Indoor Swimming Pools: Monitoring and Diagnostics

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Agenda

• Aquatic Centres
• BMS - Capabilities
• Project Case Study – BMS monitoring in an aquatic centre
  • Junee Aquatic Centre
• Lessons learnt
Aquatic Centres

• High humidity
  • Poor visibility
• High risk
  • Damage
  • Electrical safety
• Chlorinated air
  • Human health
  • Corrosion
Addressing These Issues

• Through passive measures – natural ventilation .etc
• Through mechanical HVAC plant

• Control is important – automated and/or manual
  • Manually opening louvres
  • HVAC plant operating on time schedule

• To maintain space temperature (°C) and relative humidity (%)
Building Management System (BMS)

- Automated control
- Also known as BAS, BACS
- Controls and monitors operation of energy consuming equipment in a building, such as:
  - Mechanical HVAC – pumps, air handling unit
  - Lighting
  - Fire

![Building Management System Interface](image-url)
Capabilities

• Control

• Monitoring
  • System
  • Monthly energy targets – keep track of monthly energy consumption

• Remote access - Diagnostics

• Alarming / exception reporting

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Botany Map Room: Zone Temp South value 16.8 is exceeding limit of 17.0

05 Sep, 2017 1:25:32 AM, LOW LIMIT, Universal, Botany Map Room: Zone Temp South value 16.8 is exceeding limit of 17.0

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http://www.avg.com
Project Case Study

- Junee Junction Recreation and Aquatic Centre (JJRAC)
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Project Case Study

- Junee Junction Recreation and Aquatic Centre (JJRAC)
- Owned and operated by the Junee Shire Council (NSW)
- Area: 3,500m$^2$
Project

• HVAC Upgrade

• Objectives – to improve:
  • Energy efficiency
  • System reliability
  • Thermal comfort conditions

• Project obtained grant from NSW Office of Environment and Heritage (OEH)’s Energy Saver program
Summary of Project

Before

Pool hall served by obsolete electric heat pump
## Summary of Project

<table>
<thead>
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<th>Before</th>
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<td>Pool hall served by obsolete electric heat pump</td>
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<td>Five instantaneous hot water heaters</td>
<td>Replaced with three high efficiency condensing-type water heaters (boilers)</td>
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<td>provide heat source for pool water, in-slab</td>
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Summary of Project

• Installed a new BMS
Summary of Project – Result

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<th>After Installation, before tuning</th>
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<tbody>
<tr>
<td>Electricity (kWh/y)</td>
<td>366,910</td>
<td>333,015</td>
</tr>
<tr>
<td>Gas (MJ/y)</td>
<td>4,230,499</td>
<td>4,227,194</td>
</tr>
<tr>
<td>GHG emissions (tCO₂-e/y)</td>
<td>635</td>
<td>601</td>
</tr>
<tr>
<td>% GHG Reduction</td>
<td>N/A</td>
<td>5</td>
</tr>
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• Better controls
• Improved system reliability
• Objective is not just reducing GHG emissions!
Post-Completion Monitoring
• Preceded by site visit for inspection of installation
• Monitor equipment operation
• Ensure no latent defects remain

• Analysis on energy consumption through:
  1. Demand side
  2. External influences – eg. weather
Demand Side: Energy

- Establishing baseline data
- Electricity – Interval data, BMS
- Gas – BMS
- Water – BMS

ELECTRICAL METER

- V1-N: 242 V
- V2-N: 241 V
- V3-N: 240 V
- L1-A: 46 A
- L2-A: 41 A
- L3-A: 45 A
- kWh: 266751 kWh
- Pf: 0.96
- Kw: 29 kW
- KVA: 30 KVA
- KVAR: 7 KVAR

FILTRATION PUMP 1

- kWh: 187.97 kWh
- A: 0 A
- Hz: 0 Hz

FILTRATION PUMP 2

- kWh: 49855 kWh
- A: 16 A
- Hz: 50 Hz

POOL MAKE UP WATERMETER

- W: 8965 m3

GAS METER

- G: 561088 m3

WATERMETER

- W: 7765 m3
Demand Side: Issues Noted Through BMS Monitoring

• Unusually high gas consumption
  • Boilers incorrectly commissioned – all three boilers operating when only one is required
  • Controls associated with Pool Hall heat exchange unit – excessive OA etc.

• Controls incorrectly set on BMS – time schedule, setpoint
• Washroom, foyer and gym lights on 24/7
Weather Dependency

• Through degree day and regression analyses
• Is energy consumption affected by weather?

• Degree day analysis:

1. Obtain annual weather data from BoM
2. Nominate base heating and cooling temperature (typically 18°C and 24°C)
3. Hypothesis: Higher HDD, larger gas consumption for heating
4. Hypothesis: Higher CDD, larger electricity consumption for cooling
Heating Degree Days – Regression Analysis

\[ y = 1037.7x + 93213 \]

\[ R^2 = 0.8625 \]
Cooling Degree Days – Regression Analysis

\[ y = 103.91x + 28578 \]
\[ R^2 = 0.5112 \]
Weather Dependency

• Heating degree days in 2017 higher than 2016 by 11%
• Colder in 2017!

• One of the reason for high gas consumption
• Benefit of energy-efficient measures may not be evident due to weather effects
Summary of Monthly Gas Consumption
Summary of Monthly Electricity Consumption
Ongoing Tasks

• Remote monitoring through BMS
  • Alarms

• Issue Measurement and Verification (M&V) report to Council on monthly basis, covering:
  • Energy consumption
  • Weather
  • Issues noted through BMS
  • Recommendations
Future Opportunities

• Pool filtration plant monitoring
Lessons Learnt

• Weather
• Building Staff
• Distance between project teams and site
Summary

• Controls – complex, however beneficial if implemented and used correctly

• Remote access and good BMS functions – allows energy consumption to be monitored

• Good relationship with clients and contractors important
Thank You

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