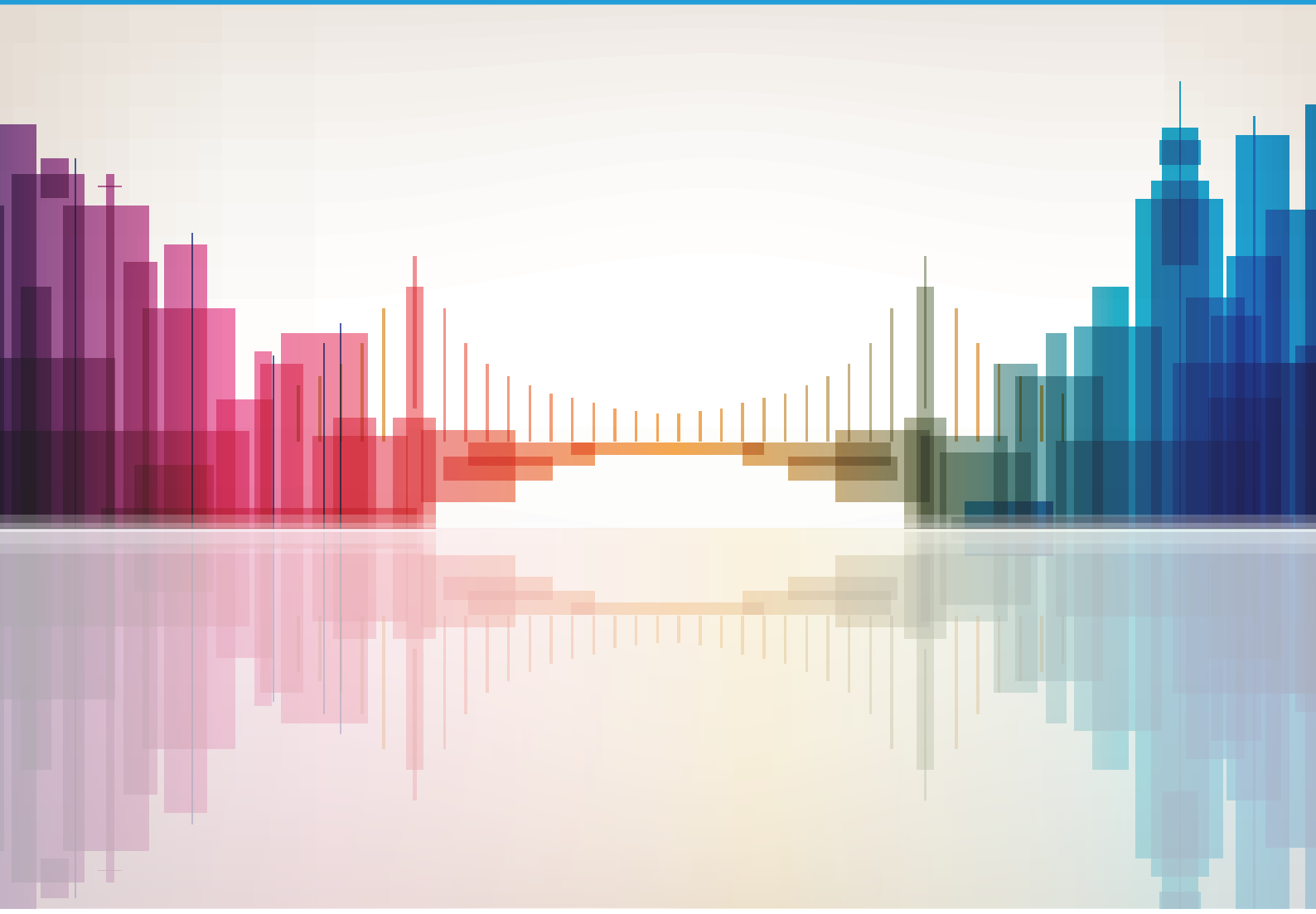
United 4 Smart Sustainable Cities

Data driven energy savings in the Hyperdome shopping centre in Queensland, Australia

Case study of the U4SSC City Science Application Framework



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Case study: Data-driven energy savings in the Hyperdome shopping centre

Queensland, Australia

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Foreword

This publication has been developed within the framework of the United for Smart Sustainable Cities (U4SSC) initiative.

Acknowledgements

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1. Introduction

1.1. Background

Logan City is located in Queensland, Australia, and is home to 320,583 residents with 217 different nationalities among its population. The number of resident increases approximately by 1.5% each year and the city's median age is 34 years old with 22.6% of the population aged under 15 years, and around 50% of residents are under 30. Being such a young city has contributed to its strong desire to limit the impacts of climate change, which is a primary focus for the Logan City Council.

Figure 1: Logan City in Queensland, Australia

Challenge and response

Logan City acknowledges climate change as a growing crisis and encourages residents to do their part in slowing the global warming process. Buildings contribute to 40% of global energy usage and carbon dioxide emissions, providing a massive opportunity to increase overall sustainability in the city.

Logan Hyperdome Shopping Centre in Shailer Park, Queensland, is the largest shopping centre in Logan City and one of the largest single-storey shopping centres in Australia.

Note 1 – Source: Wikipedia

Figure 2: Hyperdome Shopping Centre

Hyperdome as a major shopping centre uses significant amount of energy which would result in the release of substantial amount of carbon dioxide emissions. Optimising the Hyperdome's building operations could significantly reduce energy use and move the needle in the right direction in the fight against climate change.

To optimize energy usage and limit the Hyperdome's emission, a Switch Platform has been installed, which is a digital platform that is connected to the Building Management Systems of the Hyperdome. It provides operational insight to the facility team at the Hyperdome that aims to save electricity consumption and fine tune all the Building Management System equipment to run as designed. At the same time, the conditions within the building remained comfortable for occupants as air conditioning equipment were optimised to save a substantial amount of energy.

It is a practical case study that demonstrates the use of actual building data to reduce and optimise energy consumption, making it highly pertinent for the U4SSC City Science Application Framework deliverable.

2. The smart project(s)

2.1. Vision and content

The vision behind the Switch Platform project is to optimize the Hyperdome Shopping Centre's building operations in order to significantly lower energy usage and cost while maintaining a comfortable environment for tenants and shoppers.

Logan City focuses on sustainable living and combatting climate change and the city places a huge emphasis on reducing energy usage for residents. To realise this vision, the city:

- Offers rebates for energy efficient equipment installed;
- Implemented a lighting upgrade project funded by the Australian Government; and
- Set a plan for achieving carbon neutrality for the Logan City Council's operations by 2022.

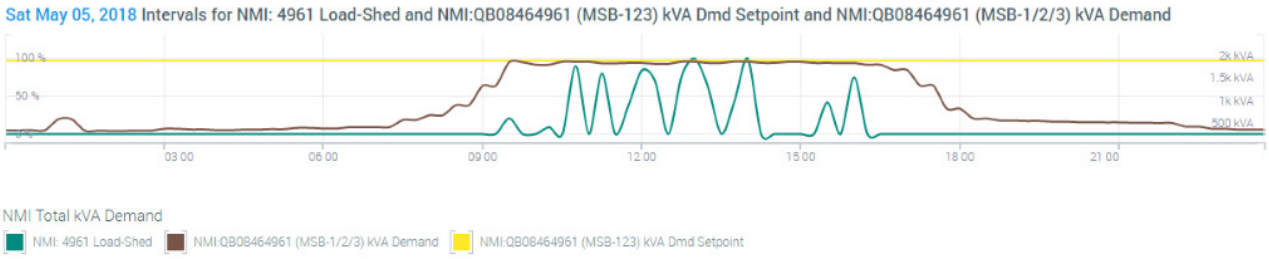
As a marquee institution in Logan City, the Hyperdome attracts thousands of visitors and is highly visible to its residents. The Hyperdome building management company has invested the necessary resources into optimising the shopping centre's energy consumption, leading the charge for other organisations to do the same.

Using the building's network infrastructure including IoT sensors and the existing building management system (BMS), the Switch Platform (the platform which integrates building data, systems and equipment to provide insights into site performance) connects into the BMS via the cloud to add deeper visibility into the energy consumption pattern of the Hyperdome. By using this single digital platform, the building management company is able to fine-tune the BMS operation of the chiller plants and associated Air Handling Units (AHU) in order to maximise efficiencies of all equipment, while maintaining conditions within the building to ensure occupant comfort.

Due to the centre's large single-storey floorplan, the air-conditioning utilised cooling from seven separate chilled water plants spread across the centre. Because of this unique layout, the Hyperdome proved to be a difficult building for managing energy in comparison to a site with a central cooling plant. The multiple chilled-water plants and nine separate power supply transformers for the site (spread across four switch rooms) have also added another layer of challenges to maximize the Hyperdome's energy efficiency.

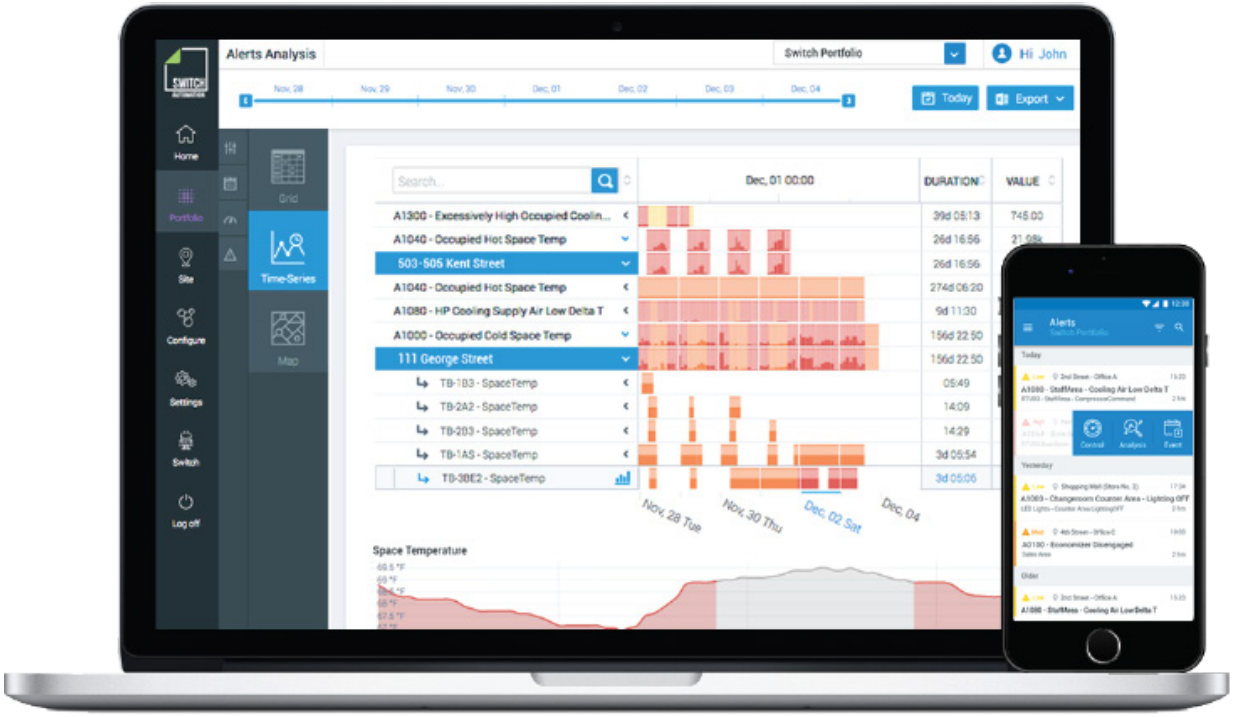
Peak demand utility usage accounted for almost half of the total electricity costs for the site. Therefore, it was necessary to implement a strategy to reduce peak demand. To ensure conditions were maintained at all times within the centre, the demand-limiting strategies utilised variable control to automatically adjust load shed field devices and to ensure no loads are switched off. This allowed the building management company to successfully reduce peak demand without losing conditions and avoid any complaints from the tenants or customers.

Figure 3: Site-Analysis chart showing the kVA demand did not exceed the setpoint. If it was to approach, the BMS load-shed signal (0...100%) would begin to increase, ensuring the peak demand was maintained below setpoint.



Switch Automation, the developer of the Switch Platform, connects to the building management company's existing BMS using the existing network infrastructure and IoT sensors. The Switch Platform then uses an IoT Gateway to post sensor data to the cloud, then aggregates the sensor data to perform advanced building analytics to optimise operations, energy usage and cost. Optimisation techniques utilised in this case included big data analytics and machine learning capabilities coupled with systems integration and user-configurable fault detection.

Figure 4: Performance Optimisation through Analytics



Note 2 – Source: https://www.switchautomation.com

2.2. Implementation

The Hyperdome's building management company worked closely with Switch Automation to connect the existing BMS to the Switch Platform, delivering a comprehensive building optimisation solution. The Switch Platform virtually connected to the company's existing system to reveal deeper insight into the Hyperdome's energy consumption.
Prior to the project implementation the BMS was doing exactly what it was designed to do: control all equipment to setpoint, with the least amount of error possible. However, temperature and pressure setpoints needed to be optimised and the control of all plants needed to be in conjunction with energy use. By implementing the Switch Platform, the BMS has been successfully converted to a BEMS (Building & Energy Management System), in which energy consumption are monitored and optimised without compromising occupants' comfort.

The team at the Hyperdome's building management company and at Switch Automation were key drivers of this project. The collaboration between the building manager at the Hyperdome's management company and a building engineer at Switch Automation played a key role in realising the project's full potential. Together they identified:

- Opportunities for savings;
- Key building systems to connect; and
- Appropriate adjustments to make in order to maximise operations.

Additionally, the following enablers were crucial in its success:

- **Leadership**: The owners understood the opportunity to make Hyperdome more performant through the use of real-time data from the BMS. This data enabled the facilities team to tune the BMS to perform at its optimum without compromising the comfort of the shoppers in the mall. Additionally, once the fault detection rules were deployed, a continuous commissioning program could be realised so the BMS would continue to operate at its peak.
- **Financial:** The team at the Hyperdome's building management company saw the value of investing in a Platform to add deep energy consumption insights to their existing BMS. The return in energy cost savings ultimately offset the initial investment in the Switch Platform.
- **Organisation**: The team at the Hyperdome's building management company and the team at Switch Automation partnered to implement this project.

Some other critical success factors included:

- Standardised fault rules deployed at scale;
- Consistent naming convention that could be deployed across multiple buildings, allowing all site teams to benefit across the portfolio;

- Connecting into the Hyperdome's IoT sensors and the existing building management system;
- The Switch Platform interface with the BMS via the cloud to add deeper visibility into energy consumption.

Replacing the previous way of manually managing buildings, owners can now digitally monitor and adjust building systems from a single Platform.

As conditions change due to external weather events and occupancy levels, the solution keeps the Hyperdome's energy use optimised.

It required significant amounts of data to be collected in order to successfully implement the project. The collected data include, among others:

- Energy consumption for the building for each piece of equipment;
- IoT sensor data collected in 15-minute intervals;
- Occupancy sensor data collected in 15-minute intervals;
- Utility bill data.

The Switch Automation solution used the following mathematical models for optimising energy usage:

- Statistical models of energy consumption;
- Machine learning for pattern recognition using historical data to calculate performance benchmarks;
- Weather normalisation modelling to account for outside conditions.

2.3. Results

During the first year of integrating the Switch Automation Platform, Hyperdome building management company identified energy cost savings of $337,516. This figure represents 12.6% of total energy costs for the Hyperdome Shopping Centre site. More specifically:

- 1,220,884 kWh of energy saved at the Hyperdome site alone;
- $337,516 in annual energy cost savings achieved;
- 7.7% peak demand reduction attained; and
- Occupant comfort maintained despite lowering energy usage.

With this solution in place, the building will continue to save on costs and energy consumption while maintaining occupant comfort. The project requires buy-in and effort from the building management company to maintain and monitor, and to continue to invest the capital needed to continue the success of this project.

Furthermore, the project significantly reduced energy consumption in a large, marquee building in Logan City, advancing the city's vision for implementing sustainable practices and fighting climate change.

The impacts from this project are briefly indicated below.

- Social Impact
  - By implementing this strategic solution at such a high-profile institution, the Hyperdome paved the way for other businesses in the city to follow suit.
  - The Hyperdome occupants' comfort was maintained without adverse impact on them.
- Economic Impact
  - The Hyperdome building company and various outlets in it saved on energy costs, resulting in direct economic impact.
  - Lowered building operational costs are passed on to the consumer, giving them more cash (disposable income) to spend to stimulate the economy.
  - Projects like this provide ample opportunity and demand for private sector companies and start-ups to invest in energy saving solutions by developing and deploying them.
- Environmental Impact
  - The Hyperdome's energy usage lowered by 12.6% as a result of the project implementation. Due to the large footprint of the building in the Logan City, this has a massive impact on the overall sustainability and energy consumption for the city.
  - The reduced energy consumption concomitantly reduced the carbon dioxide emissions for the Logan City, having a positive impact for the environment and the climate change.

3. Conclusions

Buildings provide a huge opportunity for lowering energy consumption in a city and positively impacting the environment. Investing in an advanced platform that aggregates building data and translate it into actionable insights can dramatically reduce energy use and operational costs. Reduced building operating costs results in lower costs for tenants, and ultimately these savings trickle down to consumers. Shoppers have more cash to spend at the Hyperdome stores which helps stimulate the economy of the entire city.

The partnership between the Hyperdome's building management company and Switch Automation was the most critical factor in this program's success. By working closely with the Switch's Engineering Services team to integrate their systems, the building management company of the Hyperdome has gained new insights and data on the patterns of energy consumption of the building. The Switch Platform is then able to analgise and visualise the collected data to optimize the energy usage of the Hyperdome.

Optimising building equipment while maintaining comfortable conditions for occupants continues to be a challenge. While it's crucial to lower overall energy usage, if the building temperature is out of an acceptable range, shoppers are less likely to spend their time and money at the Hyperdome. Maintaining open lines of communication and collaboration between the Hyperdome's building management company and Switch Automation is crucial to the continued success of the project.

There is room for optimisation of buildings in every city. With the proper building network infrastructure and facilities management team in place, enterprises can connect building systems and realise huge savings in energy consumption and cost.

Buildings with existing network infrastructure can connect sensors to a comprehensive building management platform like Switch's to optimise energy consumption and equipment performance. Building owners and operators can optimise entire portfolios from a single Platform to lower costs and drive down energy usage.

A. References

B. List of discussion partners/interviews

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