Understanding Energy Performance Of The Ku-ring-gai Fitness And Aquatic Centre

Peter Vun
Ku-ring-gai Council
Introduction - Ku-ring-gai Council

- Population of 114,700, projected to increase to 147,650 (24%) by 2031
- 84 square kilometres
- 16 kilometres north of the Sydney CBD
- Diverse range of assets – commercial office space, sports fields, libraries, amenities blocks
- 130 NMIs
- 250 Sydney Water connections
Introduction - Ku-ring-gai Council

Climate Change Policy Emissions and Energy Management

Policy aligned with the climate science and limiting warming to 2°C

2°C warming emissions target

1. 2020 target – 20% reduction in emissions
2. 2030 target – 50% reduction in emissions
3. 2045 target – 100% reduction in emissions

Relative to 2000 baseline
Ku-ring-gai Fitness and Aquatic Centre

$18M Redeveloped facility opened October 2014

Visitor numbers
- 250,000 / year
- 21,000 / month

Pools
- 50m outdoor (6 lane) – heated 26°C
- 25m indoor (8 lanes) - heated 28.5°C
- Indoor learn to swim (100m²) - heated 30.5°C
- Outdoor learn to swim (200m²) – heated 27°C
Ku-ring-gai Fitness and Aquatic Centre

- Gym
- Program / Yoga room
- Crèche
- Cafe

- Space Heating / Cooling – Heat Pumps
- Pool Hall HVAC uses heat recovery units to reclaim energy from vented air
- Pool hot water – 3 gas heaters (boilers)
- Amenities hot water – gas
Ku-ring-gai Fitness and Aquatic Centre

Operating Model
Ku-ring-gai Council is the asset owner

External Operator is in charge of running
Day-to-day operations
- Management fee
- Provide staff
- Responsible for activity programming
- Management of contractors and reactive / preventative maintenance

Profit / losses to Council - so any excess energy costs are borne by Council

Future years, the operating model may stay the same or change to 100% lease, profit-share, or some other model
Ku-ring-gai Fitness and Aquatic Centre

- 50% of Council’s energy footprint
- $340,000 / yr energy costs
- 2,000 tCO2 / yr

- 28% of total water consumption
- $82,000 / yr water costs
Where We Started

Key Questions

- How much energy is this asset going to consume each year?
  - “a lot, but we’re not sure”

- How will we know if it’s performing as intended, better than intended, or worse?
  - “we’re not sure”
Where We Started

Key Questions

- Who is responsible for energy and water management and making sure the centre performs as well as it can? – “the external operator”
Where We Started

Key Questions

- Does our contract with the external operator have an incentive to invest in making sure energy / water is well managed?

“Sort off. But not really. Actually, they may have a incentive to not manage energy/water consumption efficiently (it would over inflate the expected running costs used for any future lease agreement)”
KFAC Energy Performance Project

- Sense check and baseline consumption levels of all key plant.
- Use baselines to set performance indicators/targets for key plant (monthly / qtrly monitoring)
- Develop anomaly alert criteria to pick up unexpected consumption events (low level hourly / daily monitoring)
- Undertake gap analysis of energy / water management processes
- Develop an energy management framework suitable for incorporating into the next version of the Council/Operator contract
- Survey other aquatic centres energy and water footprint
What We Found – The Good

A generally good design (smart facility - but with poor performance with certain plant)

- 15 minute interval sub-meter data for every distribution board
- Gas sub-metering
- Water sub-metering

- BMS display and trend logs for temperatures, humidity

- BMS scheduling of all plant and set points

- Email alerts for HVAC and filtration plant

- Email of alerts for consumption anomalies
Ku-ring-gai Fitness and Aquatic Centre

Electricity Consumption Breakdown

- General Power and Lighting: 13%
- All other HVAC: 13%
- Pool Hall HVAC: 31%
- Pool Filtration: 43%

Water Consumption Breakdown

- Pool Make Up: 65%
- Amenities & Café: 35%
What We Found – The Good

Aquatic centre Benchmarking data

![Graph showing net energy consumption per month per m² (excludes any energy exported to grid)]

- Climate zones correspond to those defined in the Building Code of Australia

Kuringai Council
Loving Living Kuringai
Sustaining Sydney's green heart
What We Found – The Bad

- Defects – electricity, gas, water meters missing, condensers not working, BMS not commissioned to spec, faulty sensors, sub-meters integrated to BMS with incorrect scaling factors.
- Missing as-built documentation
- HVAC plant programmed to run continuously (24hr/7days)
- Water and energy being wasted – potable water being continuously discharged by a water treatment system that hadn’t been setup correctly.
- Gaps in operating model – responsibility for energy / water consumption not defined in Operator contract. Which ultimately led to a absence of any technical resources in the Operator’s team, even though the management team at Council had assumed the Operator would take care of all technical aspects.
- No process for Operator or Council to regularly review energy / water consumption
What We Found

Two key assumptions, led to two key lessons

**Assumption 1:** Council assumed the builder had fully implemented all energy management and BMS features

**Lesson 1:** Projects delivering new facilities need a post construction evaluation to catch all defects related to building controls, energy management features, and the BMS.
What We Found

Assumption 2: Council and the Operator assumed that with a few preventative maintenance contracts in place, that “a new, smart, modern facility would run itself, and perform very efficiently”

Lesson 2: A smart building is not an autonomous building. A smart facility is not necessarily a high performance facility.
The Autonomous Building Myth

A smart building or facility ≠ Autonomous building or facility

The X-47B is a US Navy demonstration plane that can fly, take-off, land, and undertake aerial refuelling without any human assistance. It is the closest thing ever built to a fully autonomous plane.
The A380 is one of the most advanced passenger aircraft ever built. It’s smart and modern systems make it faster, more efficient, quieter, and safer than previous generation aircraft.
The Autonomous Building Myth

X-47B

A380
The Autonomous Building Myth

A facility with an advanced BMS ≠ Autonomous facility

A facility with an advanced BMS ≠ High performing facility

Smart facility
+ 
performance objectives
+ 
suitably skilled resources

= High performing facility

KFAC Energy Management Framework
KFAC Energy Management Framework

Key Components for Effective Facility Management

- Environmental condition objectives - eg. water quality, air temp, RH%
- Energy / Water consumption and demand objectives
- Equipment condition objectives
  - Preventative maintenance
  - Reactive maintenance
- Clearly defined accountability: KPIs / performance targets, incentives / disincentives, assigned roles / responsibilities

Equipment condition monitoring

Performance Indicator Targets
- Monitoring
- Tuning
KFAC Energy Management Framework

Performance Indicator Targets

Electricity
- HVAC
- General power and light
- Pool filtration plant
- Indoor pool heating circuit

Water
- Total water consumption (seasonal)

Gas
- Total Gas consumption (weather normalised)

Plant Status
- Unresolved equipment alerts
KFAC Energy Management Framework

Anomaly Alerts

DB-LG-3 Light May 2016

Time (hrs)

kWh

0 1 2 3 4 5 6

0 1 2 3 4 5 6

Time (hrs)
## KFAC Energy Management Framework

### Responsibilities Matrix for Key Plant

<table>
<thead>
<tr>
<th>KFAC Components</th>
<th>Council</th>
<th>Operator</th>
<th>Maintenance Contractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring</td>
<td>Define criteria for energy/water anomaly alerts. Define energy/water performance indicator targets. Define plant status reports.</td>
<td>Monitor BMS and facility for energy/water anomalies and equipment alerts. Coordinate actions to resolve all equipment alerts and energy/water anomalies. Compile monthly or quarterly report of - energy/water performance indicators against targets - plant status report. Key Operator staff to participate in monthly or quarterly energy management review with Council staff.</td>
<td>Alert operator of issues identified during site inspections</td>
</tr>
<tr>
<td>Tuning</td>
<td>Undertake monthly or quarterly review of - energy/water performance indicators against targets - actions proposed by Operator to address any exceedances of performance targets.</td>
<td>Initiate and coordinate tuning of plant settings by operator’s facility manager and site staff to ensure a) effective operation of plant, i.e. environmental conditions are met b) efficient operation of plant, i.e. meets or exceeds expected energy consumption c) correct operation of plant, i.e. plant status alerts are resolved through timely reactive and preventative maintenance.</td>
<td>Alert operator of issues identified during site inspections</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>Review and sign-off on maintenance spec/plan. Undertake monthly review of maintenance related performance indicators provided by operator. Optional: Undertake 6monthly site condition audits using independent 3rd party.</td>
<td>Administer and procure maintenance contracts for - HVAC plant - BMS - Pool heating and domestic hotwater systems - Pool filtration systems - Rainwater filtration systems - Lighting systems. Coordinate and ensure contractors carry out all tasks and responsibilities in the relevant maintenance specifications.</td>
<td>Carry out tasks as per maintenance spec/plan</td>
</tr>
<tr>
<td>Reactive Maintenance</td>
<td>Undertake monthly or quarterly review of - plant status report - actions proposed by Operator to address any outstanding alerts in the plant status report. Coordinate works &gt;$4,000</td>
<td>Coordinate works &lt;$4,000</td>
<td>Carry out tasks as per maintenance spec/plan</td>
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### KFAC Components
- HVAC
- BMS
- Pool water heating
- Lighting
- Pool filtration
- Rainwater filtration
KFAC Energy Management Framework

Amounts above the max exceedance levels are subject to *cost recovery* by Council.

**HVAC for Gym, Program Rooms, Creche**

- **PI Target**
- **Actual**
- **PI Max Exceedance (+25%)**

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Outcomes and Opportunities

Outcomes

• Water consumption is now down by 35%

• Electricity consumption is down by 7%

• Pool hall excess humidity resolved

• Improved temperature stability and thermal comfort in pool hall

Opportunities for energy efficiency

• lower filtration rates overnight

• lower overnight set point of the pool water

• lower overnight ventilation rates and zone temperatures for pool hall
Closing Thoughts

1. Sub-metering for gas, water, and electricity is invaluable – running an aquatic centre is like running multiple facilities (one incoming utility meter isn’t enough)

**Electricity**
1. Pool filtration
2. HVAC Pool Hall
3. All other HVAC
4. Pool heat-pumps / boiler heating circuits

**Gas**
1. Gas meters pool
2. Gas meters amenities

**Water**
1. Pool makeup
2. Amenities
Closing Thoughts

2. Measure existing performance and use to set annual targets

3. Don’t treat your aquatic centre like an autonomous facility. Define who is responsible for
   - Tuning plant for effective **AND** efficient operation
   - Resolving equipment issues and faults
   - Reviewing energy / water consumption against performance targets
   - Providing you with monthly or quarterly updates of actual performance against targets
Closing Thoughts

4. A NABERS or industry benchmarking tool for aquatic centres?

Thank you!!

Peter Vun
Senior Sustainability Officer – Ku-ring-gai Council
p. 02 9424 0935
e. pvun@kmc.nsw.gov.au