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Retro-commissioning (RCx) –

A Way for System Optimization

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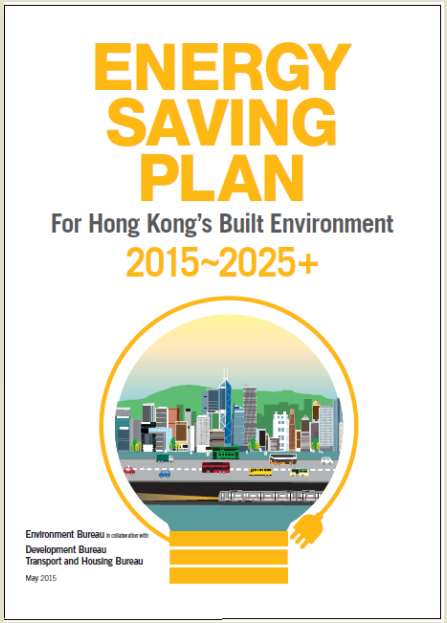
1. Background on RCx



Retro-commissioning and retrofitting of buildings

Most of the existing buildings were designed and built at a time when energy saving was not a foremost consideration. Nevertheless, many of the commercial and institutional buildings built in the past two decades were designed to meet various standards and had equipment built-in. When they were first built, there should have been a commissioning process to test performance. Retro-commissioning is a cost-effective systematic process to periodically check an existing building's performance. The process identifies operational improvements that can save energy and thus lower energy bills. The process can be performed alone or with a retrofit project, such as replacing less energy efficient appliances with more efficient ones (e.g. chillers, pumps, elevators, lights etc) and fitting meters to measure operations.

Global experience shows that even buildings that are just a few years old can benefit from retro-commissioning because it can still help to identify unnecessary energy losses, such as leakage in the building envelope, where energy management systems need to be reprogrammed, controls that are out of calibration or fault in equipment.

2. RCx Definition and Objectives

RCx, as defined in ASHRAE Standard 202, US Department of Energy, among the other references:

Resuming the system efficiency back to the design standard or optimizing the operating system efficiency of the CBSI

2. RCx Definition and Objectives

RCx is to improve building operational efficiency by:

1. review of building operation

2. original intended design

3. improvement and optimization

4. ensuring buildings keep least energy consumption

3. Current Situation in Hong Kong

Buildings constructed before 1989
(>25 years old)

Private office	**~40% of total**
Commercial buildings	**~65% of total**

3. Current Situation in Hong Kong

Existing Building Stock

Data from Buildings Department			
Building Age	Office/Commercial	Residential/ Composite	Industrial
10 or below	229	3,616	73
11 - 15	170	2,796	85
16 - 20	294	2,797	85
21 to 25	294	4,314	268
26 - 30	293	4,314	267
31 - 40	731	6,662	592
41 - 50	318	4,629	364
above 50	130	5,040	117
Total	2,459	34,168	1,851

3. Current Situation in Hong Kong

Existing Building Stock

A Shared Problem

"Most buildings will lose up to 30% of their efficiency in the first three years of operation."

– Bill Harrison,
ASHRAE Presidential Member
(Data based on Texas A&M Study)

3. Current Situation in Hong Kong

Retro-commissioning is not common in Hong Kong.

Building owners not familiar

Value not demonstrated fully

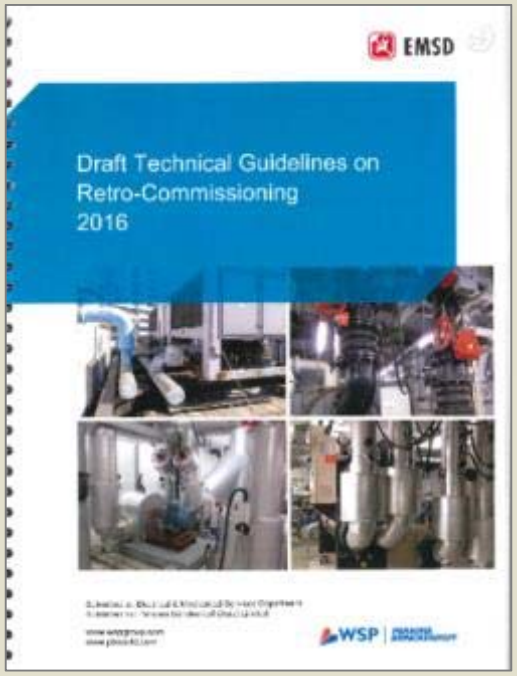
Insufficient local guidelines

Limited experienced staff and service providers

X

Lack of building information

4. Consultancy and Pilot Projects on RCx



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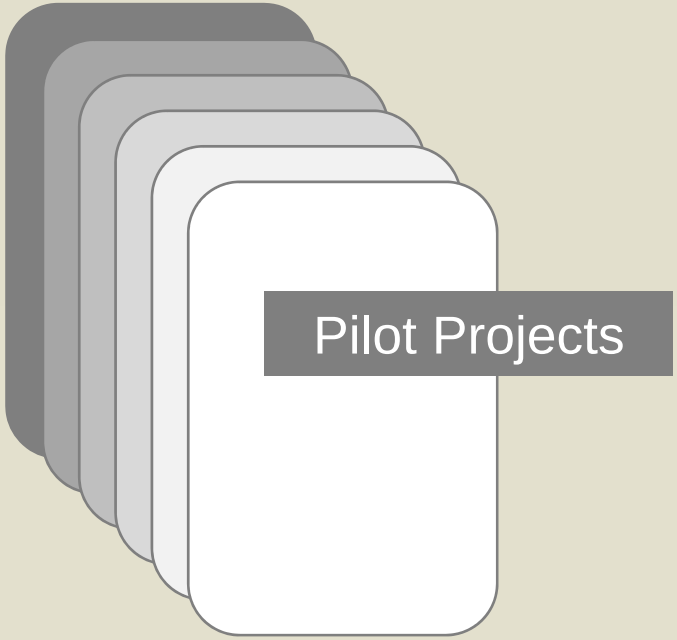
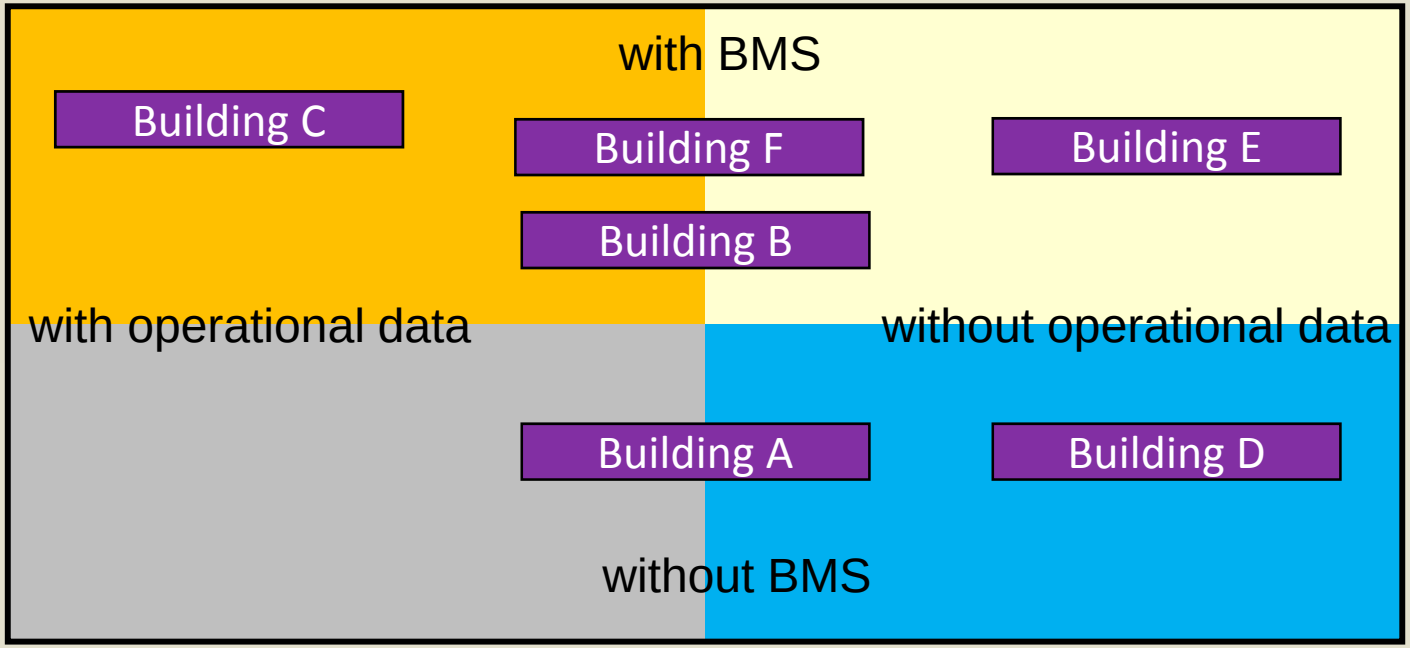


Draft TG(RCx)

Building Profile and Status of BMS



4. Consultancy and Pilot Projects on RCx

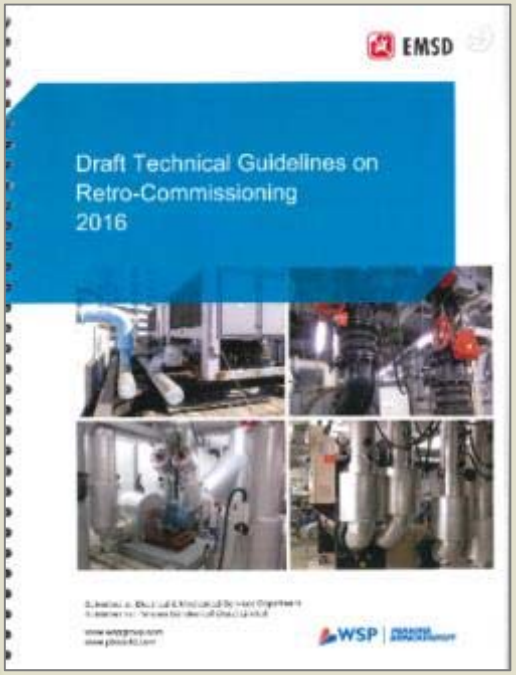
Phase 1

1) Develop one set of draft Technical Guidelines on RCx (TG)

Phase 2

1) To implement the draft TG in pilot projects
2) To consult stakeholders for the draft TG
3) To update and re-fine the draft TG

5. Current Development of TG on RCx



- Draft TG completed
- Pilot projects in progress

6. Framework to conduct RCx

Step 1: Planning

Step 2: Investigation

Step 3: Implementation

Step 4: Handover

Stage 1 (Planning)

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- Collect Building Design Information
- Interview with O&M Staff and/or Occupants (Optional)
- Carry out Initial Building Walk-through
- Perform Initial Equipment and System Checking
- Consider Performing Energy Modeling (Optional)
- Develop a RCx Plan

→ Building Documentation
→ Building Operation Values: e.g.
  1) Indoor Air Temperature
  2) Humidity
  3) Ventilation rate
  4) Building operating schedules
→ Electricity Bills & Metering Data

Form 1.1-1 Provides Building Design Information Checklist

Form 1.1-2 Provides Building Current Operating Requirements

Form 1.2-1 Provides O&M Staff Interview Form

Form 1.2-2 Provides Building Occupant Interview Form

Stage 1 (Planning)

- Collect Building Design Information
- Interview with O&M Staff and/or Occupants (Optional)
- Carry out Initial Building Walk-through
- Perform Initial Equipment and System Checking
- Consider Performing Energy Modeling (Optional)
- Develop a RCx Plan

→ Recognize on-site equipment and system condition

→ Record Visual Inspected Defects

Form 1.3-1 Provides Site Walk Through Checklist

Form 1.3-2 Provides Photo Record for Building Walk-Through

Stage 1 (Planning)

- Collect Building Design Information
- Interview with O&M Staff and/or Occupants (Optional)
- Carry out Initial Building Walk-through
- Perform Initial Equipment and System Checking
- Consider Performing Energy Modeling (Optional)
- Develop a RCx Plan

→ Simple repairs of equipment defects

→ Increase the effectiveness of the diagnostic monitoring

→ Facilitates understanding the root problems of operational issues

Form 1.4 Provides Initial Equipment Checking Item Checklist

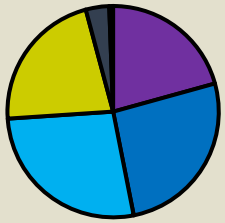
Stage 1 (Planning)

- Collect Building Design Information
- Interview with O&M Staff and/or Occupants (Optional)
- Carry out Initial Building Walk-through
- Perform Initial Equipment and System Checking
- Consider Performing Energy Modeling (Optional)
- Develop a RCx Plan

→ Breakdown energy use of building accurately

→ Evaluate the amount of energy cost saving

→ Help select identified opportunities



Form 1.5 Provides Input Parameters for Energy Modeling

Stage 2 (Investigation)

Conduct Diagnostic Monitoring

Analyze Trend Logged Data and Develop a List of Energy Gap

Equipment and System Investigation Tests

Identify Potential Optimization Opportunities

Shortlist Recommended Optimization Opportunities

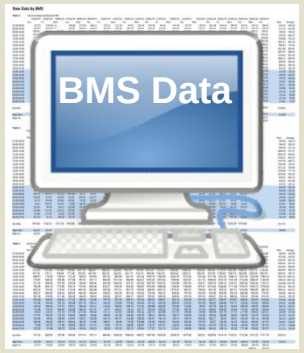
→ Collect Trend Data by BMS

→ Use Portable data loggers

→ Interval can be every min to hour

→ Duration of data collection:

at least for a week



Form 2.1-1 Provides Instrumentation for Data Collection Using Portable Data Logger

Form 2.1-2 Provides Instrumentation for Data Collection Using Portable Data Logger

Stage 2 (Investigation)

Conduct Diagnostic Monitoring

Analyze Trend Logged Data and Develop a List of Energy Gap

Equipment and System Investigation Tests

Identify Potential Optimization Opportunities

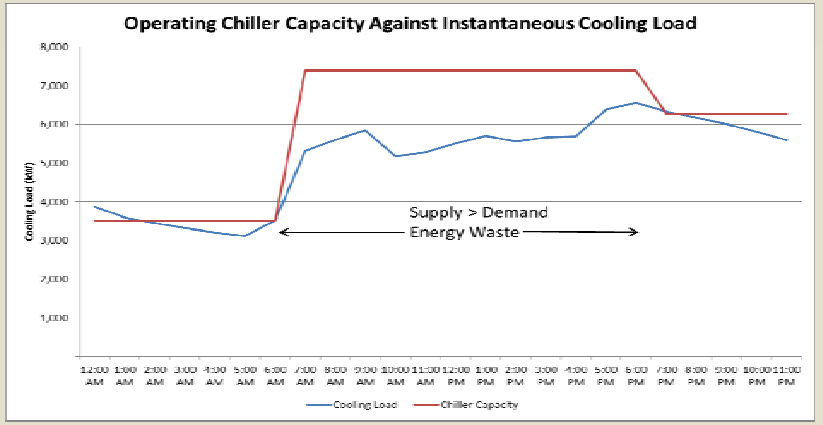
Shortlist Recommended Optimization Opportunities

→ Plot the logged data

→ Find out energy gaps

→ Provide a list of energy gaps

→ Identify possible improvement and optimization



Form 2.4 Provides List of Energy Gaps and Identification of Improvement and Optimization Opportunities

Form 2.5 Provides List of Potential Improvement

Stage 3 and Stage 4

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Stage 3 Implementation

- Implement Selected Opportunities
- Performing Verification
- Develop RCx Final Report
- Develop Ongoing Commissioning Plan
- Conduct Training for O&M Staff

Stage 4 Handover

- Implement Ongoing Commissioning Plan
- Ongoing Commissioning

Common Optimization Opportunities

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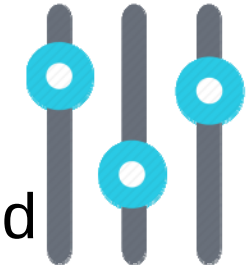
Time clocks disabled

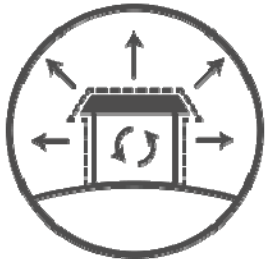
Control sequences not optimized



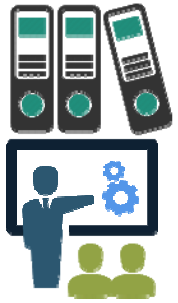
Energy Management System not understood or fully utilitied

Control / sensors / actuators out of calibration

Ventilation excessive



Documentation & training inadequate



Energy Gaps and Optimizations

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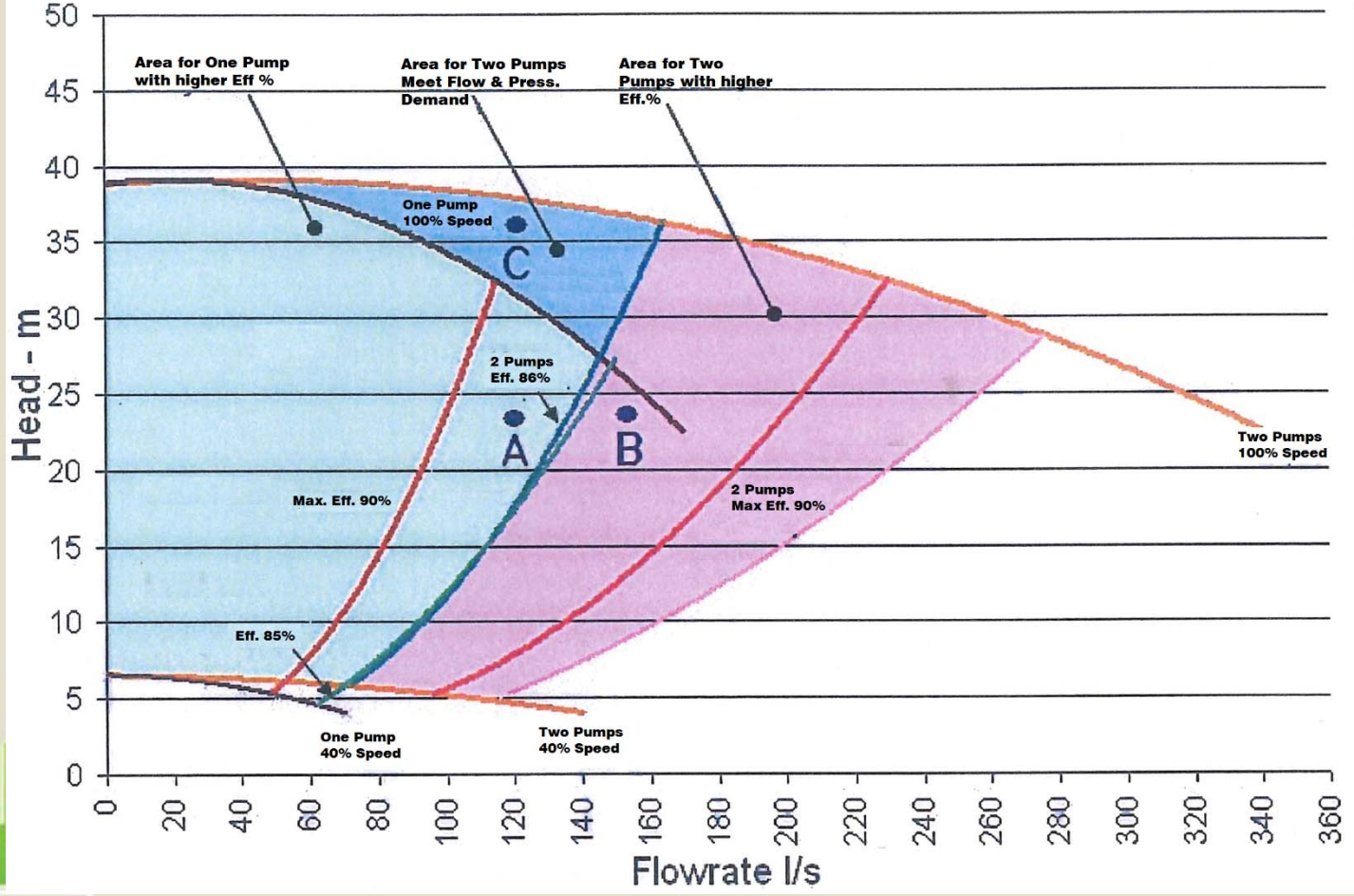
Scheduled pumps

One-Two Primary Pumps operation Optimum control



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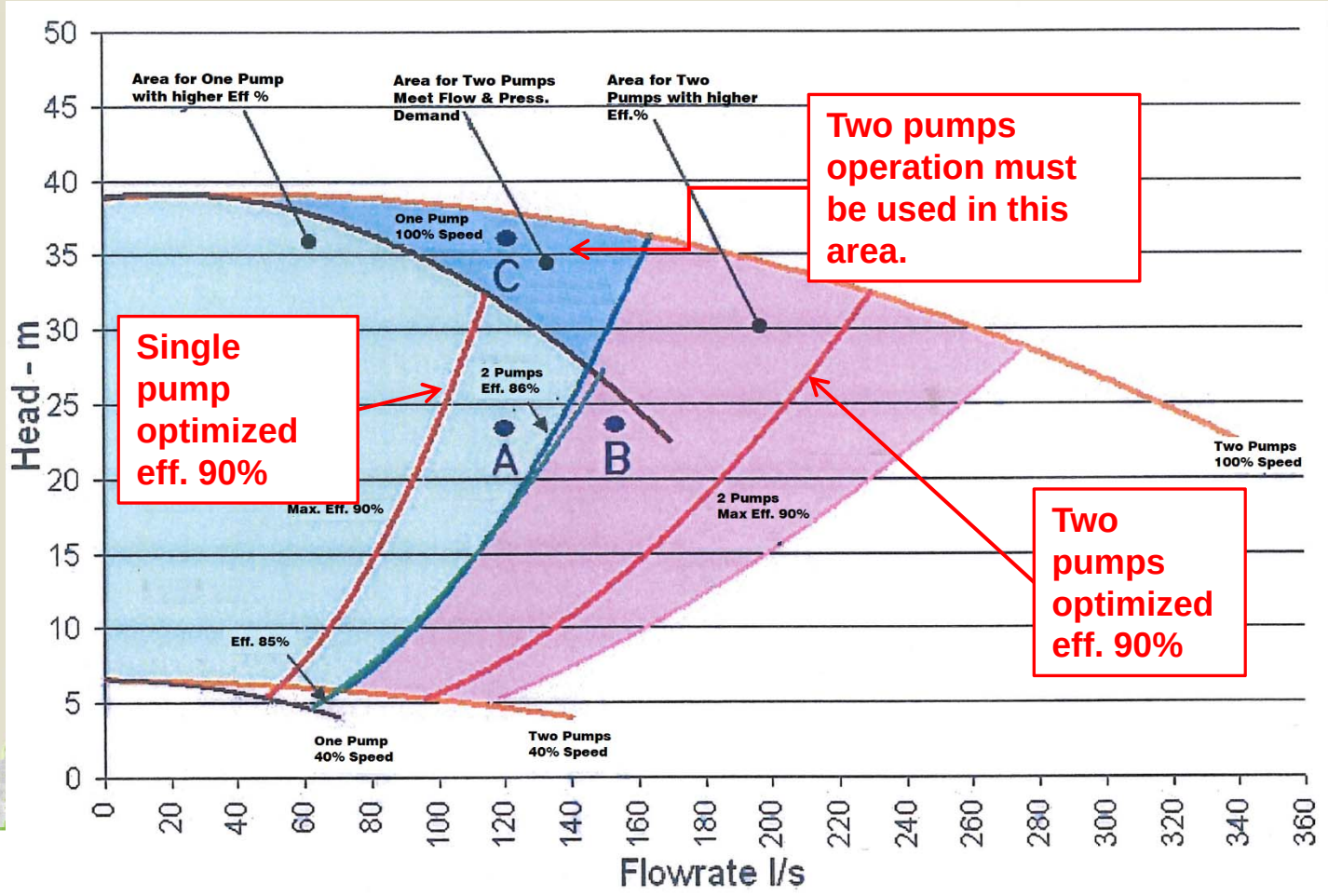
Energy Gaps and Optimizations

Scheduled pumps

One-Two Primary Pumps operation Optimum control



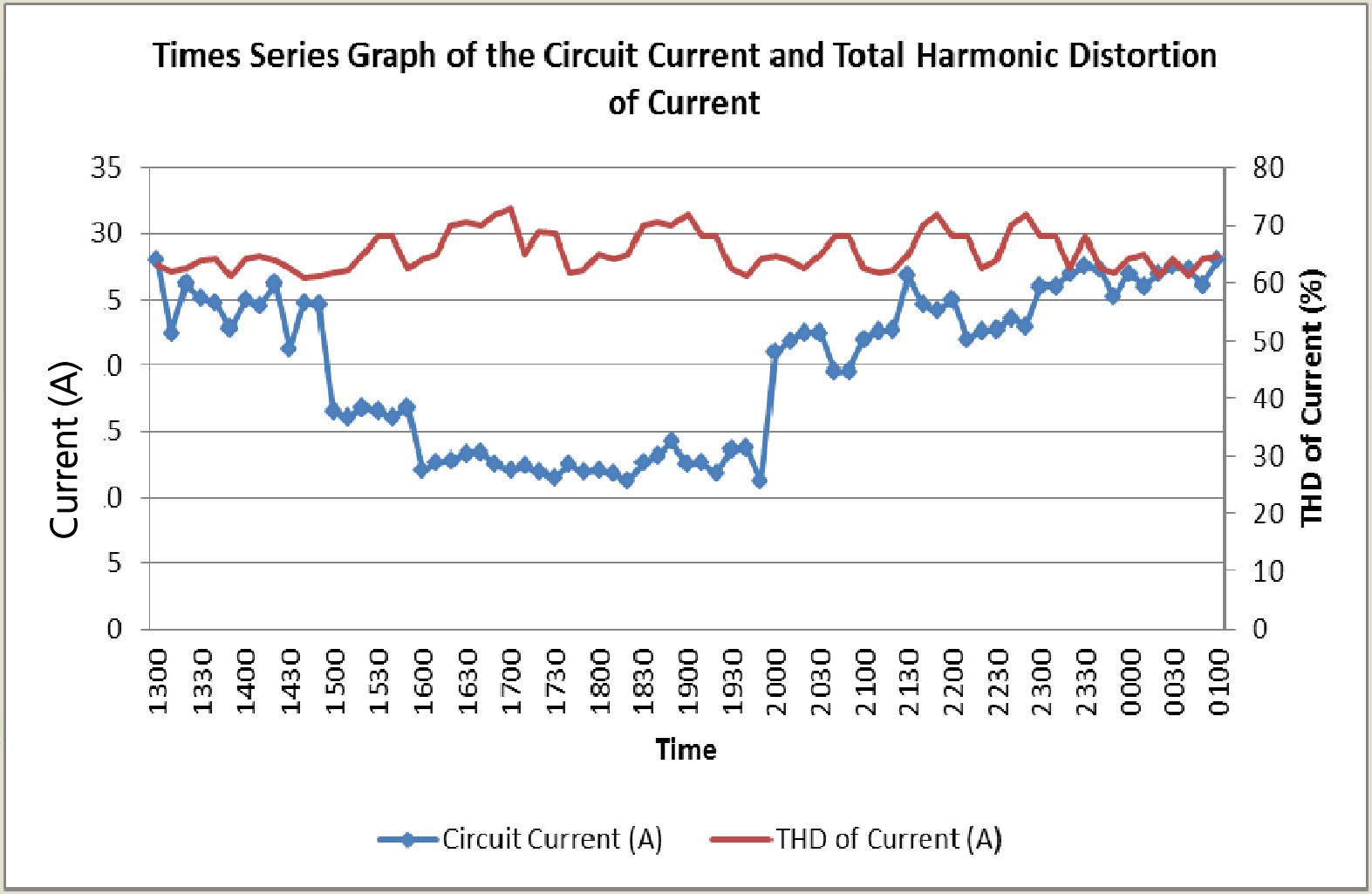
Two pumps operation must be used in this area.

Single pump optimized eff. 90%

Two pumps optimized eff. 90%

Energy Gaps and Optimizations

Example : Measuring THD current and compared with limited design percentage



Possible Cause: VSD for motors, VVVF drive controllers

Energy Gaps and Optimizations

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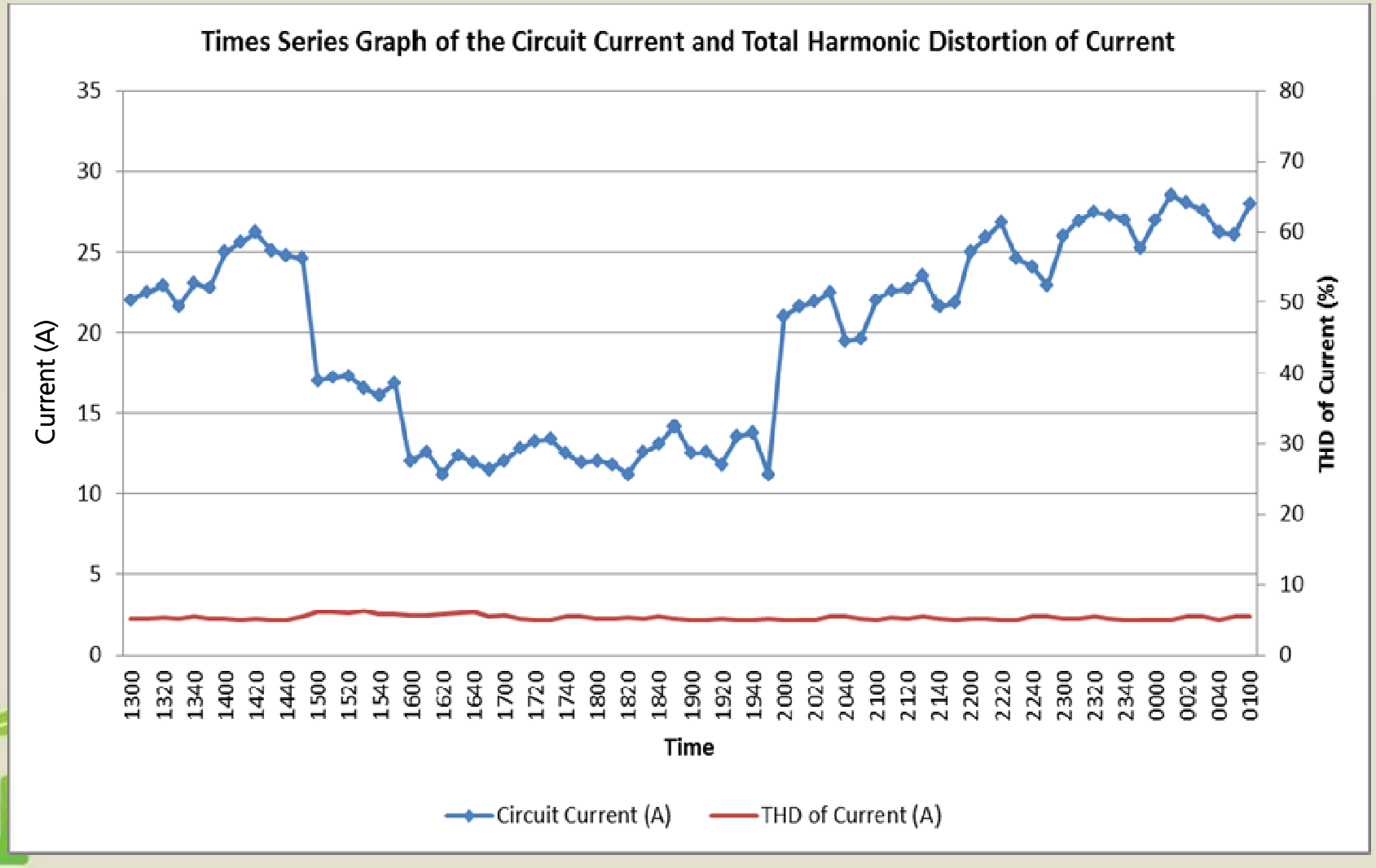
Solution: Install Harmonic Reduction Devices



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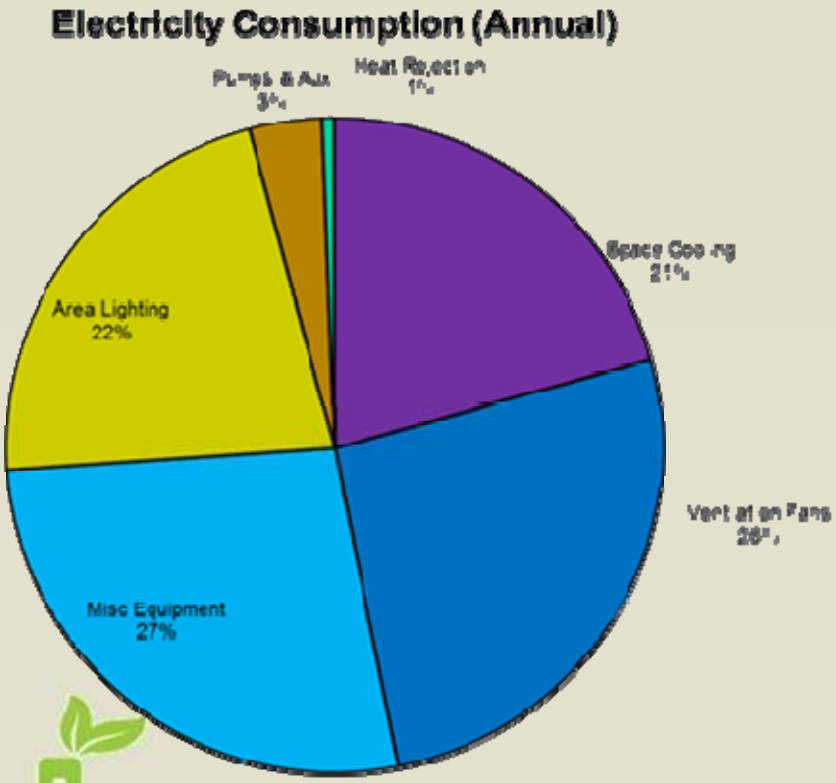
Optional Method – Energy Modeling

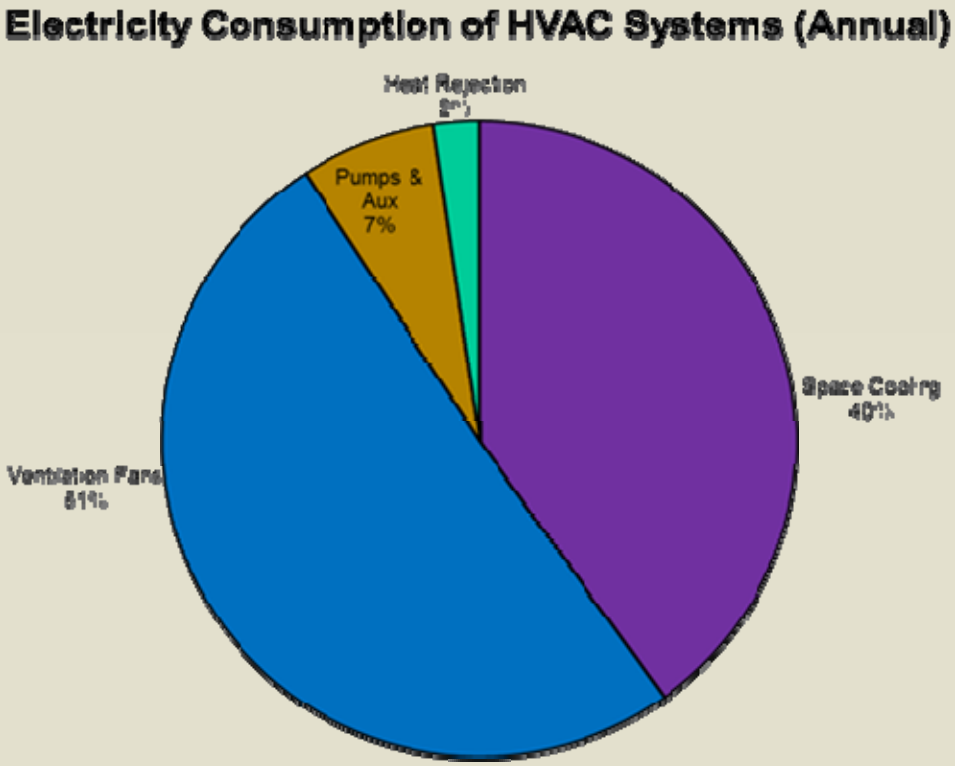
Establishment of Design Model (Necessary Information Required)

Optional Method – Energy Modeling

Generate energy consumption on different BS installations from the Model



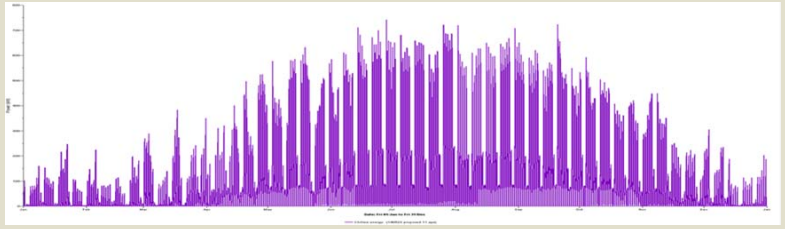
Sample pie-chart of the energy consumption for various BS system



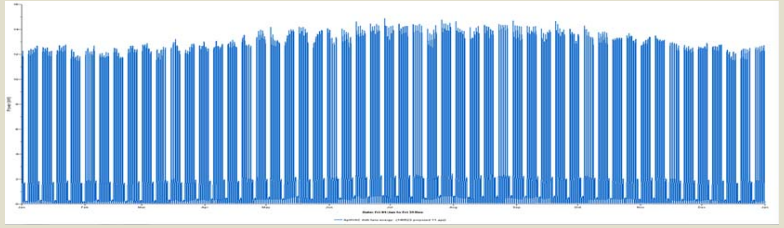
Sample pie-chart of the energy consumption for various HVAC system

Optional Method – Energy Modeling

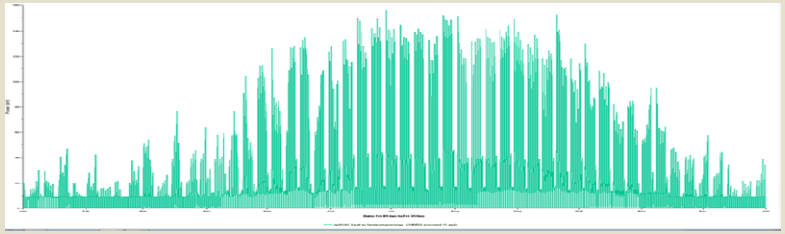
Generate energy consumption profiles from the Model



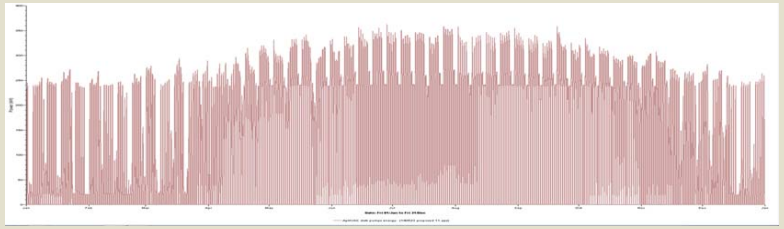
Sample diagram of the energy consumption for chiller



Sample diagram of the energy consumption for MV fans



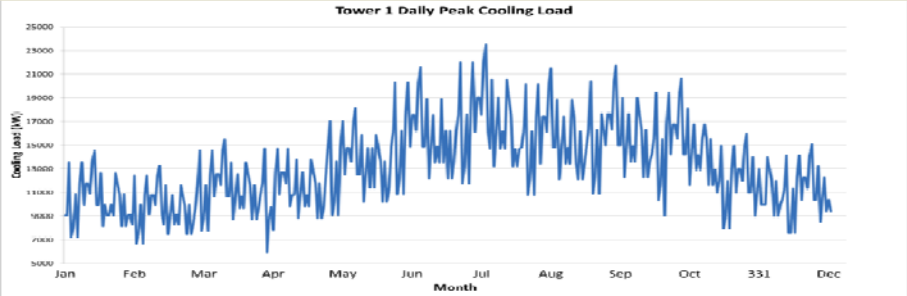
Sample diagram of the energy consumption for heat rejection equipment



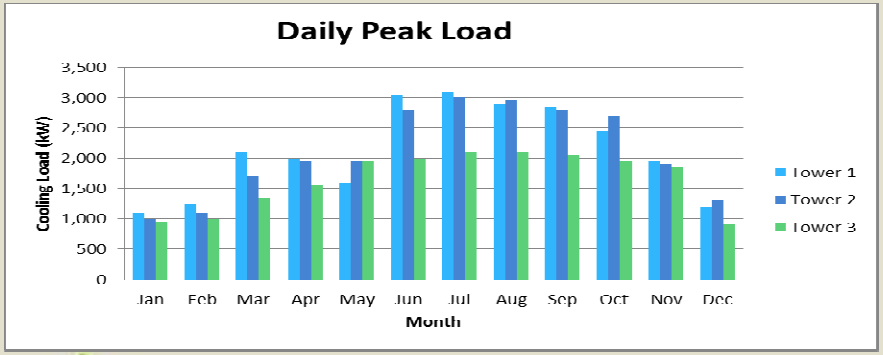
Sample diagram of the energy consumption for AC pumps

Optional Method – Energy Modeling

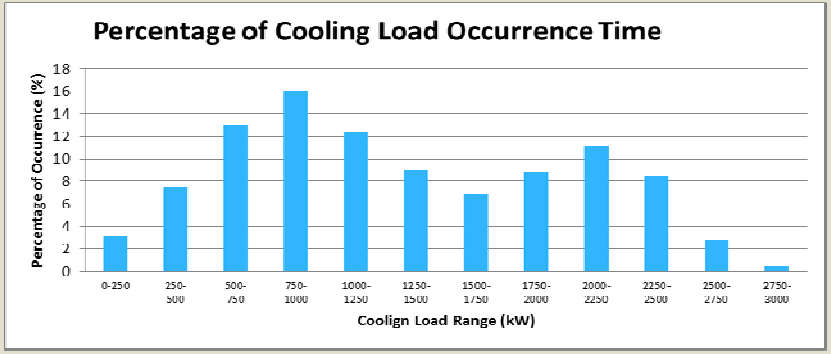
Generate cooling load profiles from the Model



Sample diagram of Monthly Peak Cooling Load



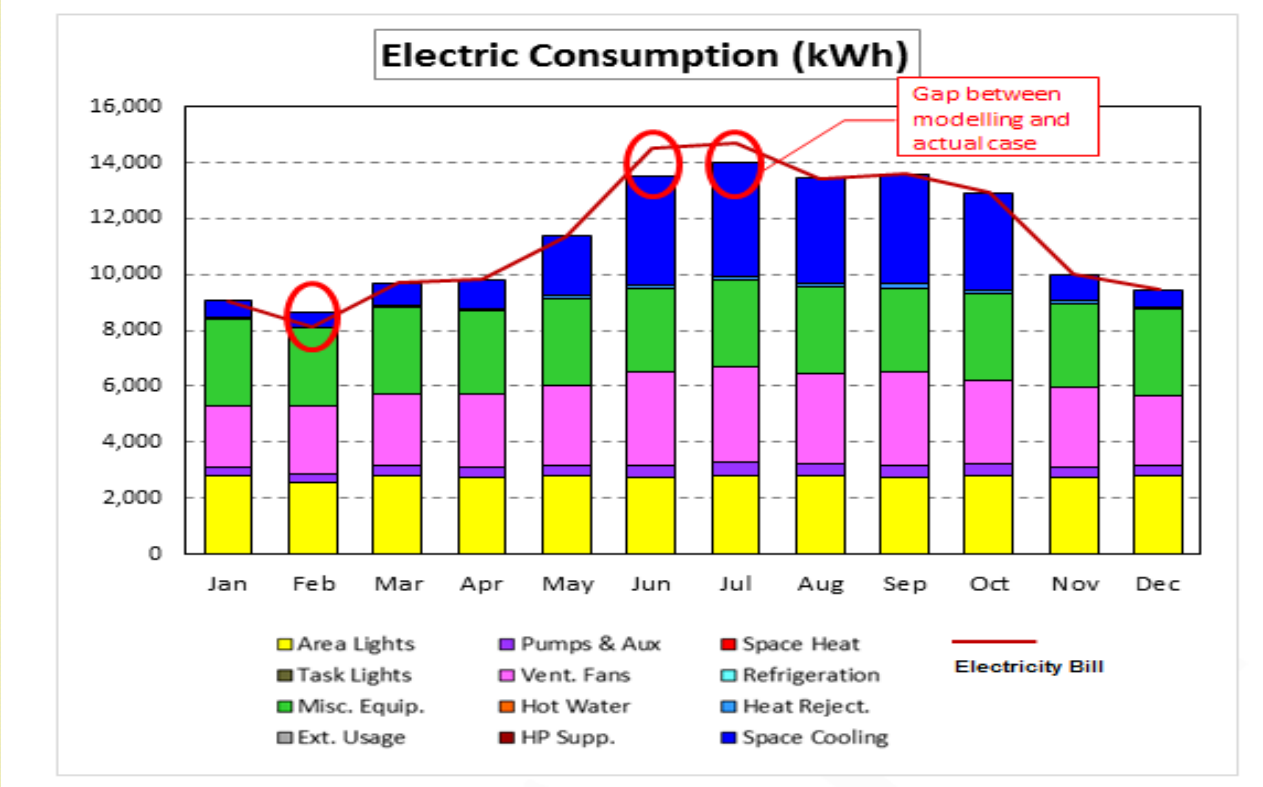
Sample diagram of Daily Peak Cooling Load



Sample diagram of Yearly Percentage of Occurrence Time

Optional Method – Energy Modeling

Identify Gap detected between Energy Bill and Energy Model after Calibration



Gap Detection After Calibration

7. Benefits from RCx

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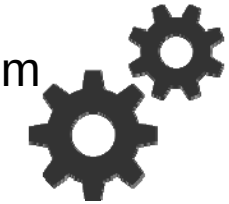
Improve building performance

Improve occupant comfort and productivity

Improved building systems efficiency and extended equipment useful life

Improve system reliability



Reduce maintenance cost

Provide appropriate training to O&M staff

No or Low cost - short payback

Way Forward

- Pilot project still in progress and targeted to be completed by mid 2017.

- Experienced local and overseas service providers to conclude findings and experience gain in pilot project;

- The feedback and experience gained from both consultation and pilot projects will be used to fine-tune the TG before official launch in 2017.

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Thank you !