Greening the Concrete Jungle

9th October 2013

By Ero Rodjio
Ascendas Services Pte Ltd
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Getting to know Ascendas

Ways to connect with Ascendas

- **Ascendas corporate website**
  - 13,335 unique visitors, 54,036 page views

- **Spacetobe by Ascendas**
  - Total Likes: 28,723

- **Ascendas Spaces**
  - 1,642 tweets, 571 following, 746 followers

- **Ascendas youtube**
  - 8,403 video views
Getting to know Ascendas
Getting to know Ascendas
Green Vision of Ascendas

Ascendas takes a holistic view of our real estate business in terms of minimizing the impact of our business activities on the natural environment.

We ensure that our business places are energy efficient and minimize the environmental impact through the entire life cycle, starting from design through to building maintenance and operations.
Walk the Talk

Commitment
- Reduce Energy Consumption
- Improve Space's Comfort and Health

Selection
- Air-Cool Chiller
- Old and Inefficient Water-cool Chiller
- Large Capacity and Long Hours
- High Maintenance Cost

Justification
- Payback Period
- Life Cycle Cost
- Replacement at End of Life

Verification
- Measured Plant Efficiency
- Calculated Energy Saving
Walk the Talk

**Ascendas Green Efforts**

- Total energy savings: 2,234MWh
- No. of Green Mark buildings: 22
- Water efficient features in every aspect of Ascendas’ projects
- Amount of recyclables collected: 7,325 kg
Walk the Talk

Ascendas' Green Mark Journey

<table>
<thead>
<tr>
<th>Year</th>
<th>Certified</th>
<th>Gold</th>
<th>Gold+</th>
<th>Total</th>
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<td>Total</td>
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<td>5</td>
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Space to be
Our Success Story at Acer Building
Walk the Talk

Commitment

• Reduce Energy Consumption
• Improve Space’s Comfort and Health

Selection

• Air-Cool Chiller
• Old and Inefficient Water-Cool Chiller: 13 years
• Large Capacity and Long Hours
• High Maintenance Cost

Justification

• Payback Period: 6.7 years
• Life Cycle Cost
• Replacement at End of Life

Verification

• Measured Plant Efficiency: 0.55kW/RT
• Calculated Energy Saving

Consumption
Background of Chiller Plant at Acer Building

- **ACER BUILDING** is located at 29 International Business Park, Singapore 609923
- TOP in 1996
- A 8-storey tower interlinked by a 5 storey podium with 1 level of basement carpark.
- Total GFA: 29,185 m²
- Total NLA: 21,226 m²
- Tenants’ operations: Business & Science Park, Retail, and Amenities.
- Peak cooling load demand: 686RT with 92% Occupancy
- Off-peak cooling load demand: 372RT
## Background of Old Chiller Plant at Acer Building

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity/Power</th>
<th>Quantity</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-Cooled Chiller</td>
<td>200RT</td>
<td>6</td>
<td>Multiple Compressors</td>
</tr>
<tr>
<td>CHW Pump</td>
<td></td>
<td>7</td>
<td>Installed with VSD</td>
</tr>
</tbody>
</table>

### Chiller Operation Schedule

![Chiller Operation Schedule](image)

### Description | Amount
--- | ---
Annual Energy Consumption (kWh) | 2,585,860
Annual Cooling Load (RTh) | 1,447,509
Average Annual Chiller Plant Efficiency (kW/RT) | 1.786
Annual Chiller Plant Energy Cost (S$) | 517,172
Existing Air-cooled Chiller Plant at Acer Building
Background of Old Chiller Plant at Acer Building

<table>
<thead>
<tr>
<th>Description</th>
<th>Audit’s Findings</th>
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<tbody>
<tr>
<td>Chiller</td>
<td>Each chiller has 7 multiple compressors. 24 compressors were running out of available 35 compressors when operating 5 chillers during peak load.</td>
</tr>
<tr>
<td>CHW Pump</td>
<td>5 numbers of CHW pump were running</td>
</tr>
<tr>
<td>CHW Flow Rate</td>
<td>Excess flow rate due to 5 number of pumps were running.</td>
</tr>
<tr>
<td>CHW ΔT</td>
<td>Low ΔT due to excess flow rate</td>
</tr>
</tbody>
</table>

RECOMMENDATIONS:

1. Replace the Air-Cooled Chiller system to Water-Cooled Chiller system.
2. Optimize selection of chiller’s capacity.
3. Install precision chiller plant monitoring and control system
4. Install auto tube cleaning system
5. Modification of piping work to minimized pressure drop in the water distribution system
6. Minimized chiller’s enclosure to prevent additional GFA
7. Optimize the plant to achieve efficiency of 0.59 kW/RT
## Summary of New Chiller Plant at Acer Building

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity/Power</th>
<th>Quantity</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiller</td>
<td>500 RT</td>
<td>3</td>
<td>Centrifugal</td>
</tr>
<tr>
<td>CHW Pump</td>
<td>18.5 kW</td>
<td>3</td>
<td>Horizontal Split Case</td>
</tr>
<tr>
<td>CDW Pump</td>
<td>18.5 kW</td>
<td>3</td>
<td>Horizontal Split Case</td>
</tr>
<tr>
<td>Cooling Tower</td>
<td>7.5 kW</td>
<td>8</td>
<td>Crossflow</td>
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</table>
New Water-cooled Chiller Plant (1/4)
New Water-cooled Chiller Plant (2/4)
New Water-cooled Chiller Plant (3/4)
New Water-cooled Chiller Plant (4/4)
Challenges encountered during construction
Challenges During Construction Period

1. Ensure 24/7 uninterrupted chilled water supply to tenants’ operations.

2. Building a new chilled water and condenser header to reduce pressure drop along the distribution piping system.

3. Sequencing the chiller replacement is a challenge due to some of the existing air-cooled chillers were no longer in operation and were located in the middle of the plant room.

4. Removal of Trellis above the existing air cooled chillers.

5. Minimize noise and vibration generated during the construction period

6. Prevent damage to water proof system at the roof top

7. Limited floor loading on the ground floor to support a larger crane for hoisting of equipment and materials (500-ton crane is needed)

8. Localized strengthening of floor slab at basement Car park.
Maneuvering the piping to achieve lower pressure drop
Prevent damage to water proof system at the roof top
Prevent damage to water proof system at the roof top

- Casting and curing of cooling tower plinth (3 cells)
Removal of the Trellis to allow hoisting of the Chillers

- Removal of trellis
Providing Temporary Support for the 500TON Crane
Hoisting

- 500 Ton crane setting on 7 May 2011

- Hoisting down old air-cooled chiller
Hoisting
Positioning of Chillers and Pumps
Positioning of Chillers and Pumps

- Installation work of new CHWP and CWP
Verification of Result
Accurate and Reliable Energy Management System

Plant Efficiency (kW/RT) with overall error of 1.95%

- Power (kW) with overall error of 1%
- Cooling Load (RT) with overall error of 1.67%

Flow Rate with overall error of 1.4%, inclusive of 1% installation error

Delta CHW Temperature with overall error of 0.91%

- Supply CHW Temperature with overall accuracy of +/- 0.0452 deg C
- Return CHW Temperature with overall accuracy of +/- 0.0452 deg C

+/- 0.5% error

+/- 0.05% error

+/- 0.4% error

+/- 0.043 deg C

+/- 0.043 deg C
Chiller Plant – BMS Control & Monitoring

SCADA COMM. STATUS:

CHILLER PLANT

Weather Station
- Dry Bulb Temp (%): 28.31
- Wet Bulb Temp (%): 25.42
- RH (%): 71.37
- Average Com Temp (%): 28.0
- ABS Approach Temp (%): 27.8
- Approach Temp (%): 2.5

System Summary
- Total Chw TON: 539
- Total CH W: 258.34
- Total CHMP kW: 11.02
- Total CT kW: 12.92
- Total CT kW: 11.13
- Total SYSTEM kW: 293.41

Efficiency (KW/Ton)
- Chiller: 0.079
- CHMP: 0.020
- CT: 0.021
- Total System: 0.544

Diff Pressure S: 0.45
Chilled Water Cutin S: 9.0
Chiller Cut-Out Temp Set: 8.0
Cut-in1 Ton Set: 500.0
Cut-in2 Ton Set: 1100.0
Cut-Out1 Ton Set: 560.0
Cut-Out2 Ton Set: 1000.0

CHW Flow
- DHW (°C): 8.37
- Chw (°C): 13.61
- Chw(lps): 73.25
- Chw(lugpm): 1162
- Chw TON: 456.7

Bypass Valve
- 0.0%

Space to be
Actual realized saving from average plant efficiency of 1.786 kW/RT before to average plant efficiency of 0.55 kW/RT after the conversion from air-cooled to water-cooled chiller system.
Measurement & Verification - Heat Balance

Overall Heat Balance

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
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<tr>
<td>Total Heat Balance Data Count</td>
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<tr>
<td>Data Count &gt; 5% error</td>
<td>1009</td>
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<tr>
<td>Data Count &lt; 5% error</td>
<td>99</td>
</tr>
<tr>
<td>Data Count within ±5% error</td>
<td>16228</td>
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<tr>
<td>% Heat Balance within ±5% error</td>
<td>93.61%</td>
</tr>
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</table>
Benchmark of Chiller Plant Efficiency

Source: ASHRAE

Acer Chiller Plant
0.55kW/RT

Green Mark Baseline
0.65kW/RT
Economical, Social and Environmental Impacts

Economy Impact
Annual Energy Saving of 1,771,758 kWh.
Annual Energy Cost Saving of S$299,720.
Payback period of 3.67 years with 50% GREET fund.

Environmental Impact
Reduction of 864 metric tones of CO2 per year.

Social Impact
Job creation.
Skill Development.
Continuing the journey

2008
- Galen

2010
- Acer
- Capricorn

2011
- CLC

2012
- Corporation Place
- Tech Link
- Tech Place

2013
- Cintech 1, 2, &3
- Alpha Building
- Tech Quest
- Nordic European Centre

2014
- Science Hub
- Rutherford
- Creative Building
Q & A