Dynamic Chiller Plant Optimization

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Understanding of Retro-Commissioning
Overview of HKSAR Gov’t Policy on Building Energy Use

Energy Reduction Target:

- In COP21 held in Paris in 2015, China committed to lower carbon emission intensity (emissions per unit of GDP) by 60% to 65% from the 2005 level by 2030.

- Hong Kong has set the target of achieving energy intensity reduction by 40% by 2025 using 2005 as the base.
Technical Guidelines on RCx

• Key Objective: Enhance the **building energy efficiency**

• Focus on **energy consuming equipment/systems** that operate properly as design or users’ requirement and to **identify some area of improvements** (e.g. shifting of system control settings, inaccuracy of sensors, improper operational schedules and improper air & water balancing, etc.)
Chiller plants are one of the largest energy saving opportunities

Key Facts:
- More than 50,000 buildings in Hong Kong
- Buildings account for 90% of total electricity consumption in Hong Kong
- Among different building services (BS) systems, HVAC consumes the most energy consumption (55%) in office buildings

Implications:
- Reducing energy use by HVAC in commercial buildings is a key measure to take to help realize HK’s energy intensity reduction target.
How to further reduce HVAC energy consumption

Apart from the traditional approach
- using energy efficient equipment (e.g. VSD chiller, pumps, cooling towers)
Utilization of BMS Big Data is a Way Out for RCx

BMS Data enables us to:

- Know how the current performance is
- Understand when and where the best performance occurs
- Identify Energy Waste (due to presence of unnoticed faults)
Overview of Chiller Plant Control

### 1st Generation
- **Traditional Chiller Plant Control**
  - Features:
    - Match cooling load demand
    - Balance equipment running hours
    - Meeting design temperature set points

### 2nd Generation
- **Optimization Control**
  - Features:
    - Determine chiller sequencing based on energy use & equipment design data
    - Temperature reset (summer/winter mode)
    - Mainly focus on chiller energy use

### 3rd Generation
- **Dynamic Optimization Model**
  - Features:
    - Real time optimization for the whole chiller plant
    - Evaluate all possible combinations of equipment for optimization
    - Use actual BMS data for system model development
Data Quality Diagnosis - Flow Rate Sensors

Comparison between header CHW flow rate and individual chiller flow rate

Note: The data period is from 01 Jan 2016 to 31 Dec 2016
Data Quality Diagnosis - Temperature Sensors

Comparison between header CHWR temp and individual chiller CHWR temp

Note: The data period is from 01 Jan 2016 to 31 Dec 2016
**Annual Peak Cooling Load Profile:**

<table>
<thead>
<tr>
<th>Year 2016</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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<td>1/2/2016 8:00</td>
<td>724</td>
<td>799</td>
<td>741</td>
<td>1033</td>
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<table>
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<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tr>
<td>7/4/2016 12:00</td>
<td>1533</td>
<td>1648</td>
<td>1420</td>
<td>1391</td>
<td>1149</td>
<td>879</td>
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Calendar dates and times:
- Jan 1, 2016, 8:00
- Feb 13, 2016, 8:00
- March 30, 2016, 15:00
- April 25, 2016, 13:00
- May 30, 2016, 14:00
- June 27, 2016, 15:00
- July 4, 2016, 12:00
- August 8, 2016, 12:00
Daily cooling load profile (Summer vs Winter):

### Summer

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<th>2</th>
<th>3</th>
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<th>8</th>
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<td>14</td>
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### Winter

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<td>101</td>
<td>126</td>
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<td>84</td>
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<td>15</td>
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<td>17</td>
<td>18</td>
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<td>22</td>
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<td>96</td>
<td>78</td>
<td>120</td>
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Cooling Load Analysis

**Weekday**

- non-office - 0.5
- non-office - 1.0
- non-office - 1.5
- non-office - 2.0
- non-office - 2.5
- office - 0.5
- office - 1.0
- office - 1.5
- office - 2.0
- office - 2.5

**Weekend and Public Holiday**

- non-office - 0.5
- non-office - 1.0
- non-office - 1.5
- non-office - 2.0
- non-office - 2.5
- office - 0.5
- office - 1.0
- office - 1.5
- office - 2.0
- office - 2.5

~700kW

21°C
Actual Chiller Model

Actual Chiller Performance Chart at Tchws=7
Continuous Building Optimization

- Collect Trend log from BMS
- Data processing and cleaning
- Calculate the optimal operation point
- Command the BMS for action

BMS
Local Database Server
Cloud Optimization System
Summary

Features and Benefits:

- Real-time continuous, reliable, automated optimization control
- Whole chiller plant optimization
  - Determine the most efficient combination of chillers, pumps and cooling towers for different control setting
  - Ensure that the chiller plant is operating in its most efficient state year-round, regardless of load
  - Considered the real-time weather condition
THANK YOU