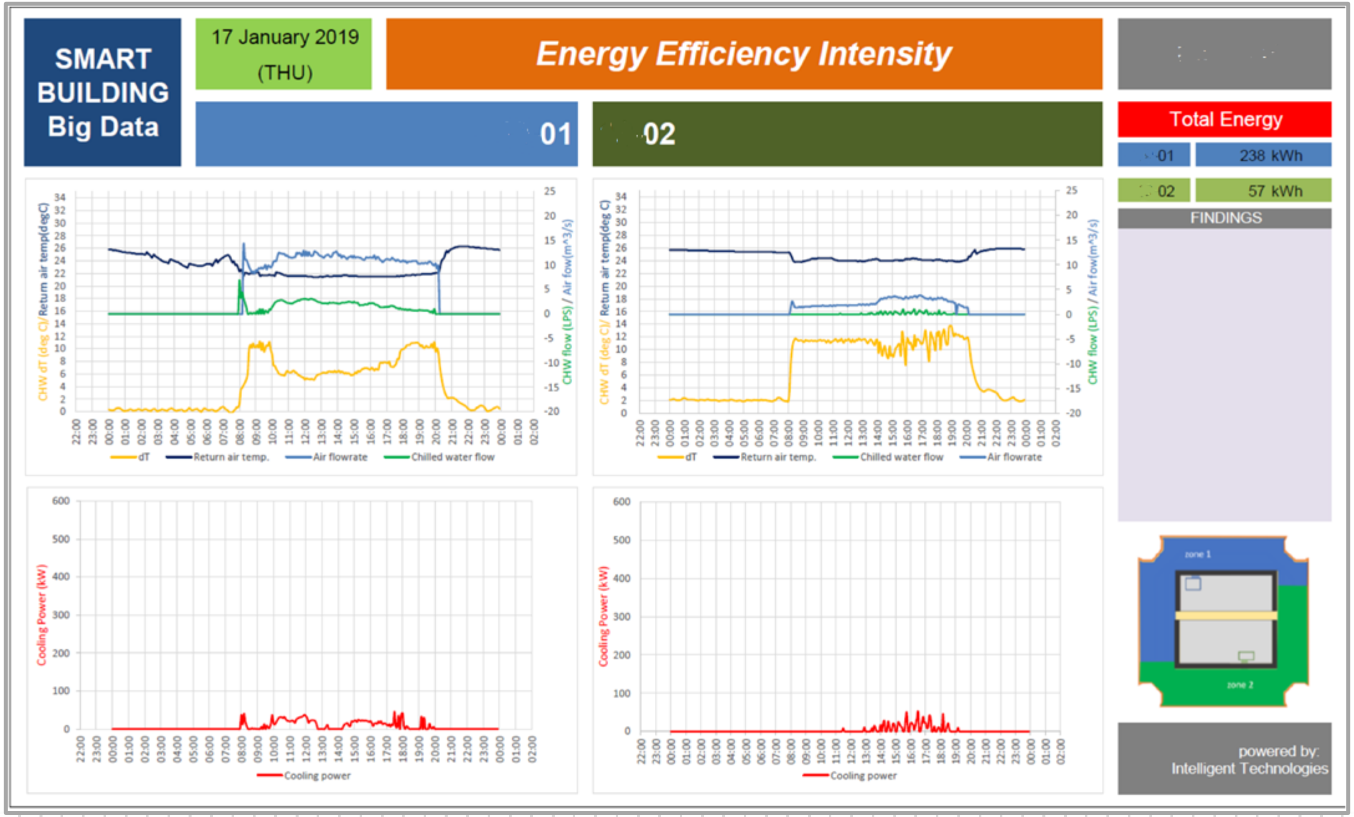
IoT Based Energy Monitoring System

- AHUs are connected by IoT devices, SMART pressure independent control valve.
- Real-time data monitoring includes air volume, chilled water delta temperature & flow rate, cooling energy and power consumption.
- Day-to-day energy consumption of air-side system is monitored closely.



Air Handler Reborn Project

Energy Efficiency Dashboard

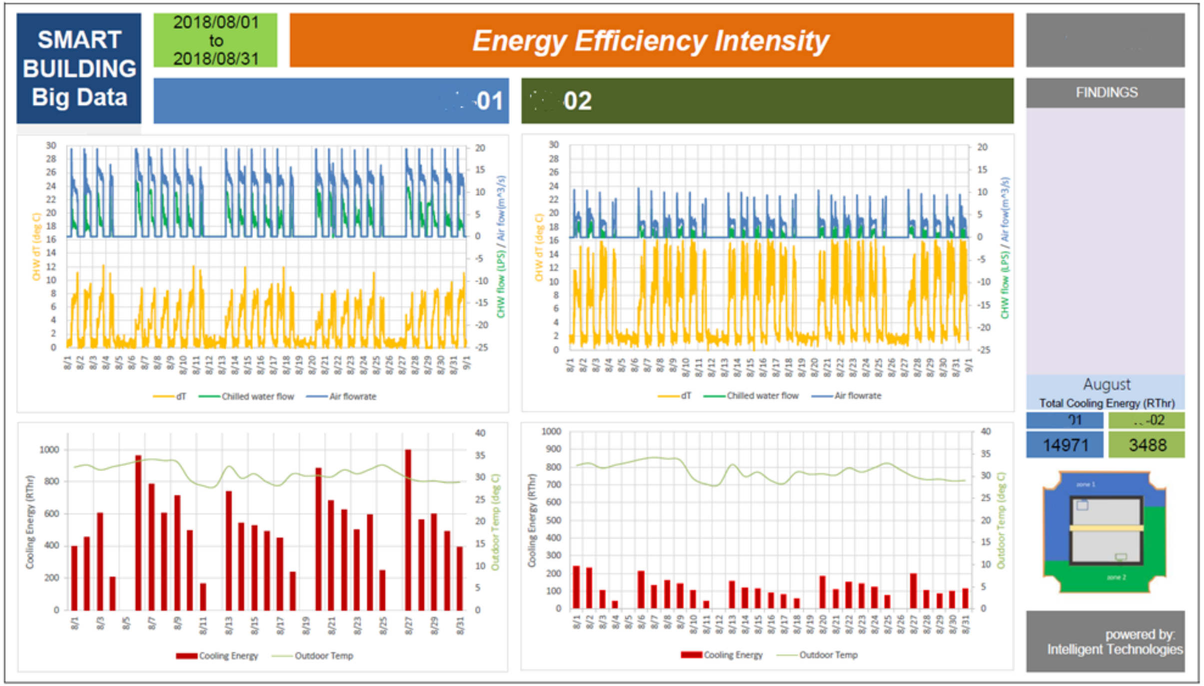


環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

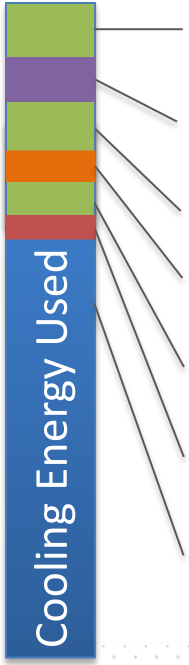
Air Handler Reborn Project

Big Data Analytics

IMPORVE COMFORT **IMPORVE ENERGY PERFROMANCE**



Energy saving categories:

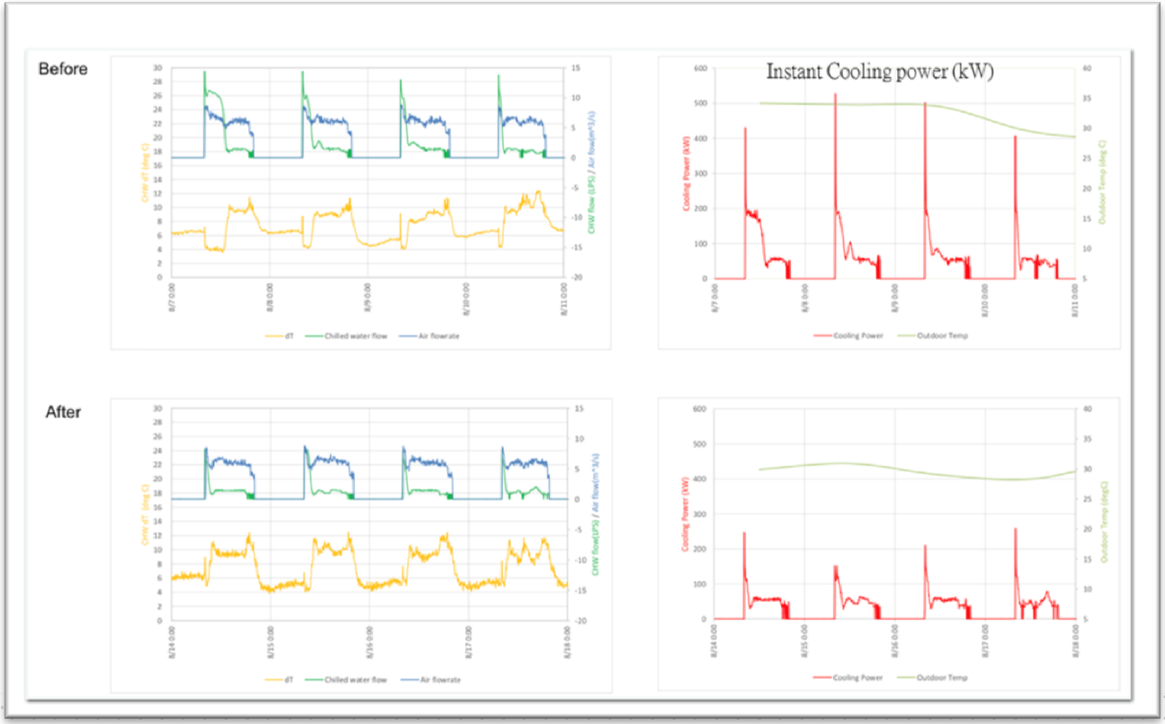


- Eliminate excess flow
- Adjust AHU operating hours by learning usage profile
- Supply temp reset
- Pump optimization
- Improve chilled water supply temp & system remedial
- Improve control logic by self learning
- Miscellaneous

Air Handler Reborn Project

Big Data Analytics for On-going Commissioning

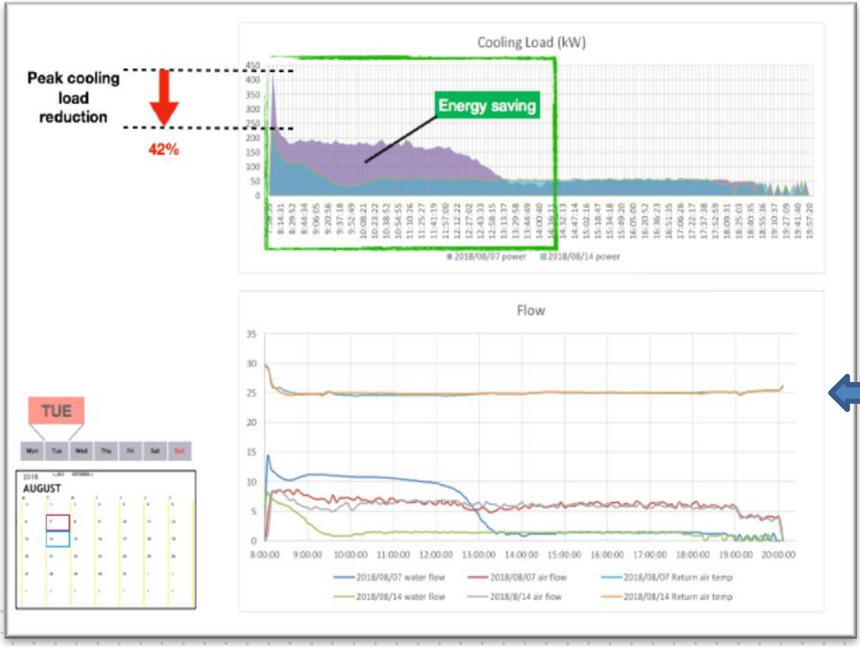
- To identify energy saving opportunities & implement on-going commissioning



Air Handler Reborn Project

Big Data Analytics for On-going Commissioning

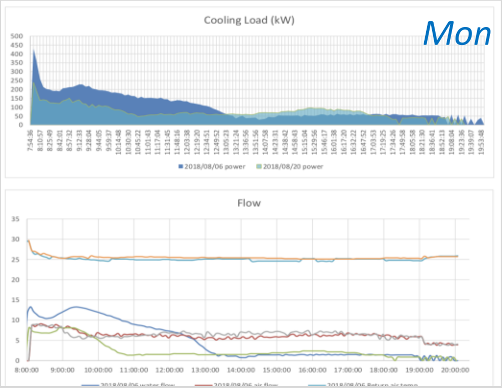
- Retro-commissioning the system based on the load trend analytics.
- By simulation algorithm, we optimize the flow control to achieve energy saving but not affecting the comfort level (return air temperature)

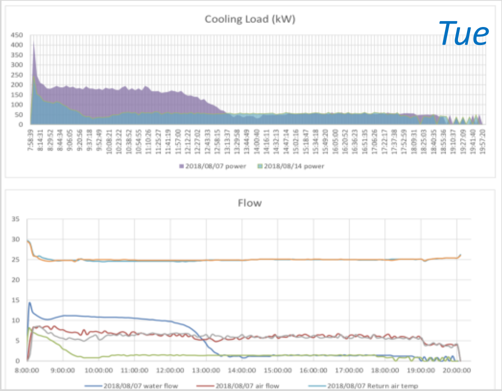


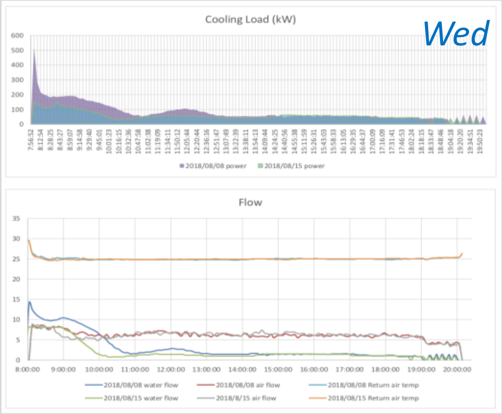
Return air temp

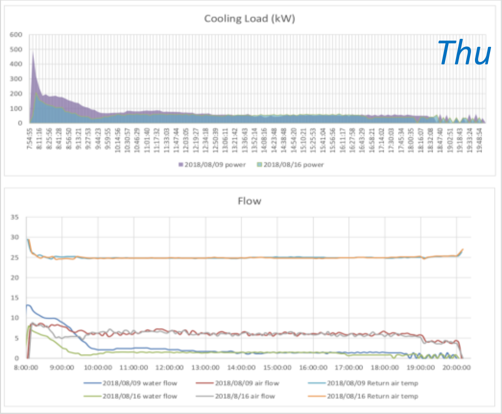
Air Handler Reborn Project

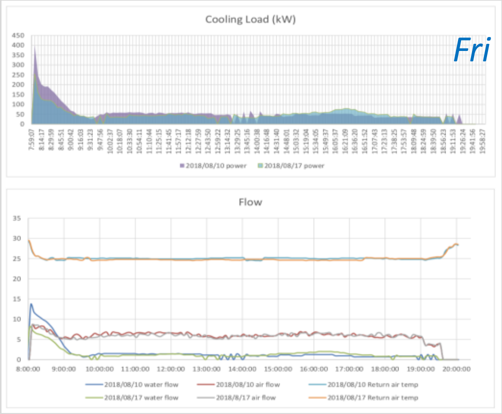
Big Data Analytics for On-going Commissioning











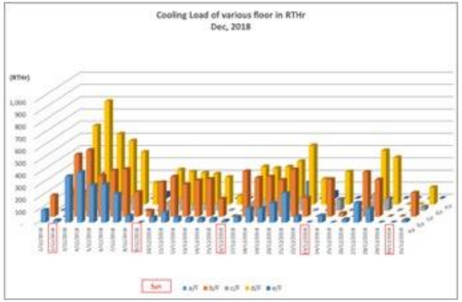
- Each zone has its own profile/ characteristic
- Optimization for each zone based on the zone weekly profile & characteristic
- Maximize energy saving is achieved responding to the zone characteristic

Air Handler Reborn Project

Big Data Analytics for On-going Commissioning

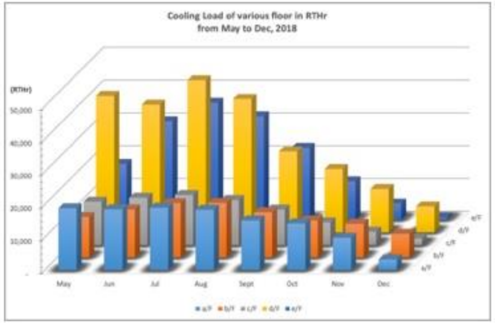
Continuous Improvement through Analytics

monthly Performance Analytics of each floor



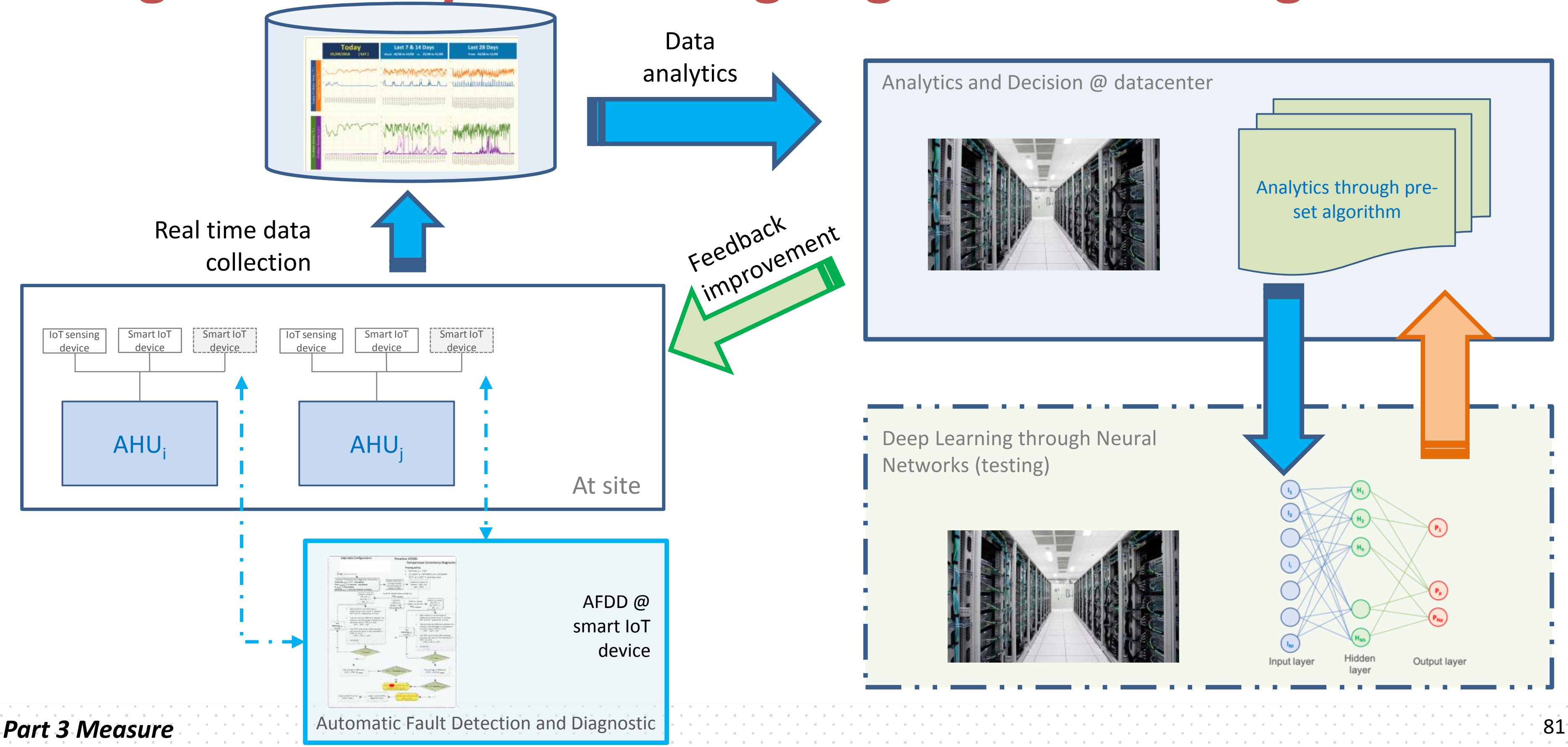
Performance Monitoring

- On-going energy saving monitoring;
- On-going Commissioning;
- Proactive maintenance action;
- Quick fault detection and diagnostics;



Air Handler Reborn Project

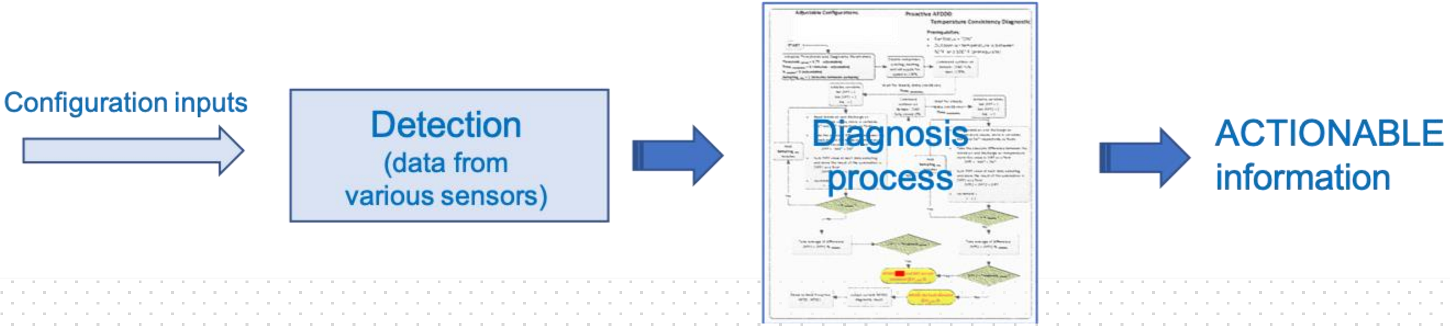
Big Data Analytics for On-going Commissioning



Air Handler Reborn Project

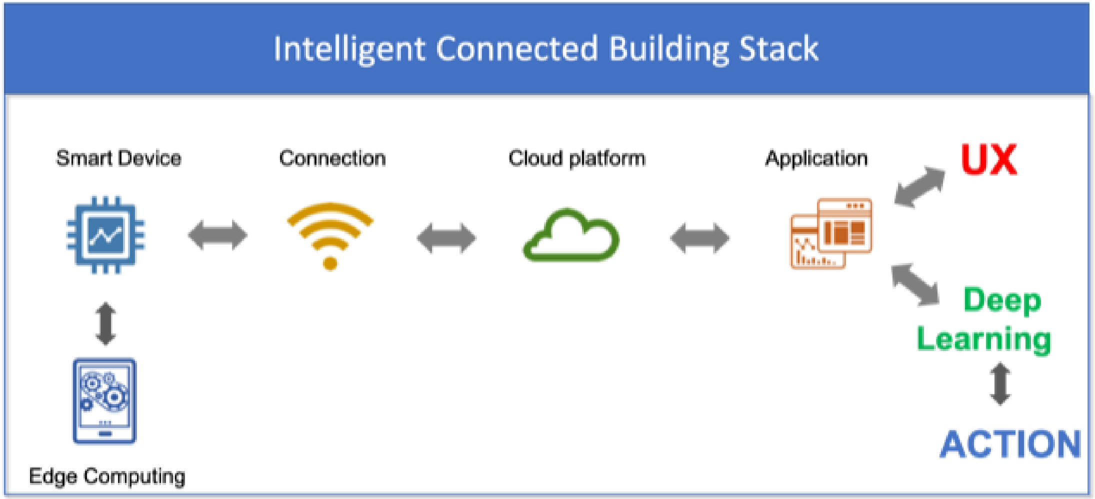
Automatic Fault Detection and Diagnostic

- Smart IoT devices with built-in automated fault detection and diagnostic process are employed
- Some algorithms include:
  - Detection of AHU/valve status/fault
  - Detection of actuator modulating status/fault
  - Detection of temperature sensor status/fault
  - Comparison of air/chilled water temperature for consistency
- Passive diagnostic process helps identify the failure in order to improve ACTION time
- Proactive diagnostic process helps diagnose and isolate faulty operations



Cloud Technologies

- Emerging Cloud technologies are used for data acquisition, analytics, storage; which benefit in faster setup, flexible resources and economies of scale
- Enable us to do data-mining in cross databases
- Enable us to share data in various applications to enhances our services



Air Handler Reborn Project

Energy Saving & Payback

Weekly Energy Saving of **one** AHU in August 2018

809 kWh

HK$970

Annual Saving for All Office Floors

65 Floors

> 3,005,000 kWh

HK$3.75 million

ROI = 1.3 Years

Summary of Air Handler Reborn Project

- *Retro-commissioning* of HVAC system beyond chiller plant is not easy, but we did it
- Result achieved in the area deployed:
  - *Cut Peak kW by 40%;*
  - *Estimated energy saving over 3 million HK dollar after applying to all office floors;*
  - *ROI 1.3 years;*
- Emerging technologies were used:
  - *IoT technologies*
  - *Cloud technologies*
  - *Big-Data analytics*
- Provide a retro-commissioning model for existing buildings
- Not only retro-Commissioning, but an on-going Cx solution
- Energy saving, but not compromise in human comfort
- Quick deployment and result model through emerging technologies

環球貿易廣場
INTERNATIONAL
COMMERCE CENTRE

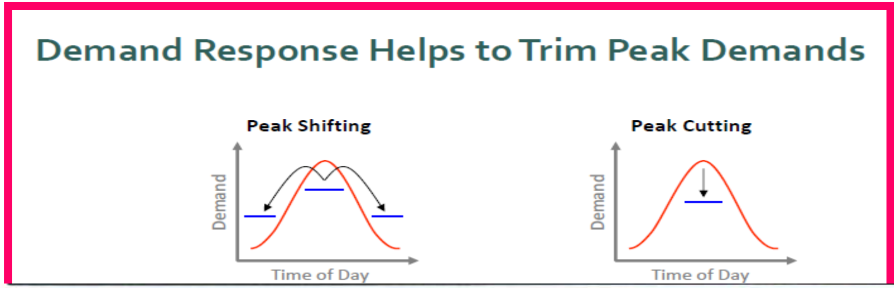
PROJECT 3
DEMAND RESPONSE PROGRAMME

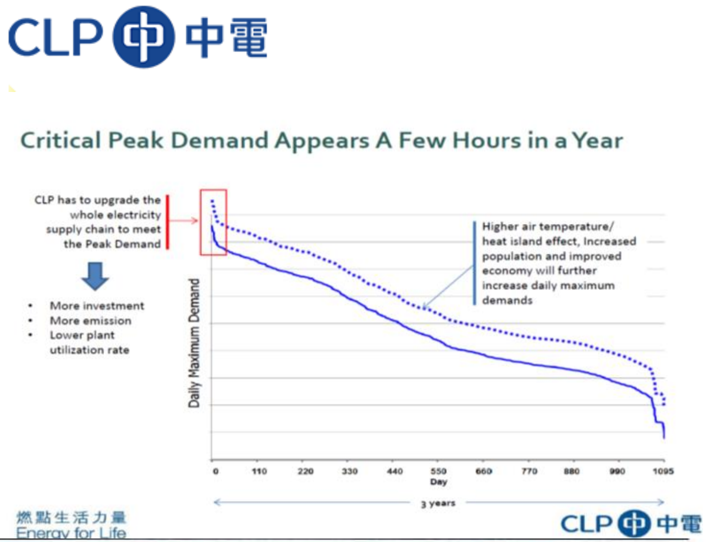
Collaboration with Power Company and NGOs

Demand Response Programme

CLP's Bi-lateral Demand Response (BDR) Programme

ICC joined the Bi-lateral Demand Response (BDR) programme launched by Power Company - CLP for reduce electricity demand during CLP peak demand hours and achieved **463 kWh saving** as well as acquired an incentive cost of HK$6,685

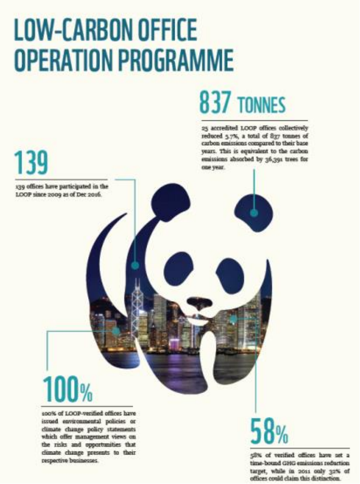




EVENT & INCENTIVE PAYMENT							
Event ID	Type	Date	Starting Time	Duration (hr)	Execution Status	Participated (Y/N)?	Incentive Payment(HK$)
AP-DO-170822	DAY-OF	22.08.2017	1400	2	Executed	Y	6,165
DR-DA-170821	DAY-AHEAD	21.08.2017	1800	4	Executed	Y	520
						Total:	6,685

Low Carbon Programme

承諾支持世界自然基金會地球一小時
IS COMMITTED TO WWF'S EARTH HOUR



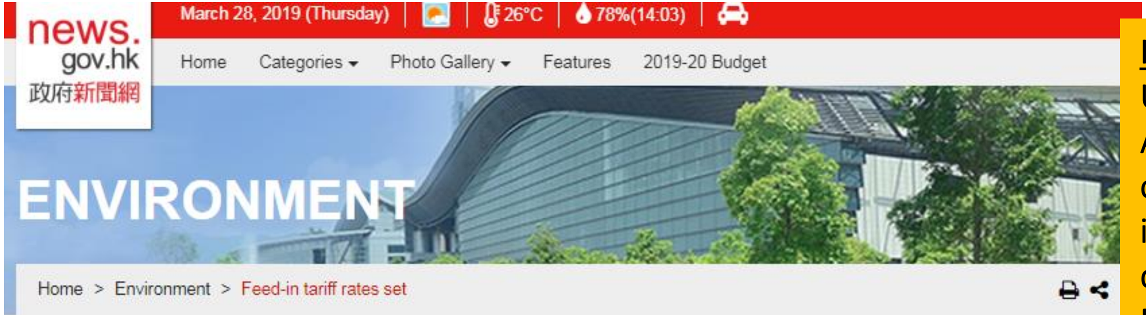
環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

PROJECT 4
RENEWABLE ENERGY

Collaboration with Power Company

Renewable Energy System

HK Government launches Feed-in Tariff Rate



Home > Environment > Feed-in tariff rates set

Feed-in tariff rates set

April 17, 2018 Like 0

港燈 HK Electric 125

CLP 中電

The Government has decided to set the Feed-in Tariff rates at $3, $4 and $5 per unit of electricity depending on the generation capacity of the renewable energy system concerned.

Feed-in Tariff (FiT) Rates

FiT rates will be offered according to the generation capacity of renewable energy power systems (REPS). The FiT rates effective from 1 January 2019 are:

REPS capacity (kW) (Note 1)	≤10	>10 – ≤200	>200 – ≤1,000
FiT rate (HK$ per unit) (Note 2)	$ 5	$ 4	$ 3

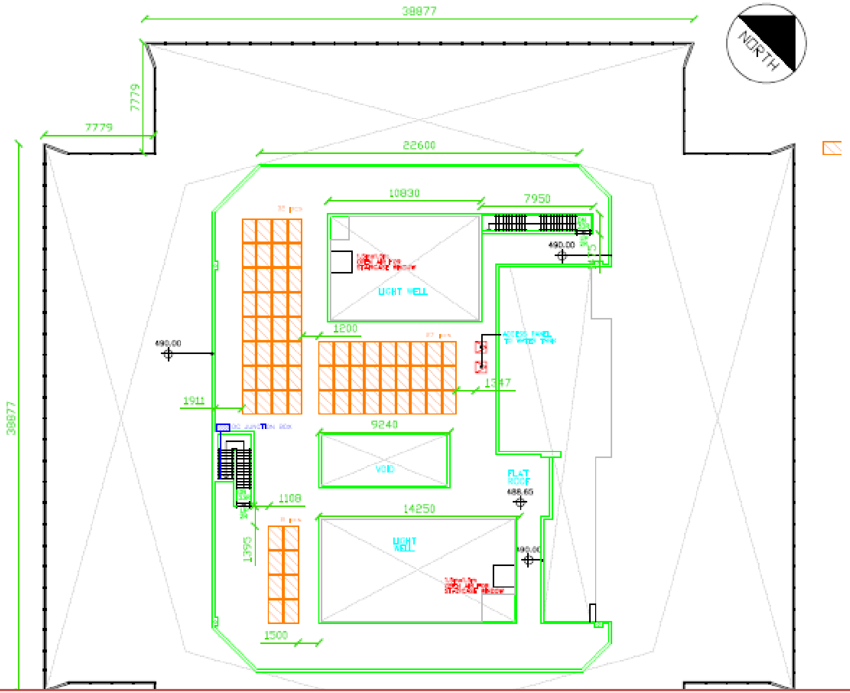
Key Information

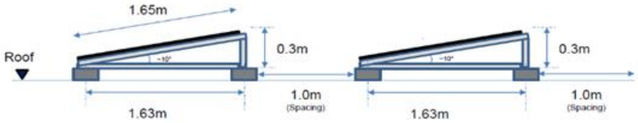
Under the post-2018 Scheme of Control Agreements (SCAs) with the two power companies, Feed-in Tariff (FiT) is one important new initiatives to promote the development of distributed Renewable Energy (RE).

FiT will help encourage the private sector to consider investing in RE as the power generated could be sold to the power companies (HK Electric and CLP) at a rate higher than the normal electricity tariff rate to help recover the costs of investment in the RE systems and generation.

Renewable Energy System

Feed-in Tariff

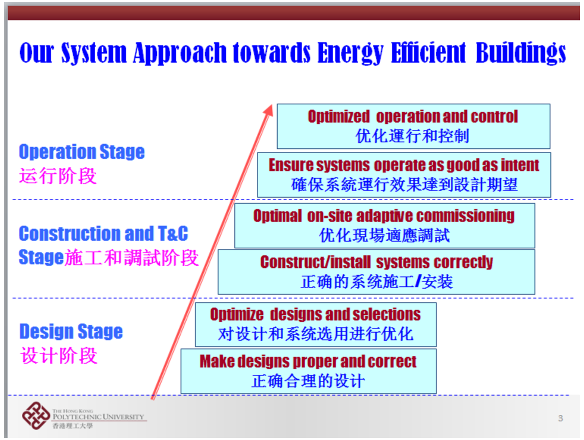




Estimated 20,000 kWh Energy Generated Annually in ICC

Section 4
Performance

Key Energy Saving Performance Highlights



1,000,000 kWh *energy consumption is saved due to the modification on the secondary water loops of Zone 3 & 4*

2,360,000 kWh , (about 5.1% *of annual energy consumption of chillers and cooling towers) of the cooling system can be saving due to the change from single speed to variable speed using VFD*

607,000 kWh , (about 2.8% *of annual energy consumption of chillers and cooling towers) of the cooling system will be wasted when the lowest frequency is limited at 37 Hz*

3, 500,000 kWh (about 7%) *of the total energy consumption of HVAC system) can be saved using PolyU control strategies based on the original design*

Key Energy Saving Performance Highlights

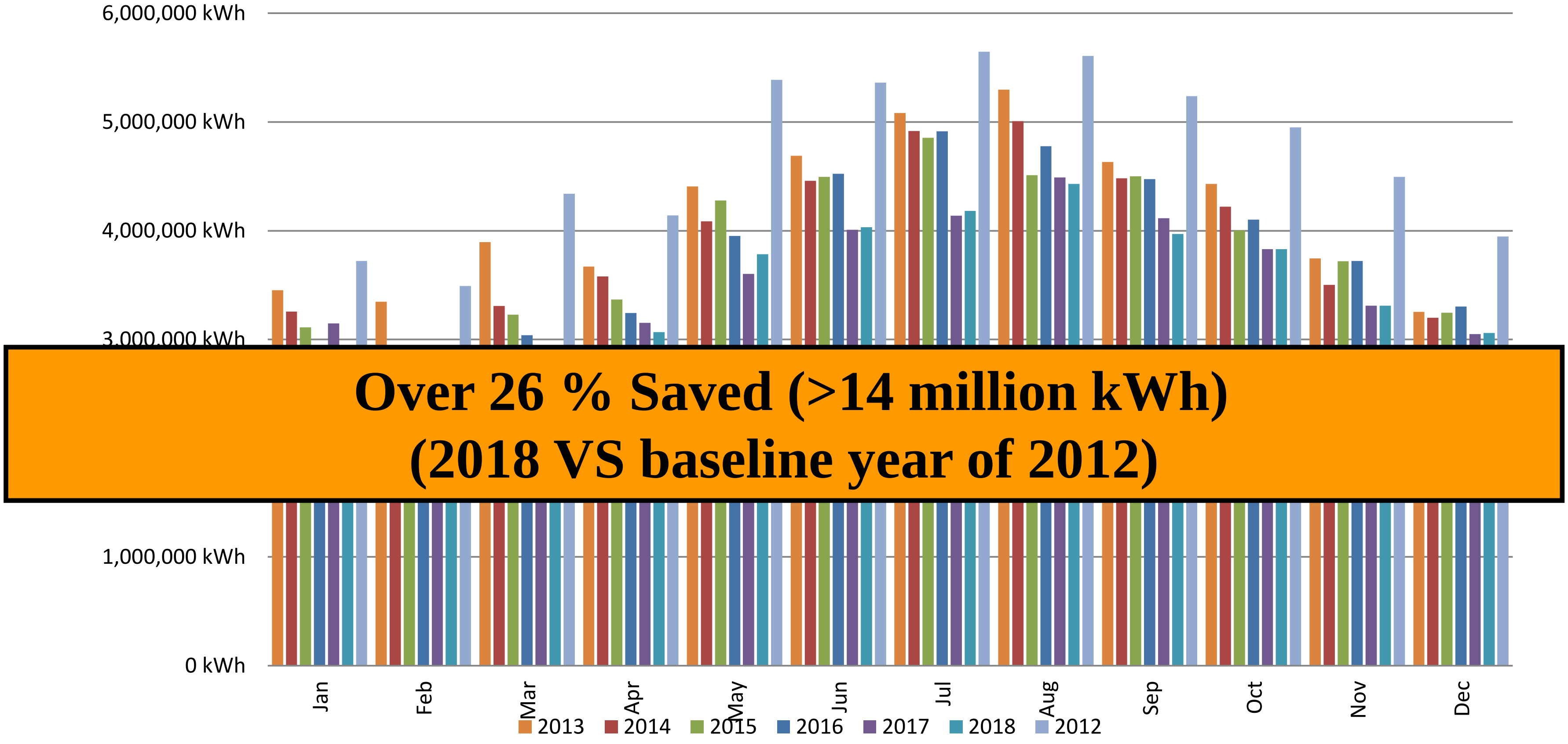
Saving by Design Optimization (Improving the system configuration and selection) *– compared with the original design.* ***About 3.5 M per year***

Saving by Control Optimization *– compared with the case when the HVAC system operates correctly as the original design intent.* ***3.5M per year***

Saving by continuous commissioning and optimization :
About 3.0 M per year

The Annual Total Energy Saving is about 10.0M kWh

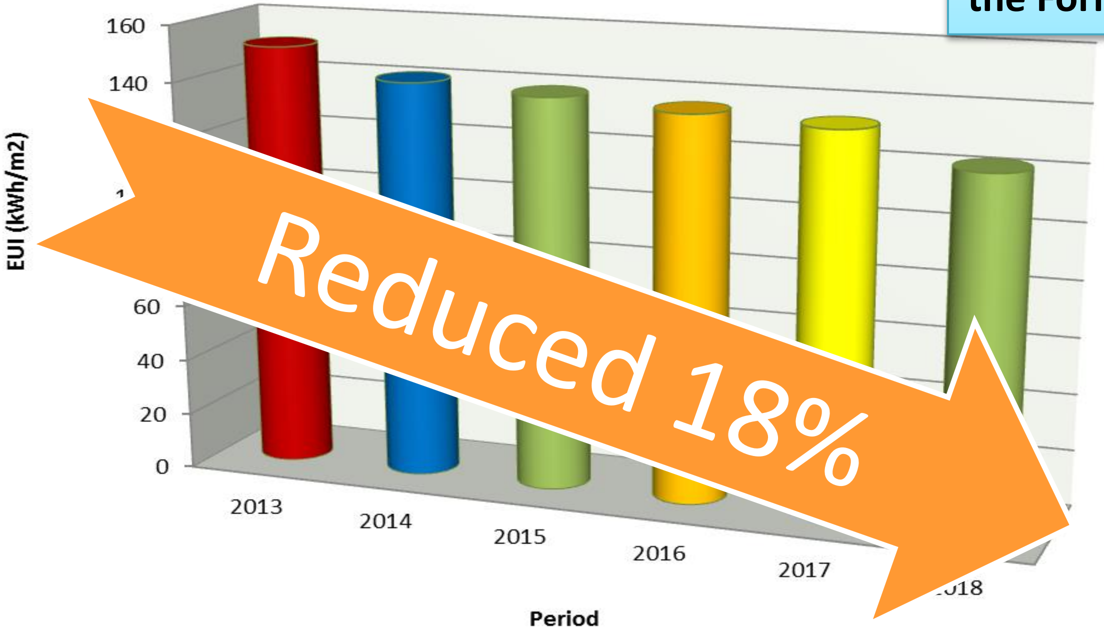
Energy Saving Performance



Energy Saving Performance

Energy Utilization Index (EUI)

Energy Audit is conducted annually. The Energy Audit Form EE-5 obtained with Energy Utilization Index (kWh/m2/annum) from Registered Energy Assessor (REA) should display the Form at building main entrance.

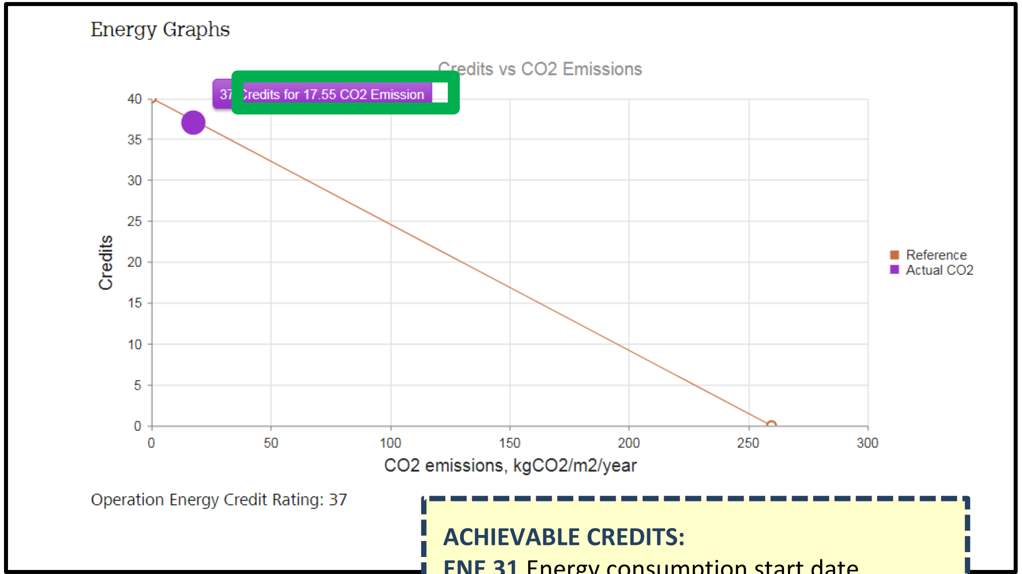



Form EE5 表格 EE5
機電工程署 EMSD
The Government of the Hong Kong Special Administrative Region
Buildings Energy Efficiency Ordinance (Chapter 610, Section 22)
Energy Audit Form
香港特別行政區政府
建築物能源效益條例
(第 610 章 第 22 條)
能源審核表格
Section A 甲部：General Information 一般資料
Name of Building 建築物名稱 English 英文 International Commerce Centre
Chinese 中文 環球貿易廣場
Address of Building 建築物地址 Street No. 街道號碼 1
Street 街道 English 英文 Austin Road West
Chinese 中文 柯士甸道西
District 地區 English 英文 Kowloon
Chinese 中文 九龍
Hong Kong 香港 / Kowloon 九龍 / New Territories 新界
Section B 乙部：Declaration 聲明
To 致：Building owner 建築物擁有人
cc 副本抄送：The Director of Electrical and Mechanical Services 機電工程署署長
The energy utilization index (EUI) per annum of the past 12-month period of the above building is 483.02 MJ/m²/annum, equivalent to 134.17 kWh/m²/annum.
Signature of Registered Energy Assessor 註冊能源效益評核人簽名
Date of issue (DD/MM/YYYY) 簽發日期 (日/月/年)

Energy Audit Form EE-5

Key Energy Saving Performance Highlights

Attained an energy credit rating of 37 out of 40
(equivalent to low CO_2 emissions)



ACHIEVABLE CREDITS:
ENE 31 Energy consumption start date
ENE 32 Energy consumption end date
ENE 33 Electricity consumption
ENE 49, 52, 55, 58 & 61
Non-standard energy consumption floor area

In shkp Sustainability Report, energy saving target of 15% by 2021 (as VS 2015), 9.74% saving was achieved for whole year of 2018

Energy Saving Performance

Building Energy Performance Assessment of ICC:

The first half-year Report of 2018

This report aims at providing an assessment of the monthly energy performance of ICC in the first half-year of 2018. In this report, the energy consumption data of the whole building and the historical operating data of the HVAC system are analyzed. The energy performance of the overall HVAC system and the individual sub-systems (e.g. chiller, cooling tower system, chilled water distribution system, air-side system) are assessed respectively.

1. Energy Consumption of whole building

Table-1 summarizes the total energy saving in the first half-year based on the original and days-corrected bill data respectively. From the original energy bill, the total energy saving of the whole building in the first half-year of 2018 was **367,532 kWh**.

Table-1 Original and corrected energy bill data in the first half-year of 2018 and 2017

	Actual days	Unit count days		Original bill data (kWh)		Days-corrected bill data (kWh)	
		2017	2018	2017	2018	2017	2018
Jan	31	31	31	3,147,165	2,789,787	3,147,165	2,789,787
Feb	28	28	28	2,715,977	2,472,152	2,715,977	2,472,152
Mar	31	31	31	2,765,502	2,879,398	2,765,502	2,879,398
Apr	30	30	30	3,152,155	3,068,763	3,152,155	3,068,763
May	31	31	31	3,603,335	3,784,789	3,603,335	3,784,789
Jun	30	30	30	4,010,209	4,031,923	4,010,209	4,031,923
Sum	-	-	-	19,394,344	19,026,812	19,394,344	19,026,812
Savings	--	–	–		**367,532**		**367,532**

1

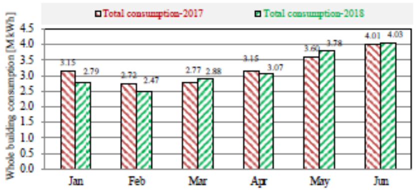


Figure-1 Whole building consumption in the first half-year of 2017 and 2018

Figure-1 shows the comparison of the total energy consumption of the whole building between the first half-year in 2017 and 2018. Significant energy consumption reductions can be observed in Jan, Feb, and Apr. In summary, the total energy consumption in the first half-year was reduced by 1.9 %.

Table-2 Energy Consumption of Main systems in the first half-year of 2017 and 2018

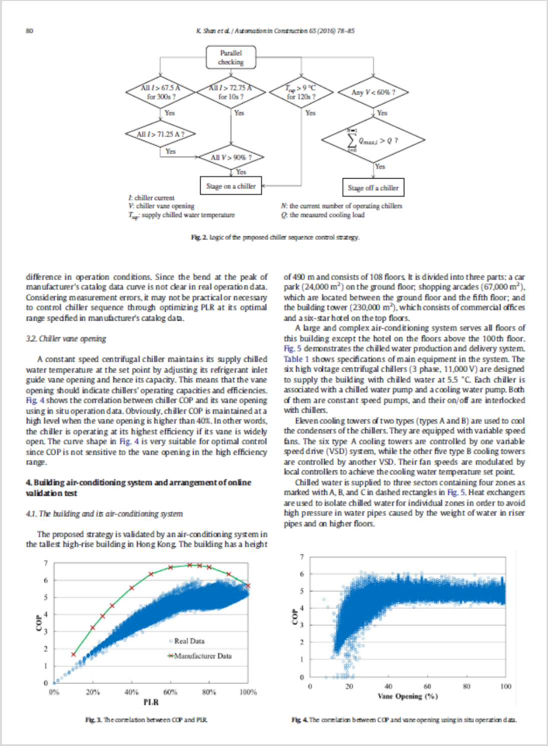
End-users	2017		2018		Energy Saving (M kWh)	Energy Saving Rate
	Consumption (M kWh)	Percentag e	Consumptio n (M kWh)	Percentag e		
HVAC	11.88	61.23%	11.65	61.21%	0.23	1.93%
Lighting & Equipment	4.65	23.98%	4.56	23.96%	0.09	1.98%
Lift	2.87	14.79%	2.82	14.83%	0.05	1.63%
Whole building	19.39	100.00%	19.03	100.00%	0.37	1.90%

The total energy consumption of the whole building is further broken down into the individual consumption of different systems, which provides more details about the energy usage and energy savings, as shown in Table-2. All energy consumers of ICC are classified into three

2

Regular Building Energy Performance Assessment Reports are conducted by PolyU. In the report, energy consumption data of the whole building and the historical operating data of the HVAC system are analyzed. The *energy performance of the overall HVAC system and the individual sub-systems* (e.g. chiller, cooling tower system, chilled water distribution system, air-side system) *are assessed* respectively

Publications



***Over 20 Publications** had been generated based on on-site implementations of new technologies*

[1]. Ma, Z., S. Wang and W. Pau (2008). "Secondary loop chilled water in super high-rise." ASHRAE Journal 50(5): 42-54.

[2]. Ma, Z., S. Wang, X. Xu and F. Xiao (2008). "A supervisory control strategy for building cooling water systems for practical and real time applications." Energy Conversion and Management 49(8): 2324-2336.

[3]. Ma, Z. and S. Wang (2009). "An optimal control strategy for complex building central chilled water systems for practical and real-time applications." Building and Environment 44(6): 1188-1198.

[4]. Ma, Z. and S. Wang (2009). "Energy efficient control of variable speed pumps in complex building central air-conditioning systems." Energy and Buildings 41(2): 197-205.

[5]. Ma, Z. and S. Wang (2011). "Online fault detection and robust control of condenser cooling water systems in building central chiller plants." Energy and Buildings 43(1): 153-165.

[6]. Sun, Y., S. Wang and G. Huang (2009). "Chiller sequencing control with enhanced robustness for energy efficient operation." Energy and Buildings 41(11): 1246-1255.

[7]. Sun, Y., S. Wang and G. Huang (2010). "Online sensor fault diagnosis for robust chiller sequencing control." International Journal of Thermal Sciences 49(3): 589-602.

[8]. Sun, Y. J., S. W. Wang and F. Xiao (2013). "In situ performance comparison and evaluation of three chiller sequencing control strategies in a super high-rise building." Energy and Buildings 61(0): 333-343.

[9]. Sun, Y. J., S. W. Wang and F. Xiao (2013). "Development and validation of a simplified online cooling load prediction strategy for a super high-rise building in Hong Kong." Energy Conversion and Management 68(0): 20-27.

[10]. Sun, Z., S. Wang and Z. Ma (2011). "In-situ implementation and validation of a CO2-based adaptive demand-controlled ventilation strategy in a multi-zone office building." Building and Environment 46(1): 124-133.

[11]. Gao, D.-c., S. Wang and Y. Sun (2011). "A fault-tolerant and energy efficient control strategy for primary–secondary chilled water systems in buildings." Energy and Buildings 43(12): 3646-3656.

[12]. Gao, D.-c., S. Wang, Y. Sun and F. Xiao (2012). "Diagnosis of the low temperature difference syndrome in the chilled water system of a super high-rise building: A case study." Applied Energy 98: 597-606.

[13]. Shan, K., Y. Sun, S. Wang and C. Yan (2012). "Development and In-situ validation of a multi-zone demand-controlled ventilation strategy using a limited number of sensors." Building and Environment 57: 28-37.

[14]. Zhu, N., K. Shan, S. Wang and Y. Sun (2013). "An optimal control strategy with enhanced robustness for air-conditioning systems considering model and measurement uncertainties." Energy and Buildings 67: 540-550.

[15]. Shan, K., S. Wang, D.-c. Gao and S. W. S. Lee (2015). "In-situ validation of a fault tolerant control strategy for VAV systems." Applied Thermal Engineering 87: 362-370.

[16]. Shan, K., S. Wang, D.-c. Gao and F. Xiao (2016). "Development and validation of an effective and robust chiller sequence control strategy using data-driven models." Automation in Construction 65: 78-85.

[17]. Shan, K., S. Wang and R. Tang (2018). "Direct chiller power limiting for peak demand limiting control in buildings—Methodology and on-site validation." Automation in Construction 85: 333-343.

[18]. Fan, C., F. Xiao and S. Wang (2014). "Development of prediction models for next-day building energy consumption and peak power demand using data mining techniques." Applied Energy 127: 1-10.

[19]. Fan, C., F. Xiao, H. Madsen and D. Wang (2015). "Temporal knowledge discovery in big BAS data for building energy management." Energy and Buildings 109: 75-89.

[20]. Fan, C., F. Xiao and C. Yan (2015). "A framework for knowledge discovery in massive building automation dataand its application in building diagnostics." Automation in Construction 50: 81-90.

Publications

Research Title:

Direct chiller power limiting for peak demand limiting control in buildings—Methodology and on-site validation

Published by:

Kui Shan, Shengwei Wang, Rui Tanga

- Department of Building Services Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong
- Research Institute for Sustainable Urban Development, The Hong Kong Polytechnic University, Kowloon, Hong Kong

Publications


Automation in Construction 65 (2016) 78–85

Contents lists available at ScienceDirect

Automation in Construction

journal homepage: www.elsevier.com/locate/autcon

Development and validation of an effective and robust chiller sequence control strategy using data-driven models

Kui Shan, Shengwei Wang *, Dian-ce Gao, Fu Xiao

Department of Building Services Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong

ARTICLE INFO

ABSTRACT

1. Introduction

1.1. Background

1.2. Typical chiller sequence control strategies

1.3. The proposed strategy and its innovation

2. The proposed effective and robust chiller sequence control strategy

3. Chiller vane opening vs energy efficiency and load—an in situ validation

3.1. Partial load ratio

Research Title:

Development and validation of an effective and robust chiller sequence control strategy using data-driven models

Published by:

Kui Shan, Shengwei Wang, Dian-ce Gao, Fu Xiao

Department of Building Services Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong

Publications

- ***Over 20 Undergraduate students*** *participated in their final year projects.*
- ***Over 6 PhD students*** *have been trained based on practical and innovative project*

Number	Name	Thesis title	Year
1	Ma Zhenjun	Online supervisory and optimal control of complex building central chilling systems	2008
2	Sun Yongjun	Online optimal control of multiple-chiller systems in large buildings	2010
3	Sun Zhongwei	Ventilation control and ventilation performance of multi-zone air conditioning systems	2010
4	Gao Dican-ce	Diagnosis and robust control of complex building central chilling systems for enhanced energy performance	2012
5	SHAN Kui	Sensitivity and uncertainty analysis, and robust optimal control strategies for air-conditioning systems with low quality measurements	2013
6	Fan Chen	Development of data mining-based big data analysis methodologies for building energy management	2016

Publications

We shared our Best Practices in various institutes

APIGBA
Asia Pacific Intelligent Green Building Alliance

World Sustainable Built Environment Conference 2017 Hong Kong
Transforming Our Built Environment through Innovation and Integration:
Putting Ideas Into Action
5-7 June 2017

Registration ID: 2236

Intelligence, Collaboration, Continuity - A case study of improving the environmental performance of an office building

ABSTRACT

Commercial Buildings Consume A Large Portion of The Total Energy Consumption In Hong Kong And Energy Use Is A Major Element Contributing to The Emission of Carbon And Global Warming. Facilities Managers Have To Be Conscious Of Their Roles In Shaping The Use of Energy of Buildings. Through Employing Available Technologies, Collaborating With Stakeholders From Within The Building and The Community As Well As Continuing Sustainable Facilities Management Practices, It Is Possible To Improve The Environmental Performance Of Commercial Buildings. The Tallest Commercial Building In Hong Kong Would Be Used As A Case Study To Illustrate How This Model Could Be Applied And The Results That Have Been Achieved That Could Derive A Win-Win For Businesses And The Society.

Keywords: High-performance building; Corporate Social Responsibility; Energy

1. INTRODUCTION

1.1. Our present environmental challenges

From construction to demolition, stocks of buildings in the built environment are the major consumer of energy. Over 68% of the greenhouse gas that leads to global warming is attributed to the burning of fossil fuels to produce energy. According to the Electrical and Mechanical Services Department (EMSD) in Hong Kong (HK), among all facilities in commercial buildings, air conditioning system consumes most of the energy (26%)[1]. Other mechanical systems such as lifts and escalators are also at the top of the chart. This pattern of energy consumption among HK's buildings is no different from other metropolitan cities worldwide, thus making this issue of global significance.

Apart from energy, waste management is another important issue in HK. Based on 2013's data from the Environmental Protection Department, 63% of the municipal solid waste went to landfills with 37% waste could be recycled [2]. The existing 3 landfill sites in HK are about to saturate with one as early as 2017. With little alternatives to handle municipal solid waste, there is an urgent need in HK for all to act immediately to support the waste reduction movement.

Unlike new buildings that could take advantage of the latest energy efficient technology and waste separation facilities during the design stage, the performance of the existing building stocks would have to resort to other ways to improve their environmental performance. With proactive management strategy, diligent and practical work approach, it is feasible to achieve energy and waste reduction in existing buildings. This does not give rise to instant upgrading of facilities and render the existing facilities immediately useless.

1

CTBUH Research Paper

ctbuh.org/papers

Title:	**ICC Hong Kong: Exemplary Performance**
Authors:	Patrick Leung, Senior Technical Services Manager, Sun Hung Kai Properties Limited Howard Yeung, Senior Technical Services Manager, Sun Hung Kai Properties Limited
Subjects:	Building Case Study Property Ownership/Management Sustainability/Green/Energy
Keywords:	Energy Efficiency Passive Design Performance Based Design
Publication Date:	2015
Original Publication:	The Future of Tall: A Selection of Written Works on Current Skyscraper Innovations
Paper Type:	1. Book chapter/Part chapter 2. Journal paper 3. **Conference proceeding** 4. Unpublished conference paper 5. Magazine article 6. Unpublished

ICC Hong Kong: Exemplary Performance

Patrick Leung, Senior Technical Services Manager & **Howard Yeung**, Senior Technical Services Manager, *Sun Hung Kai Properties*

The International Commerce Centre (ICC) is a landmark skyscraper located in Hong Kong. It is the tallest building in Hong Kong, with office spaces, fine dining restaurants, an observation deck and a world class hotel. ICC has firmly established itself as a world class businesses address that offers the highest quality in property and facilities management, providing quick and responsive services while maintaining an environmentally friendly and sustainable operation. To manage this supertall high-rise commercial building, a life-cycle commissioning and optimization approach is adopted and ISO 50001:2011 energy management systems are implemented. By continuously exploring various innovative technologies and the application of many energy savings strategies, environmental impacts of the building are reduced while delivering benefits in terms of energy efficiency, indoor air quality and cost savings to landlord and occupants.

Introduction

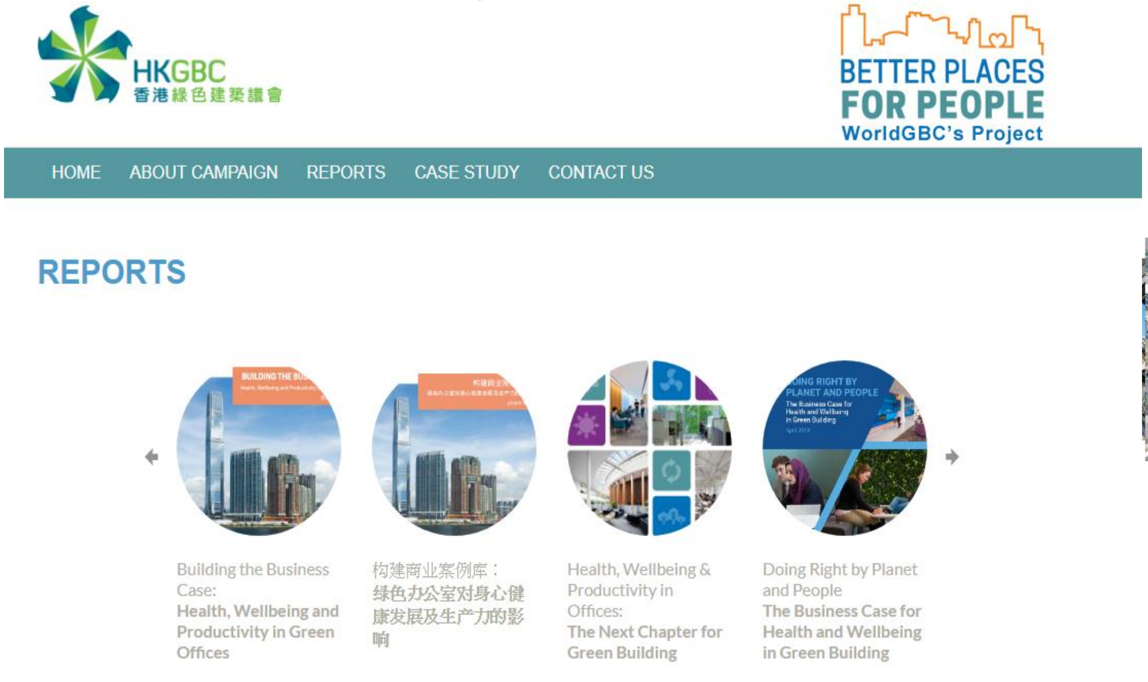
Standing at the south-western tip of the Kowloon Peninsula, the International Commerce Centre (ICC) is an iconic building in Hong Kong. The 484-meter-tall building, with 108 stories, is currently the 6th-tallest building in the world and the tallest in Hong Kong. Apart from providing Grade A office premises, ICC also contains one of the first observation decks in Hong Kong – Sky100 – as well as a premium class hotel, the Ritz Carlton Hong Kong. ICC is showcasing the prosperity of the city. The 3-million-square-foot development is also a 21st-century engineering wonder in the eyes of Hong Kong people.

With an aim to reduce the environmental impacts to the surrounding environment, ICC was designed and built based on an earlier version (04/04) of the Hong Kong Building Environment Assessment Method (BEAM) (International Commerce Centre, n.d.).[1] With its almost full occupancy, the energy consumption of the building must be further controlled even though it was built based

1. BEAM is a green building standard promoted by the Hong Kong BEAM Society Limited in Hong Kong, an authoritative but non-profit making organization.

World Green Building Council's Better Places for People

BUILDING THE BUSINESS CASE:
Health, Wellbeing and Productivity in Green Offices



ZERO CARBON BUILDING (ZCB)
The ZCB, constructed in 2012, achieved BEAM Plus Platinum in 2015 and was the first building in Hong Kong with net zero carbon emissions.

- Cross-ventilation, low VOC materials, and wind-catchers helped the building achieve IAQ 'Good'
- Daylighting and natural ventilation improves thermal comfort and also reduces energy use by 20% compared to normal buildings
- All offices have an outdoor view, with some looking out on the first urban native woodland in Hong Kong

SHATIN COMMUNICATIONS AND TECHNOLOGY CENTRE (SCTC)
SCTC is the latest addition to the Hong Kong Jockey Club's extensive property portfolio, BEAM Plus Gold.

- By using demand control CO_2 sensors, 30% more fresh air is ventilated inside the building
- Core placement on the NNW façade reduced solar gain by 32%, improving thermal comfort
- 64% of the rooftop is covered in accessible green roofs
- Employees reported 97% satisfaction with the new office

INTERNATIONAL COMMERCE CENTRE (ICC)
The ICC is the tallest building in Hong Kong and seventh tallest in the world. With over 250 000 m² of office space, it uses its health and wellbeing features as a selling point to potential occupants, including:

Tallest building in HK, 7th in world!

- Central core design to maximise daylight IAQ Excellent Class Certificate
- Pedestrian access to retail, hotels, and services in the West Kowloon Cultural District as well as public transportation
- A shingled curtain wall façade was designed to maximise views and daylight while reducing solar gain and maintaining comfort

Awards and Recognitions


Awards 2018

Certificate of Excellence

Sustainability Achievement of the Year

Kai Shing Management Services Limited - International Commerce Centre

Mr Clement Lau FRICS

RICS Hong Kong Board Chair

RICS - Sustainability Achievement of the Year 2018


HKGBC 香港綠色建築議會

hereby certifies that 特此證明

International Commerce Centre (Excluding the Hotel Portion)

環球貿易廣場 (酒店部份除外)

1 Austin Road West, Kowloon, Hong Kong

香港九龍柯士甸道西1號

has achieved Final Platinum rating under BEAM Plus EB V2.0 Comprehensive Scheme

PLATINUM 鉑金級

HKGBC BEAM Plus 綠建環評

79

23 October 2017

HKGBC BEAM Plus EB V2.0 Comprehensive Scheme - Final Platinum

APIGBA 亞太地區智慧綠建築聯盟

Asia Pacific Intelligent Green Building Alliance

Asia Pacific Intelligent Green Building Alliance (APIGBA) "Excellent Intelligence Green Building - Performance Award"

環球貿易廣場
INTERNATIONAL
COMMERCE CENTRE

Awards and Recognitions

ASHRAE Technology Award 2014 Honorable Mention

Hong Kong Awards for Environmental Excellence (HKAEE) Gold Award

World Wide Fund - Low Carbon Office Operation Programme (LOOP)

Hong Kong Awards for Industries Productivity and Quality Award 2014

Awards and Recognitions

ICC Awarded Hong Kong Energy Saving Championship Scheme 2016 – 2017

Energy Saving Championship Scheme 2017
- Hanson Supreme Grand Award (Group 1)

Energy Saving Championship Scheme 2017
- Hanson Grand Award

機電工程署 EMSD

Environment Bureau
The Government of the Hong Kong Special Administrative Region

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Awards and Recognitions

CLP Smart Energy Award 2018

IFMA Asia-Pacific Facility Management Awards 2018


香港綠色機構認證
Hong Kong
Green Organisation Certification
節能證書
Energywi$e
—Certificate—
「卓越級別」
Excellence Level
啟勝管理服務有限公司 - 環球貿易廣場
Kai Shing Management Services Limited
International Commerce Centre


香港綠色機構認證
Hong Kong
Green Organisation Certification
減碳證書
Carbon Reduction
—Certificate—
新鴻基地產代理有限公司 - 環球貿易廣場
Sun Hung Kai Real Estate Agency Ltd.
International Commerce Centre

Green Organization Certification - Energywi$e & Carbon Reduction Certificate

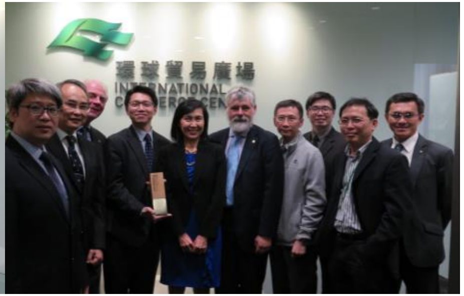

HONG KONG Q-MARK SERVICE SCHEME
CERTIFICATE
This is to certify that
Kai Shing Management Services Limited – International Commerce Centre
of Unit 1906, International Commerce Centre, 1 Austin Road West, Kowloon, Hong Kong,
has been approved by
The Hong Kong Q-Mark Council, Federation of Hong Kong Industries
as meeting the prescribed Hong Kong Q-Mark Service Standard
The scope of certification is applicable to
Property and Facilities Management Services on Office Tower of International Commerce Centre
Certificate No. S1116
Original Approval : 1 August 2017
Current Certificate : 1 August 2017
Certificate Expiry : 31 July 2020
Signed for and on behalf of
The Hong Kong Q-Mark Council, Federation of Hong Kong Industries
Mr. Bernie Ting
Chairman

HK Q-Mark Scheme Certificate

CTBUH AWARDS 2014

CTBUH Performance Award 2014

BIFM Awards - Impact on the Environment (High Commened)



CIBSE Building Performance Awards 2015

環球貿易廣場
INTERNATIONAL COMMERCE CENTRE

Awards and Recognitions

Corporate Environmental Leadership Awards 2016

2016 Corporate Citizenship Award - Silver Award

2017 Green Pioneer - Green Office & Eco - Healthy Workplace Awards Labelling Scheme

2017 Energywi$e Label

Indoor Air Quality Certificate (Excellent Class-whole building)

Caring Company Certificate

HSBC - Green Achievement Award 2016

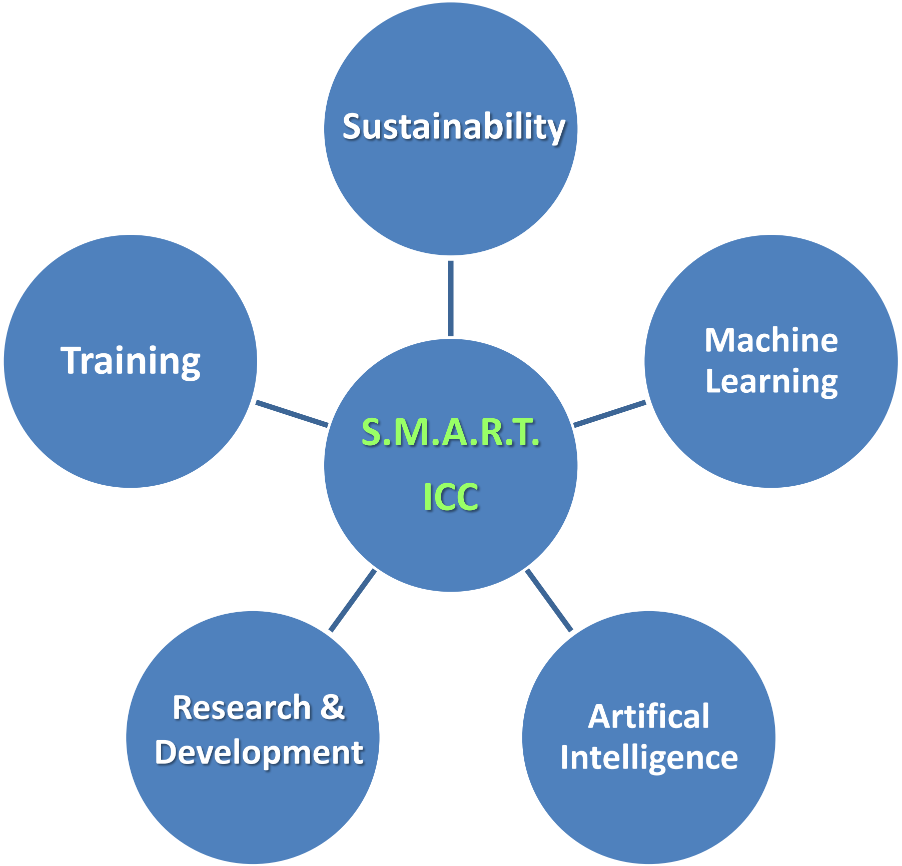
Conclusion

Highlighted Green Initiatives – Energy Use

- **Management System:**
  - Energy Management Policy
  - Energy Management Plan
  - Appointment of Energy Warden
- **Energy sub-metering and BMS and data logging system**
- **Carry out Energy Audit more frequently (Bi-yearly cycle instead of 10 years)**
- **Comprehensive data analysis:**
  - Energy Use intensity (EUI)
  - Abnormal Usage and Peak Analysis
  - Energy Saving Opportunities
  - Continuous self-Improvement in energy use
  - Assist in setting short term long term energy / carbon reduction targets
- **Building retro commissioning and ongoing commissioning**

Conclusion


S.M.A.R.T ICC


Sustainability
Training
Machine Learning
S.M.A.R.T. ICC
Research & Development
Artifical Intelligence

環球貿易廣場
INTERNATIONAL
COMMERCE CENTRE

The End