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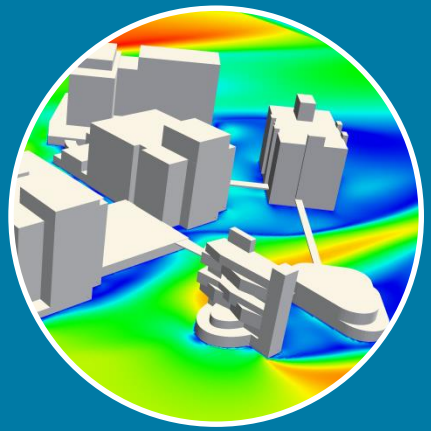
HKAEE: Technical Forum 2014

High Performance Building Design
Going Beyond Green Ratings and
Designing Buildings that Perform

Cundall Services

Sustainability

- Strategic Sustainability Consultancy
- Sustainable master-plans
- Green Building Certification
  - LEED
  - HK BEAM Plus
  - China Green Building Label (3-Star)
- Microclimate simulation & analysis
- Renewable and Low Carbon Technology
- Water resources



Building Performance

- Portfolio strategic improvement planning
- Operational Performance Audit – Energy, Water , Waste, IEQ
- BMS fine tuning/ Building optimization
- Re-commissioning
- Building Upgrade implementation, Design & PM services
- Asset Condition Assessment

Building Services

- Low energy building design
- Building Services (Mechanical, Electrical, Plumbing and Drainage, Fire Services)
- Data Centre & Critical system specialists + CFD
- Advanced system design (chilled beams, natural ventilation etc.)
- Building Information Modelling (BIM)

High Performance Buildings

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Hong Kong Science & Technology Park – Phase 3

Children's Hospital, Hong Kong

Yau Ma Tei Police Station, Hong Kong

Eaton Hotel Chiller Upgrade

Gold Award Hong Kong Awards for Environmental Excellence 2013

Mixed-use Development, Kunming

Low Energy mixed mode office tower

DFS Global Retail Portfolio

Global Energy Conservation

Green Design New / Refurb Guidelines

HK 3030 Challenge

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HKGBC Roadmap (Dec 2012)

Excellent plan for demand side management of Hong Kong's buildings which consume 90% of our electricity

The Target in Detail

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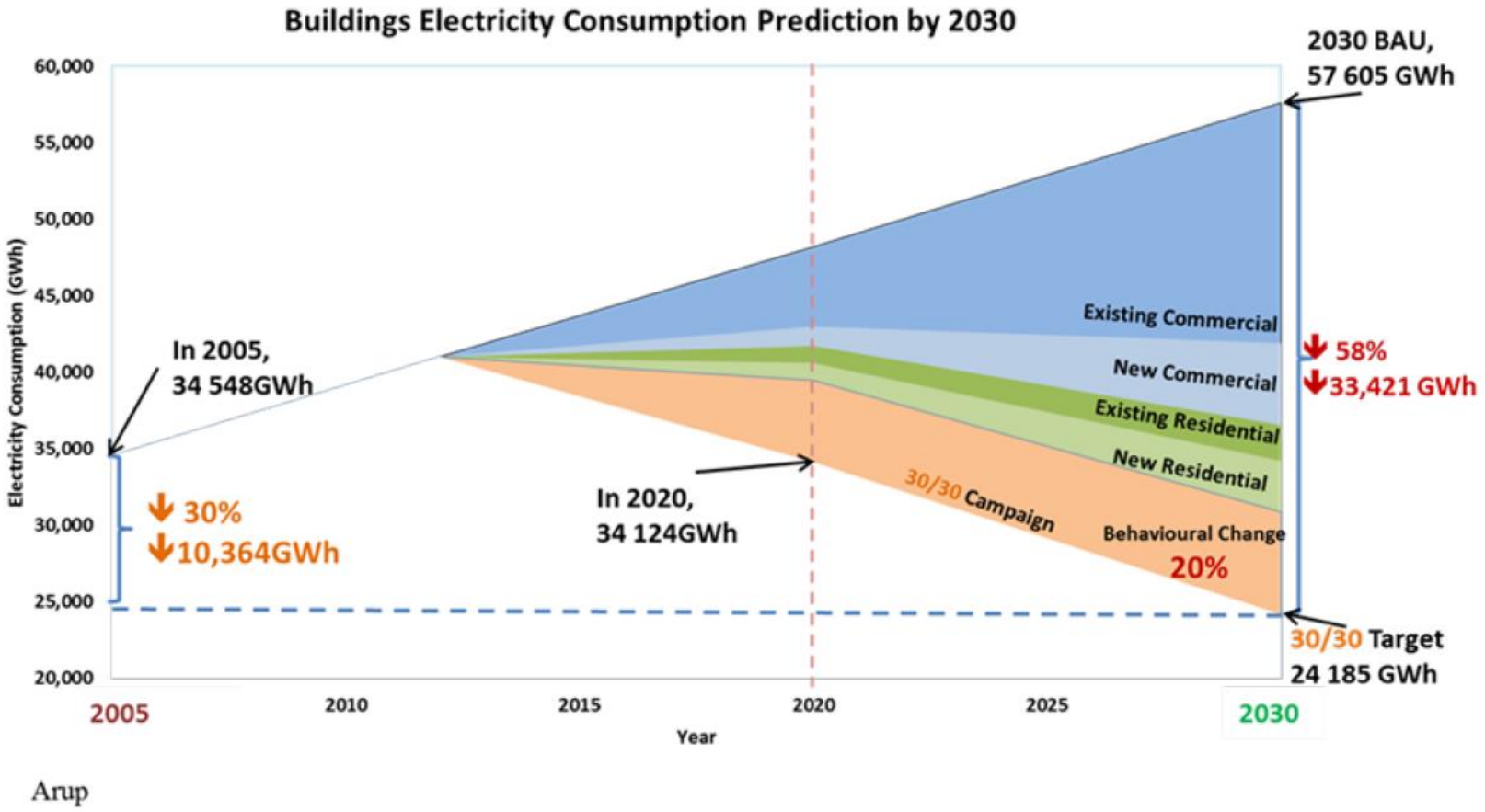
3030 target is 60% reduction from BAU



"Aggressive but achievable target"

What the 3030 target means

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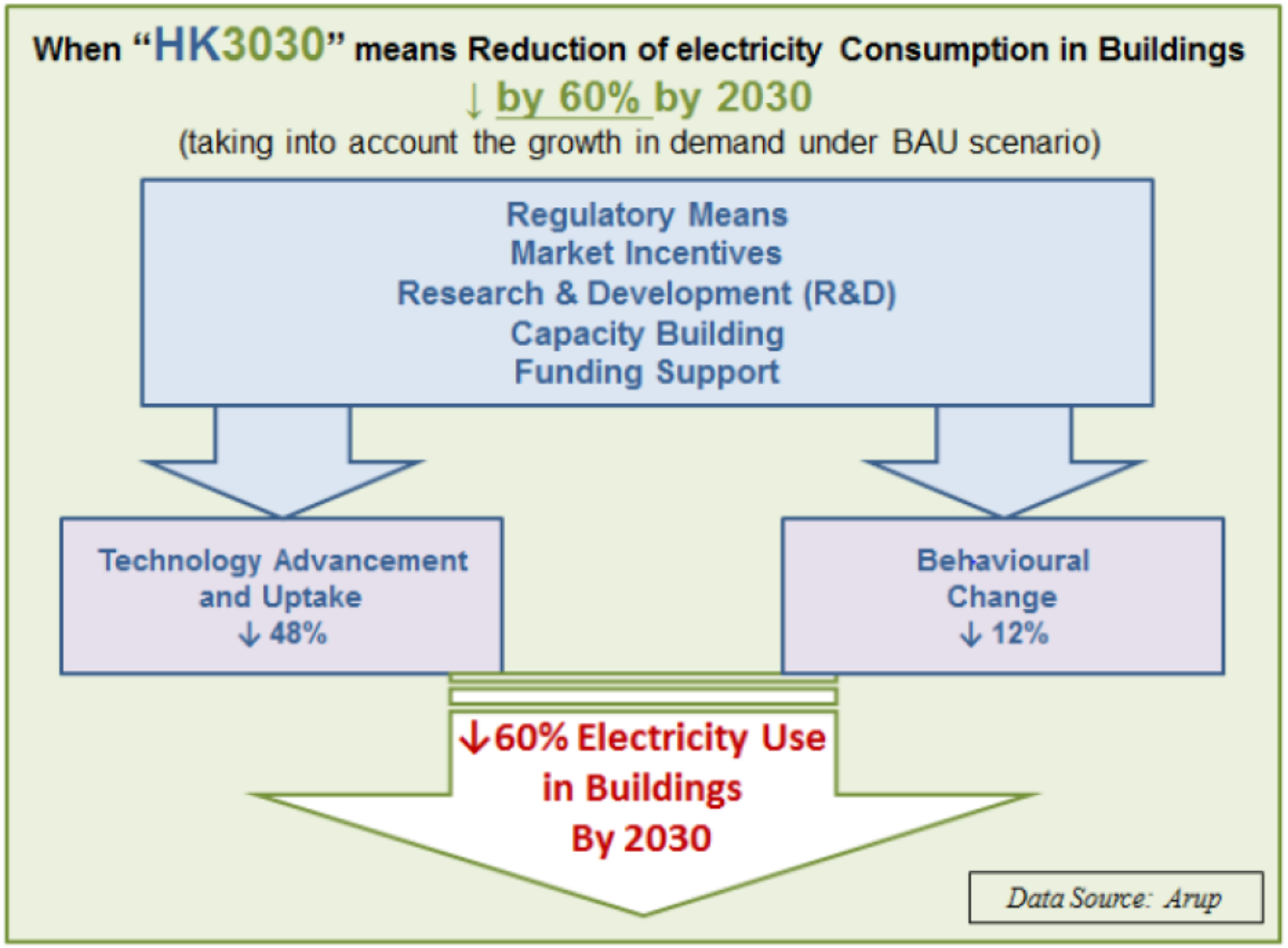
60% reduction requires a full range of measures but we need to start now and move quicker!



2014 – Where are we now

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- **BEC 2012 released**
- **Compulsory Audits but no actions required**
- **Government is building greener**
- **HKGBC EUI Benchmarking Tool under development**
- **BEAM v1.2 rapidly increasing market uptake of Green Building Assessments**

Momentum in Hong Kong is strong

WE NEED TO ASK

- **HOW CAN WE GO for 30-50% Savings TODAY?**

For NEW and <u>EXISTING</u> BUILDINGS

HK3030 ‘carrot-and-stick’ approach

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The HK3030 Campaign takes a ‘carrot-and-stick’ approach to reduce electricity level in all building types in Hong Kong, including the existing building stock which has traditionally been the most challenging. HK3030 puts forward solid recommendations to expand the scope of regulatory control to push for more green buildings, and to incentivise the market for optimal outcomes

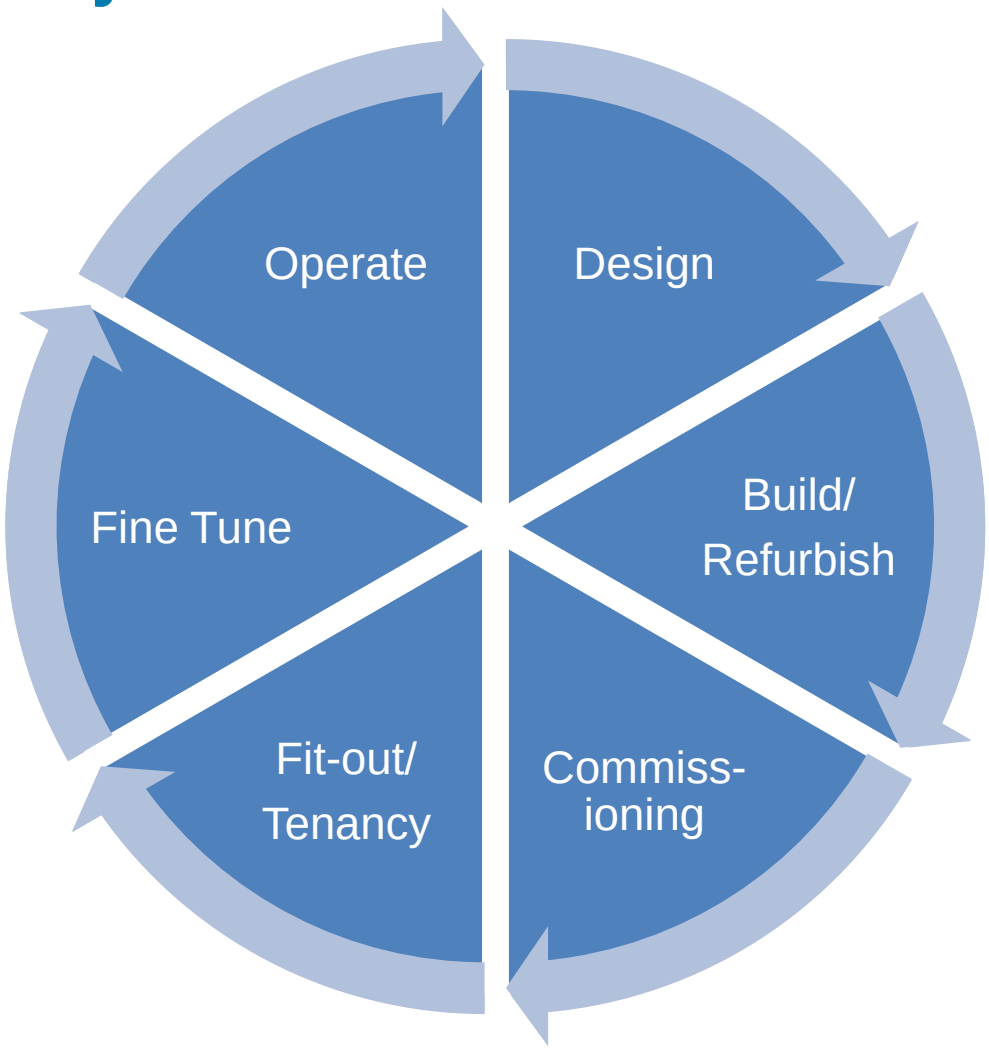
HKGBC supporting government

- Public Education - HK3030 Charter Programmes
- Developing a credible and territory-wide online benchmarking tool and labelling scheme on building energy performance;
- Developing a suite of tools under the current BEAM Plus Standard
- Research and Professional Training for the Industry

HK3030 Recommends POLICY INITIATIVES

- Regulatory Control enhancement
- Incentive suggestions & Funding suport
- Lead by example - Building Green & Renting Green
  - **Take the lead by <u>adopting EUI performance standard</u> which shall be more stringent than BEAM Plus rating and publishing the performance of the public sector buildings**

Building Lifecycle



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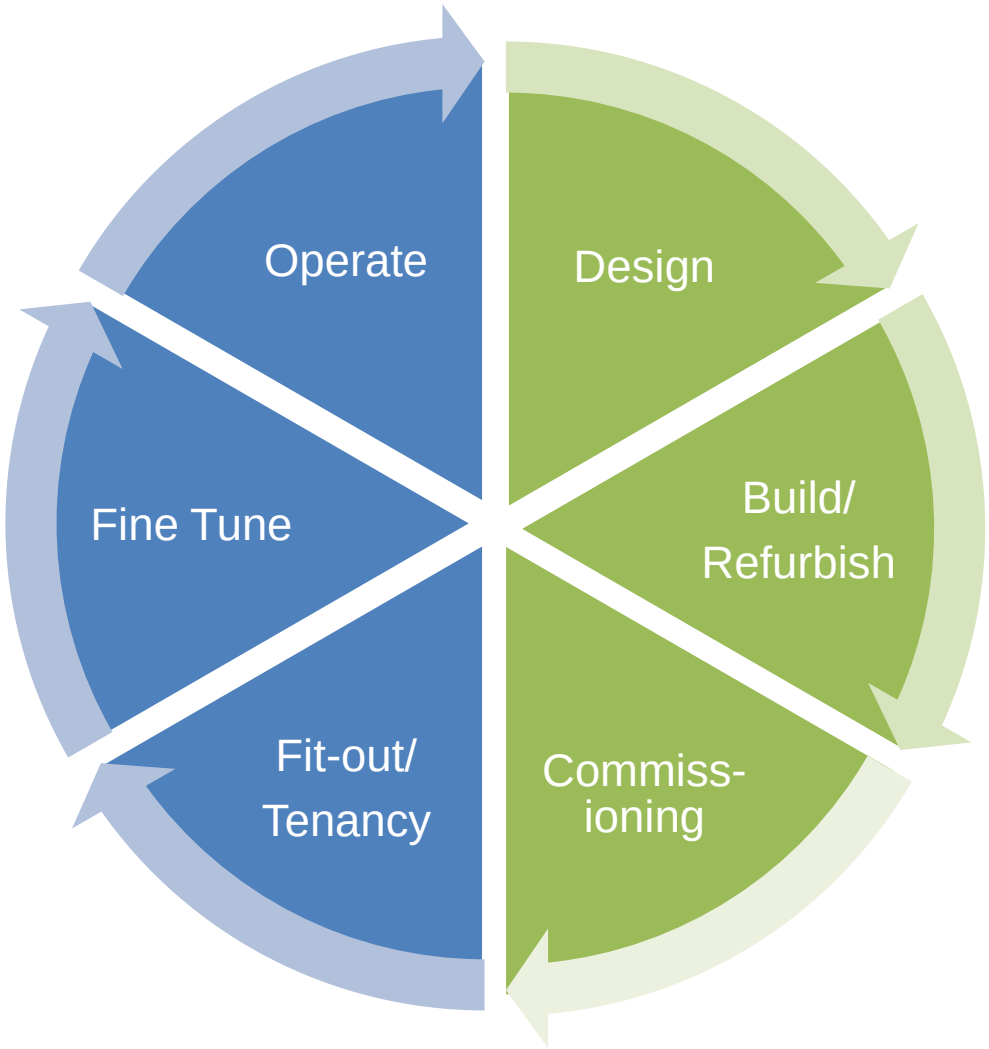
Green Building Rating Systems generally consider Design & Construction Stage only



Most Green Ratings
LEED / BEAM etc

Building Lifecycle

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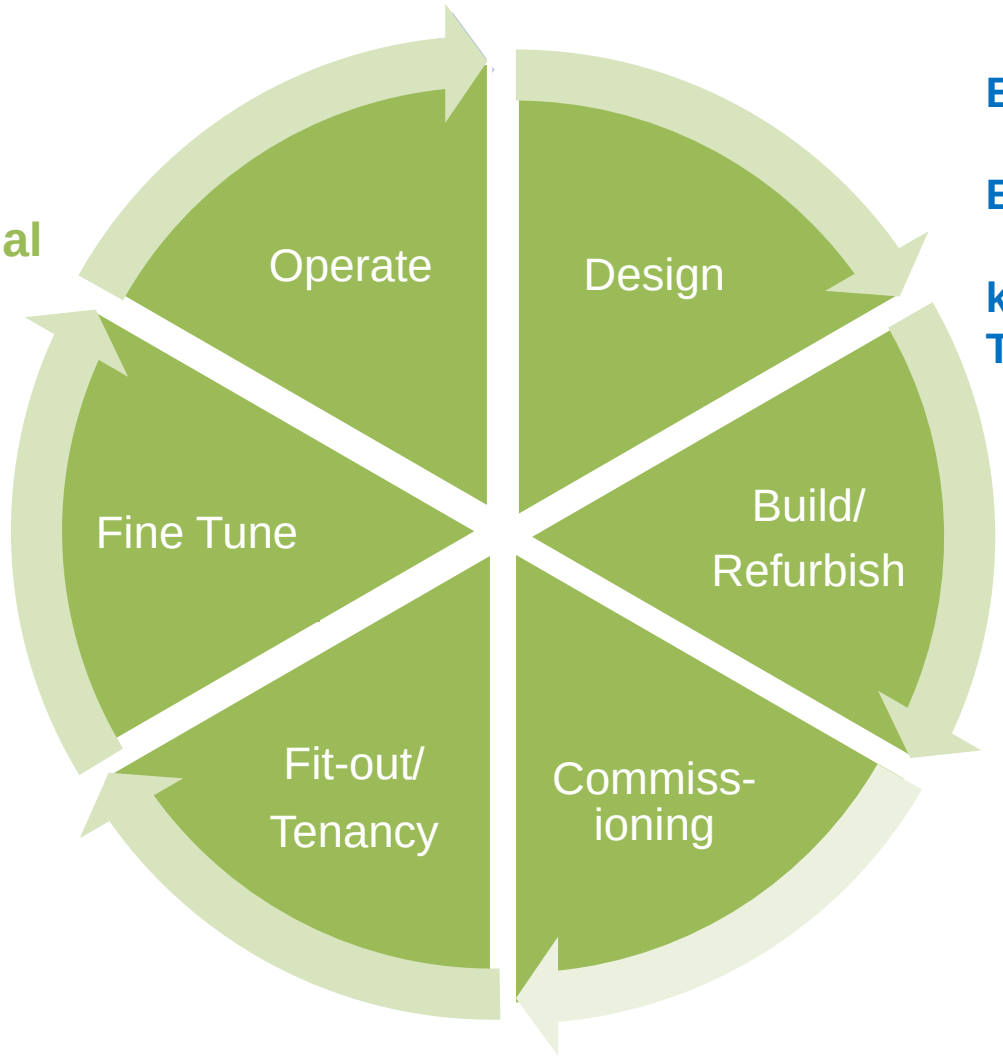
Setting an operational EUI target influences the whole building lifecycle

EUI Operational Focus



EUI = Energy Use Intensity

Energy per m2

kWh/m2 operational Target to be measured

Energy Modelling vs Operational

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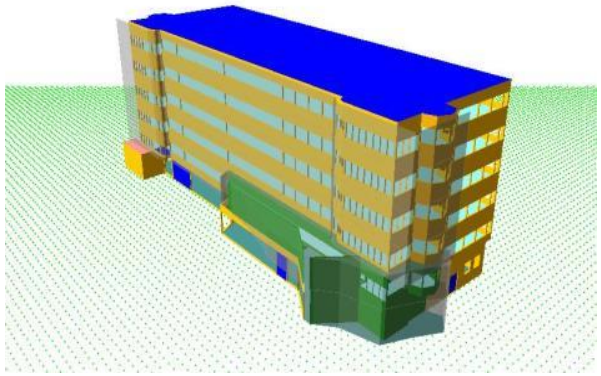
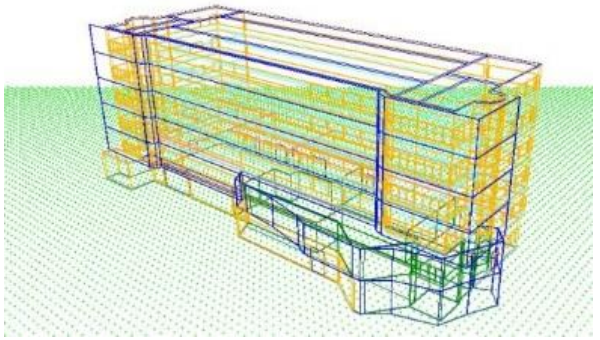
Energy Modelling is a comparative analysis looking at % reduction operating under the same schedule of operation





Baseline (code compliant) **vs** **As Designed**

Energy Modelling result = % reduction under standard operational parameters

e.g 8am to 7pm, average occupancy, average loads

Actual buildings do not operate under uniform operation or ideal scenarios.

Tenants have different operational profiles and demands so part load performance is highly variable and the ability to deal with this is not measured by energy models

Usage = Demand x Efficiency x Control

To get big savings we must reduce Demand significantly and focus on how to optimise and control the systems particularly in low load part load conditions

Reduce demand

- Passive design
- CO2 demand control
- Reduce the AC footprint
- ↓ Exhaust air make-up

Efficiency

- Optimise for part load efficiency
- Address issues of oversizing and ability to turn down at part load.
- Energy efficient equipment standard.

Control & Optimisation

- Switching off = most efficient
- Modularise and enable part load performance
- Advance monitoring and controls
- Monitor, Measure in real time. Remote analysis

Hong Kong Demands

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Buildings are very energy intensive

1. Hot /Humid Climate demands AC
2. Long Operating Hours
3. Densely occupied buildings
4. Everything is on all the time
5. Monitoring is not common or limited
6. Low energy costs (compared to other costs)
7. Energy is invisible and intangible

Comparison of two Office types

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Typical Grade A office

- Centralised Chiller Plant
- Typically VAV AC
- 500+ lux Lighting
- BMS & Dedicated Building Manager
- Large AC footprint
- Large Lobby

Typical Grade C office

- Split AC COP 2.5
- Lighting by Tenant
- No BMS
- No AC to corridors, lift lobbies or toilets
- Small lobby

Centralised vs Decentralised AC

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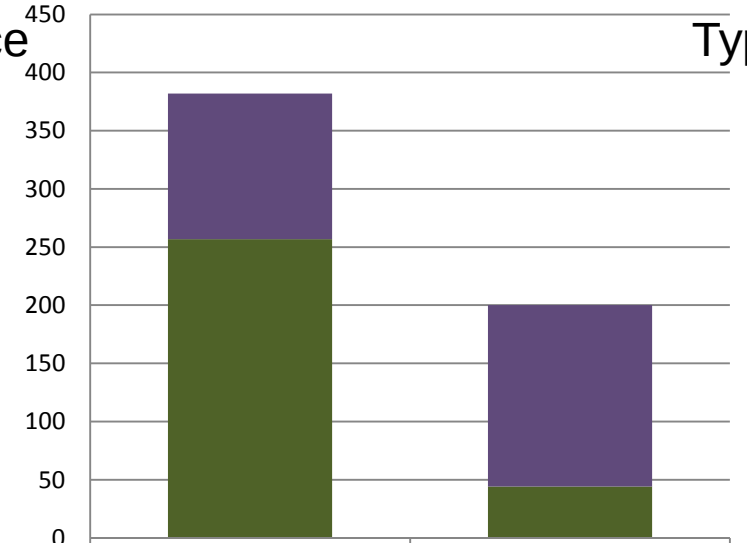
Typical Grade A office

~50% Avg. Savings Whole Building Energy Consumption

Typical Grade C office

Energy EUI kWh/m2/m2



	Grade A/B	Grade C
Tenant	125	156
Landlord	257	44

Data source : William Chung , Y.V. Hui (2009) (EUI MJ/m^2 converted to kWh/m^2)
A study of energy efficiency of private office buildings in Hong Kong
Department of Management Sciences, City University of Hong Kong, Kowloon Tong, Hong Kong

Centralised vs Decentralised AC

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Typical Grade A office

Why?

Typical Grade C office

Typical Grade A office

Everything ON during long business hours

Over Provisions (Must have spare capacity everywhere)

Large systems and oversizing - Systems can't turn down properly

Typical Grade C office

Modular AC on when the tenant wants to use it off when not needed.

The tenant controls the temperature and fan speed and pays for the bill.

Tenant adds extra provisions if they need

Impact on Designing to a brief with overprovisions

Hotel in operation for 12 months

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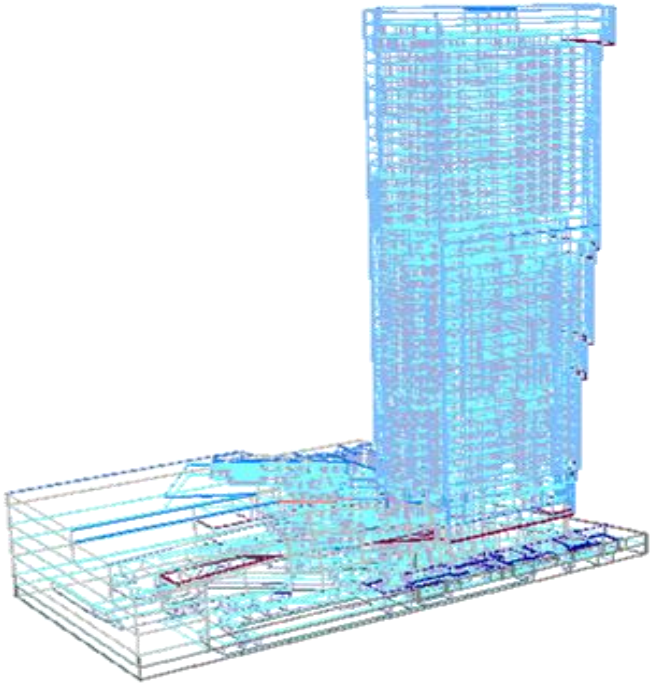
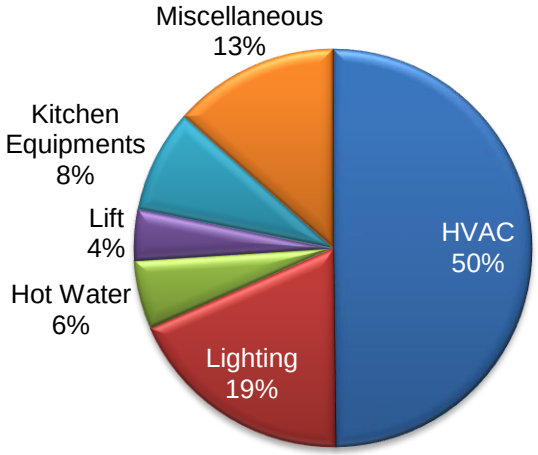
Macau Hotel Consumption:

- 735kWh/m² per year
- Double the energy of similar hotels operated by the same hotel group



Energy Use General Breakdown



	kWh	kWh/m² AC Area	%
HVAC	6,556,289	366	50%
Lighting	2,447,935	137	19%
Hot Water	736,240	41	6%
Lift	541,725	30	4%
Kitchen Equipments	1,105,557	62	8%
Miscellaneous	1,771,668	99	13%
Total	13,159,414	735	100%

Key Findings

- Drastically oversized (ventilation, exhaust, AC etc)
- High Exhaust and Fresh air ventilation rate (spa, restaurant, kitchen)
- Combined Kitchens Exhaust 100% on / off
- Lack of Chiller plant pumping controls
- Intensive halogen lighting
- Simultaneous Heating & Cooling risk in winter

Key Recommendation

- Rebalance Exhaust and Fresh Air Make up
- Add VSD controls and dampers to Exhaust & Make-up
- Add VSD Chiller plant pumping controls
- Replace Halogen with LED MR 16 fitting

> 30% energy wasted due to overprovisions

Exhaust oversized & no controls for partload

High Volume make-up outside air

126,000m³ per hour

Design for Peak

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Why do we oversize?

- Cater for all possibility and deal with the unknown
- Design briefs require it
- To cater for plant & equipment degradation
- Provide future spare capacity
- Easier & less risk than not oversizing

We oversize to provide long term capacity but this results in overprovisioning and affects the part load performance at which most buildings operate.

There are some good reasons why we do it but we could do it better by allowing for future capacity to be added later and/or built in such a way it can allow for

We need to carry out a right sizing approach

Right sizing

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- Design Briefs & standard design oversize everything

Oversizing impacts poorly on	Oversizing is Good for
VAV AC systems	Cooling Towers – Improves performance
VSD Fans – Turndown limited	Ductwork – Lower pressure low energy
VSD Pumps – Turndown limited	Cooling Coils – Allows for degradation
Large chiller plants – Capex wasted	Oil Free chillers – Better at part load
Lighting without dimming control	Lighting with dimming control

- Right sizing recognizes where we need to focus on optimising the systems
- Right sizing also requires rebalancing or re-commissiong once in operation, so it can be done during the operational phases as well.
- Right sizing takes time and extra effort but is a valuable exercise

Design Briefing

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Many Design briefs lead to overprovisions, we need to either challenge them or consider more practical and efficient ways to achieve the same objectives

Low Energy Buildings still have

- Spare capacity
- Supplementary systems

Design Briefs should also include

- EUI operational energy targets (kWh/m2)
- Requirements for Passive design (Daylight & Energy performance)
- Low Energy Design Brief (e.g. Lighting, Fresh Air)
- Right Sizing & Design for Efficient Part Load
- Commissioning to go beyond T&C and rebalance the systems
- Ongoing fine tuning and optimization to be specified at end of Defects Period

Example HK Office Building

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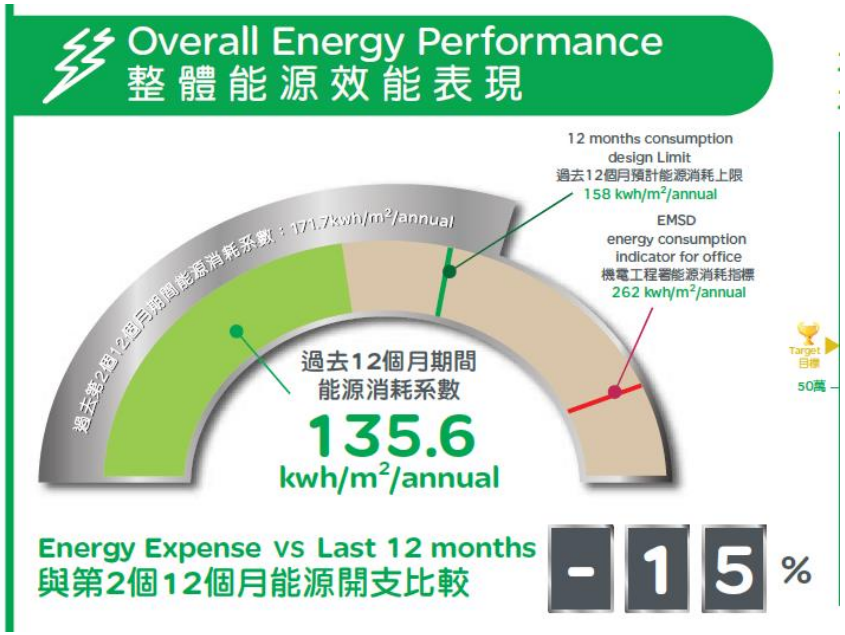
BEAM Plus Platinum & EUI target

Emphasis on demand reduction, monitoring and controls, operational fine tuning

- Passive design OTTV 10 W/m²
- Total Heat Recovery
- CO2 Demand dependent fresh air control
- All LED office lighting 350-400lux
- Real time web energy monitoring for landlord & tenants
- Energy model calibrated to set operational targets for fine tuning
- Tenant fitout guideline and engagement process
- Real time public display of performance and savings



Energy Reduction

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Demand Side

- Passive Design WWR<40% with shading
- Reduce Lux levels, add task lighting
- CO2 fresh air demand control
- Heat recovery & VSD exhaust control

Efficiency

- LED lighting office lighting <6W/m2 designed for 350-400 lux
- Oil Free Chiller and optimized plant (12W)
- Free Cooling & Natural Ventilation modes

Control & Montoring

- 100% Dimmable office lighting with Daylight & Occupancy Sensors
- Advanced BMS Control optimisation on air side and water side controls
- Modular AHU for VAV and Modular DC fan coil for SME small offices
- Real time Energy monitoring for Landlord, Tenant and Public

Lighting

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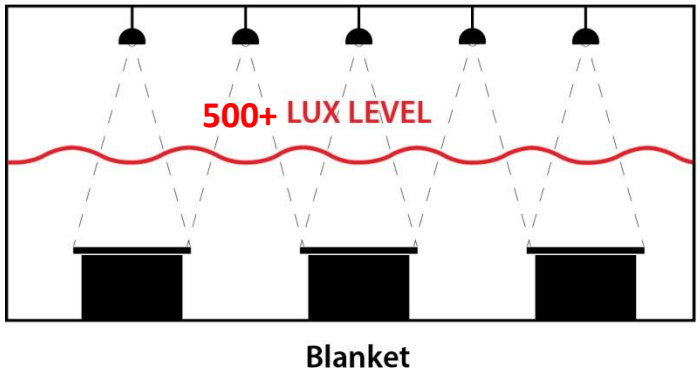
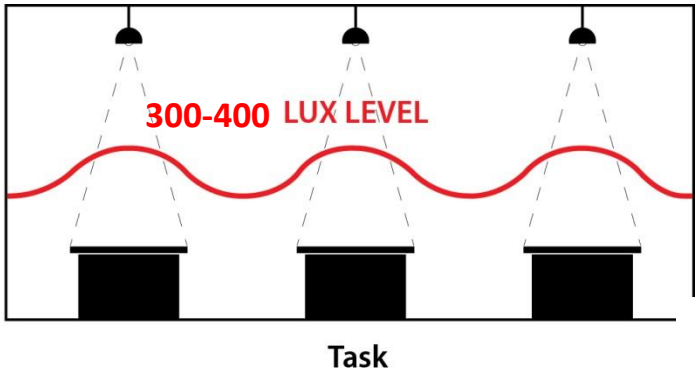
Demand Side

- Reduce Lux levels, add task lighting
- Apply light where it is needed



Blanket



Task

Efficiency

- LED lighting is now more efficient for most applications
- HKSP are using CREE latest 100lm/W fittings

Control

- All fittings are dimmable and can be adjusted for use with task lighting
- Daylight & Occupancy sensors are used throughout
- Basic control is to switch off when not in use

Oil Free Chillers & VSD controls

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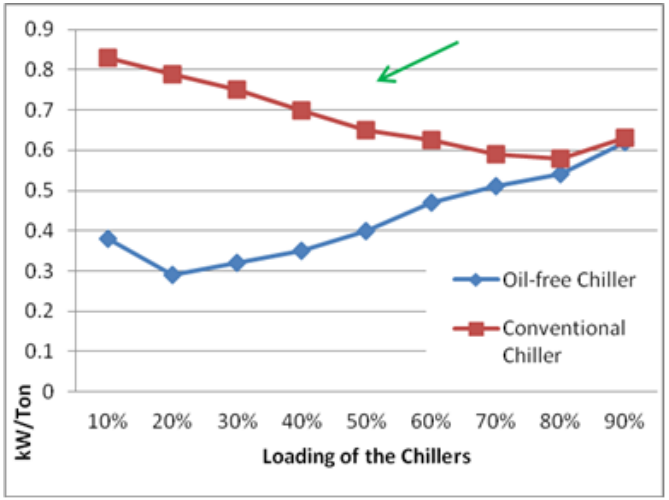

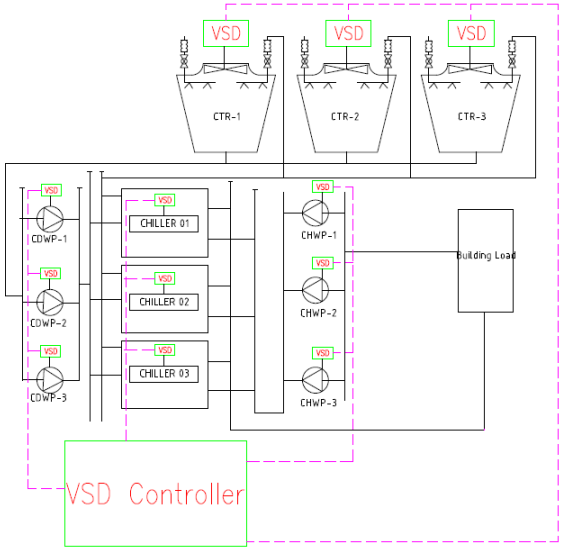

- Integrated Plant Control
- VSD on Chilled Water Pumps
  - Variable Primary Flow
  - Variable Secondary Flow
- VSD on Condenser Water Pumps
- VSD on Cooling Towers Fans

Chiller Plant replacement can target 40% savings

Total Plant inc pumps	Air Cooled chiller	Std Water Cooled	District Cooling	VSD pumps Std Chiller	VSD pumps + Oil Free
kW/Tr	1.2-1.5	0.8-1.0	0.75-1.1	0.65-0.75	0.5-0.65

Advanced Controls

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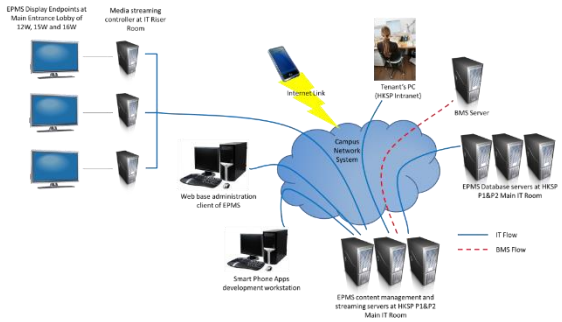
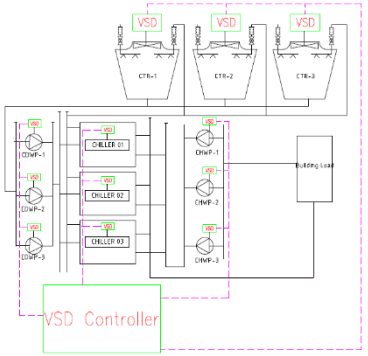
Building Energy Monitoring

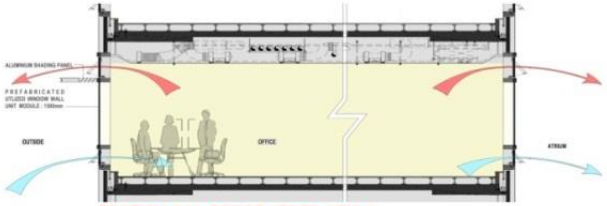
- Submetering and real time energy monitoring
- Tenant interface and monitoring
- Public display of Performance and saving

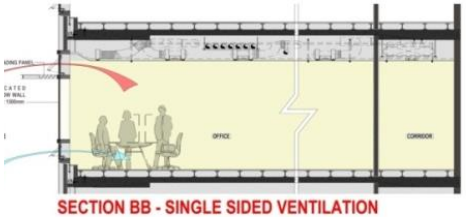


Advanced Control

- Total Chiller Plant COP optimsation
- CO2 Demand control Ventilation
- Heat Recovery & VSD exhaust interlock
- Fully Dimmable LED lighting
- Mixed Mode AC with Free cooling & Nat Ventilation modes







Energy Monitoring

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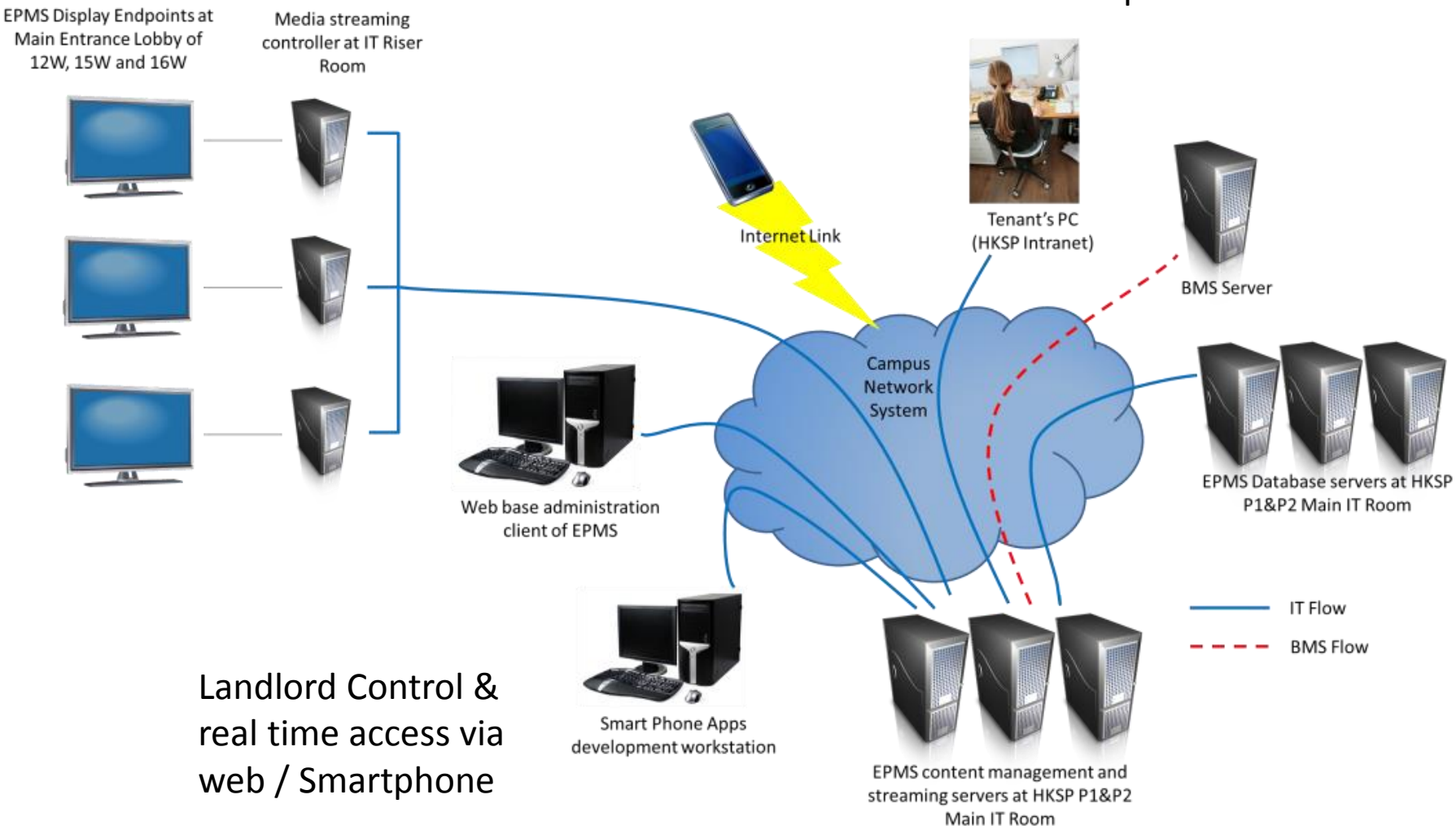
Public Display

Tenant Web/
Smartphone interface



Landlord Control &
real time access via
web / Smartphone

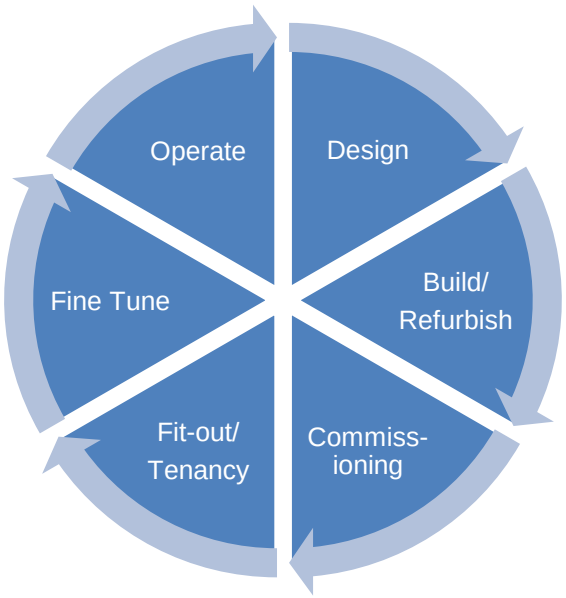
BEAM Plus Platinum & EUI target

Designed to target > 40% savings

- Reducing Demand
- Optimising efficiency
- Controls & monitoring

Operational target is reliant upon

- Tenant design review and operational co-operation
- Continual monitoring and improvement (tenant & landlord)
- Tenant behavior influence to reduce demand on services
  - Tenant Energy reviews
  - 24-26 °C set points during Summer
  - Education on use of mixed mode AC



Key Points For New Buildings

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- **Set EUI Operational target for savings**
  - Aim for 40-60% Savings over Benchmarks
  - Change the process from design focused to operational
- **Reduce Demand**
  - Reduce the AC footprint and lighting demands
  - Passive design and
- **Right Size and Rebalance for actual operation**
  - Carry out a right sizing review
  - Recognise we will still oversize and allow to rebalance
- **Modularise AC systems**
  - Advanced HVAC = smaller systems we can switch off / modulate
- **Employ advanced controls & monitoring**
- **Rebalance and Re-commission when occupied**

Focus – Existing Building

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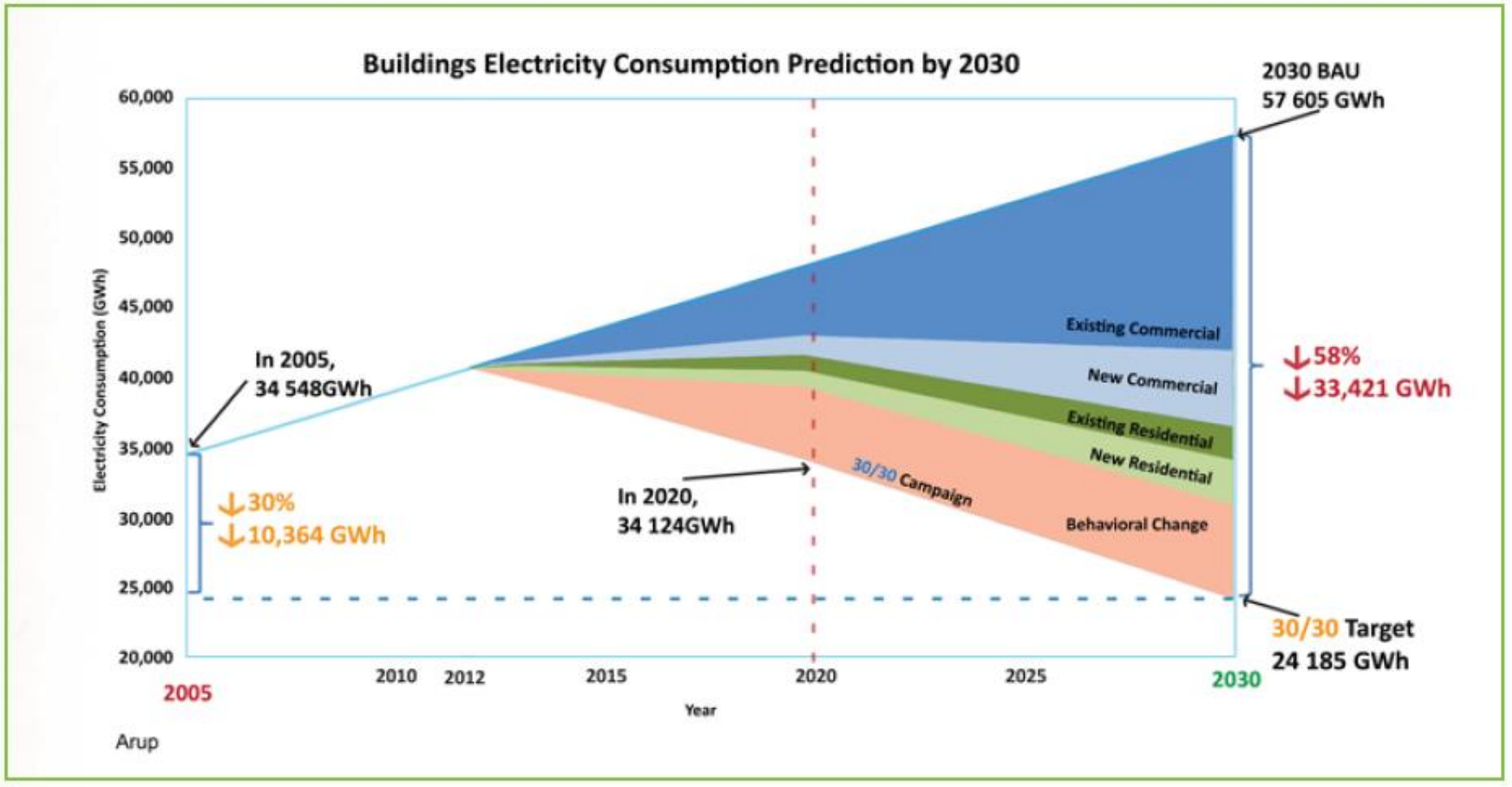
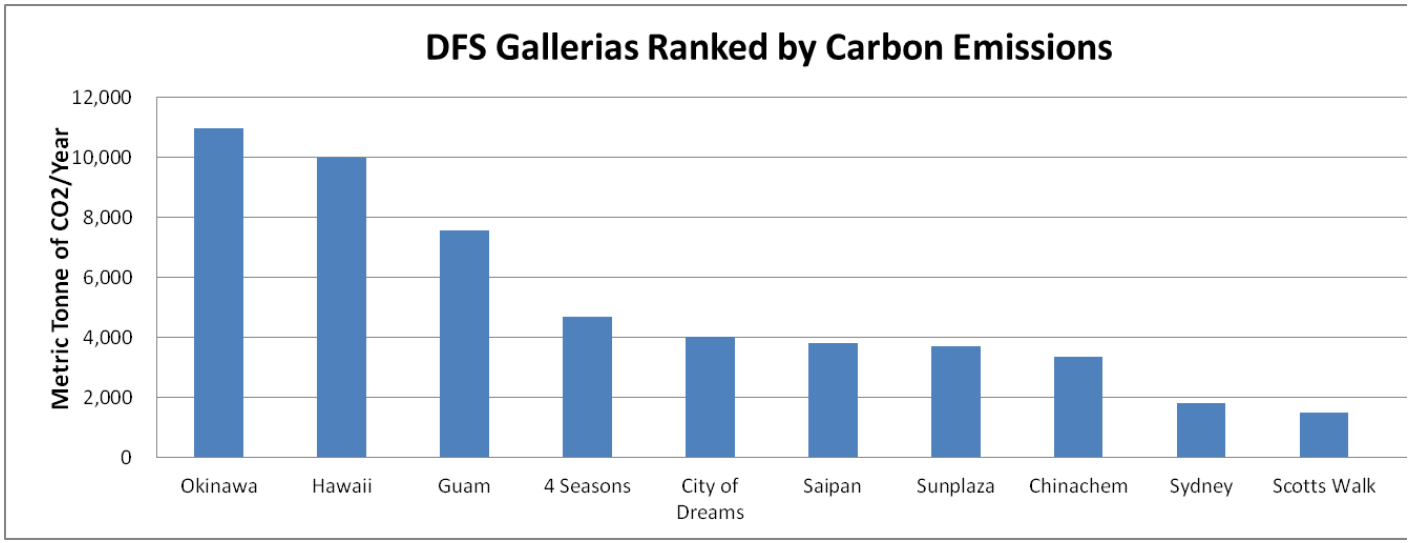
Target requires most savings from existing buildings

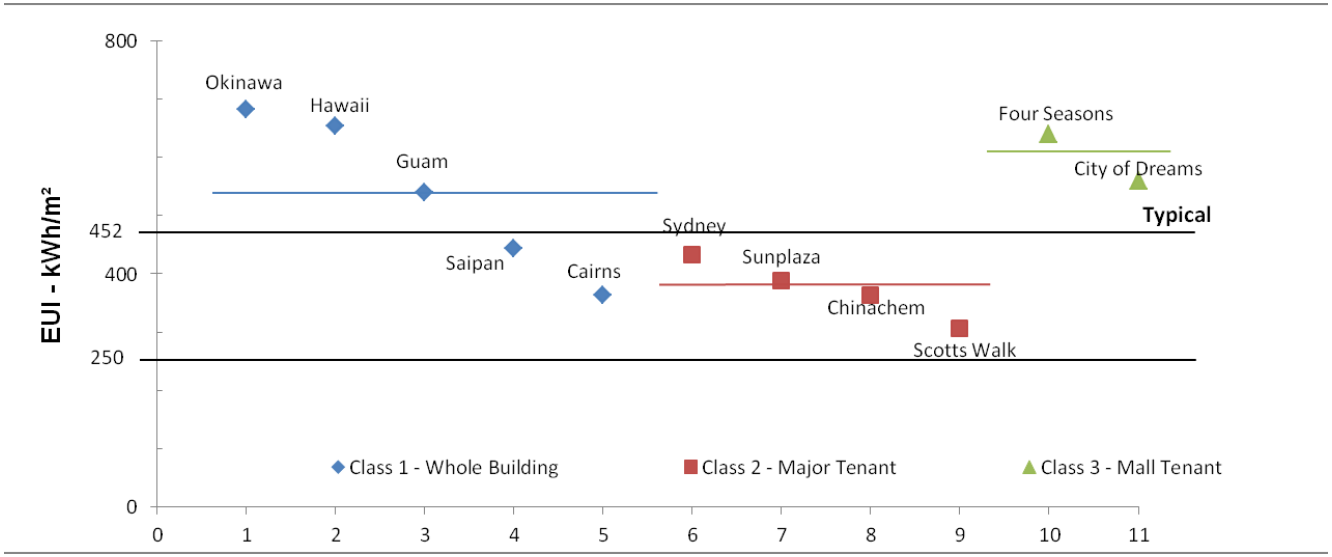


Strategic approach to Energy Retrofits

- Investigation Energy Audit (2011)
- Key Recommendations
  - Global 5 year strategies
  - Baseline and Energy Savings Target
  - Green Design guidelines for refurbishment projects
  - Global and local energy metering
  - Global LED lighting upgrades – mostly during refurbishment
  - Key initiatives for major stores

Energy Audit (2011)





Global Energy Monitoring System

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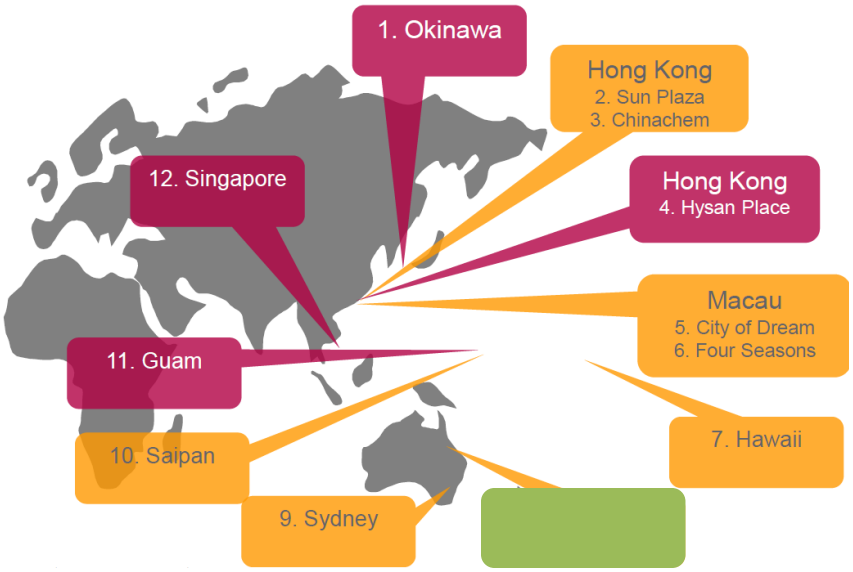
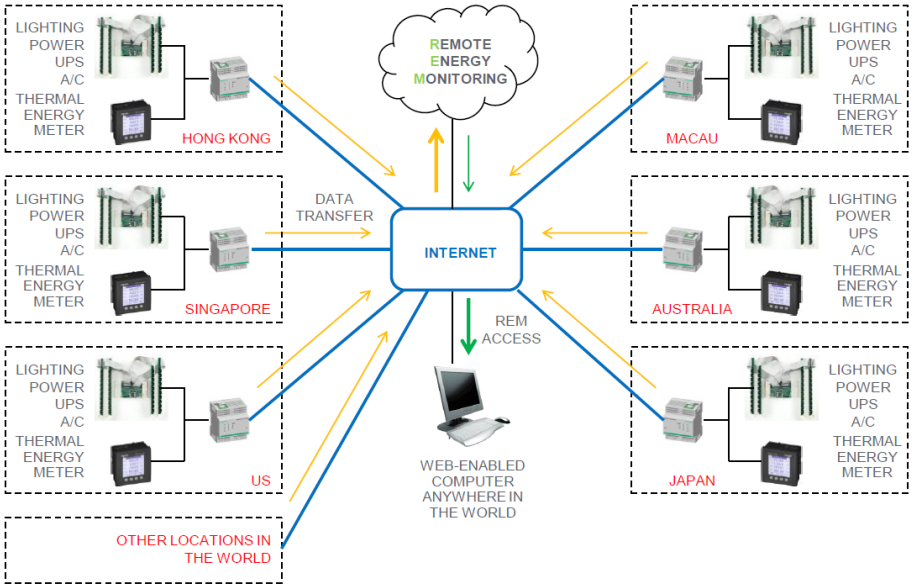
Project Locations



Global System Architecture



Web based remote monitoring of a sites

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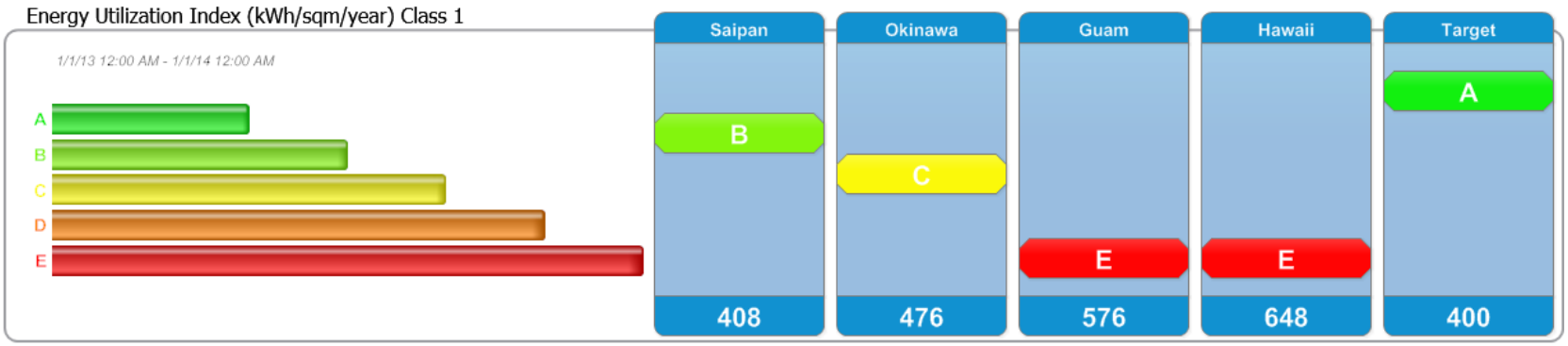

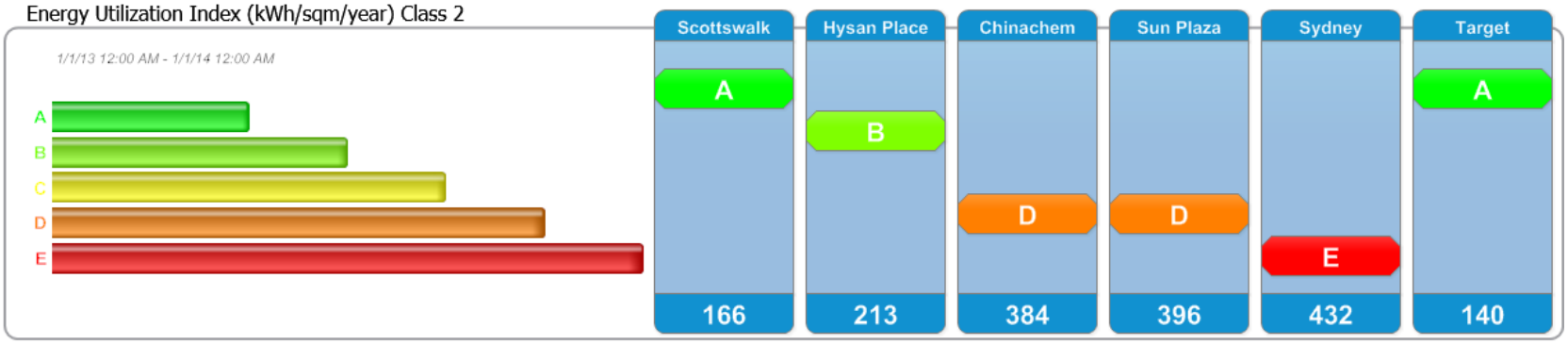

5 Phase Energy Saving Upgrade Plan

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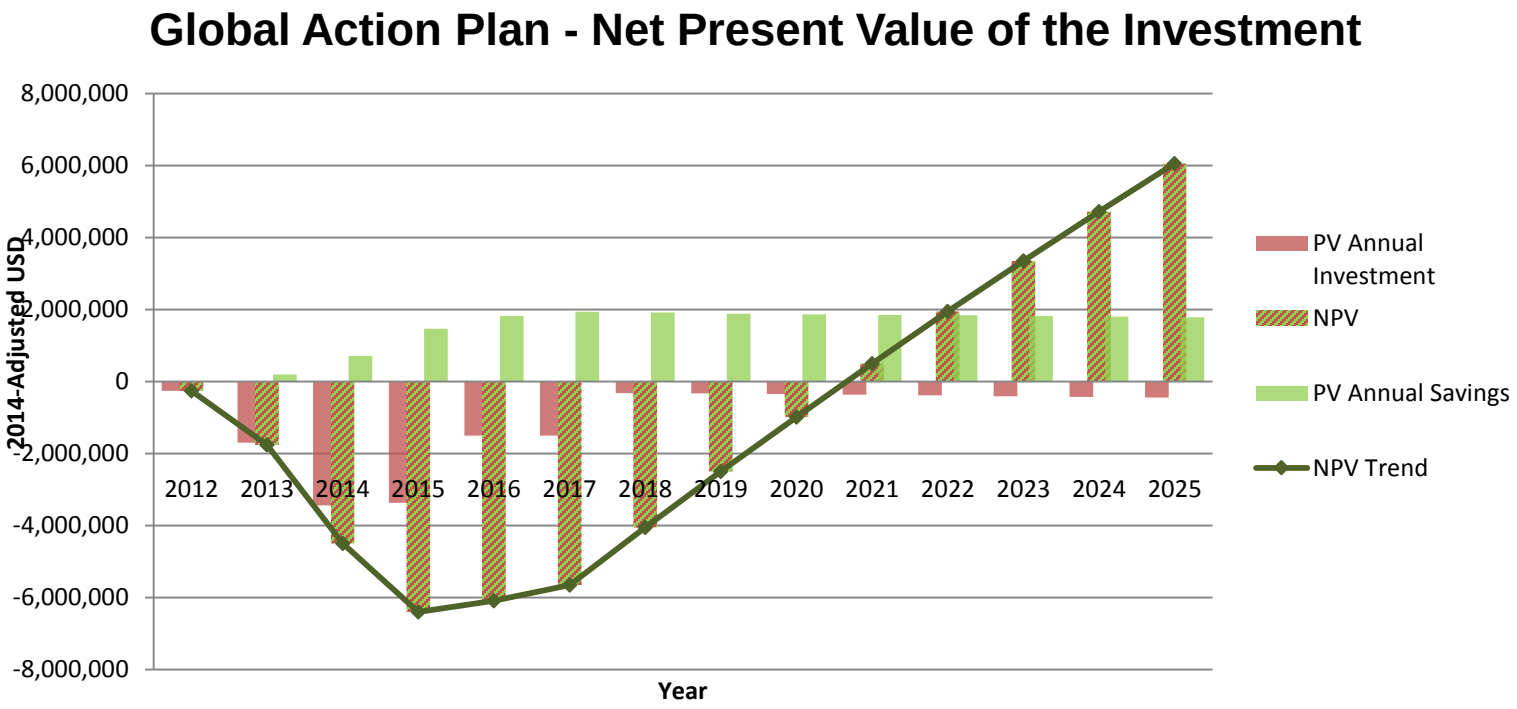
2010	2011-13	2014/15	2016	2017	2018
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Savings Target	10%	8%	5%	4%	3%
Cumulative	10%	18%	23%	27%	30%
ROI	4.2	3.9	6.5	7	8



5 Phase implementation Plan

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Phase 1 has achieved >10% Savings and ROI<4 years

Phase 2 being commenced now with buy-in from Senior Management

Key Initiatives

- Retail LED lighting upgrades achieving 20-30% reduction
- Cooling & HVAC plant reduction + chiller upgrades
- Enhance Monitoring & control
- Efficient equipment savings to offset increase technology

- Green Design guidelines for new & refurbishment projects
- Global and local energy & water metering
- Global LED lighting upgrades – mostly during refurbishment
- Chiller Plant Replacement
- BMS & Controls upgrades

Key Points For Existing Buildings

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- **Benchmark your performance & carry out a deep dive energy audit and request options to savings over a phased approach**
- **Use savings to fund each next phase**
- **Set EUI target for savings Aim for 30-40% savings**
- **Install real time energy monitoring**
- **Rebalance Systems to optimize performance**
- **Add controls and VSDs (Variable Speed Drives)**
- **Replace Chiller plants near end of life with high efficiency chiller and all VSD controls**
- **Replace Lighting with LED and controls**
- **Fine tune and continually optimise**

It takes time and effort but done properly will easily pay for itself

Final Summary

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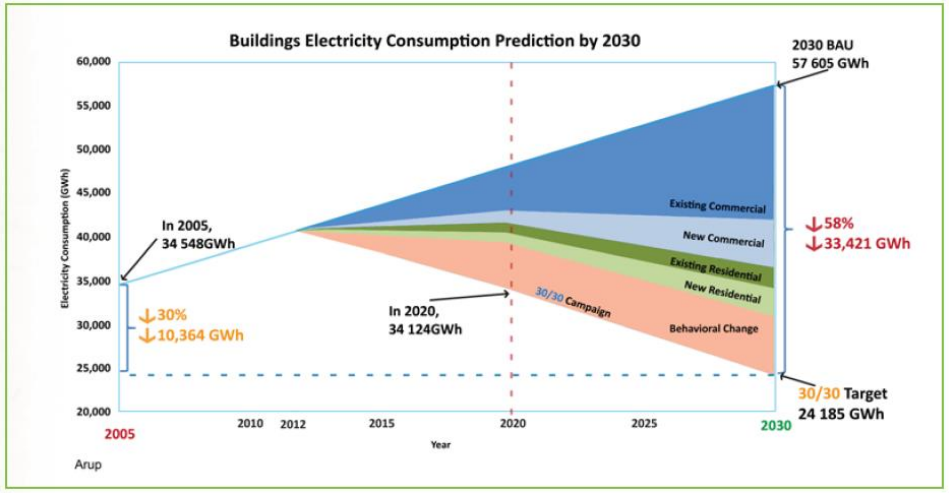
- **We need to act now**
- **Design / Retrofit with an operational focus**



- **Set more ambitious targets to go >30% savings**
- **Reduce demand, challenge design briefs and focus on controls and optimisation**
- **Plan a program for Retrofitting our buildings**
- **Embrace the HK 3030 Challenge**

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Thank You