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POOLING OUR ENERGY SAVINGS

FINAL REPORT

MAY 2015



Australian Government

Department of Industry and Science

This activity received funding from the Australian Government.

***CITY OF DAREBIN'S
AQUATIC CENTRE
ENERGY EFFICIENCY
UPGRADES***



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1. Executive Summary

Purpose of this report is to review the outcomes and learnings of the “Pooling our energy savings” project.

In 2012 Darebin City Council successfully applied for grant funding under Round 1 of the Australian Government’s Community Energy Efficiency Program (CEEP). The project had an overall budget of \$2,189,500 including Australian Government funding of \$875,800 excluding GST.

The key objectives of the Pooling Our Energy Savings project were:

1. to reduce energy use and greenhouse gas emissions through major energy upgrades at Darebin City Council’s two aquatic centres, and
2. to inform, educate and enthuse our community and assist them to reduce energy use and greenhouse gas emissions in their daily lives.

The project included energy upgrades at our two operational aquatic centres, the Northcote Aquatic and Recreation Centre and the Reservoir Leisure Centre.

The range of energy efficiency measures undertaken included, cogeneration, thermal pool blankets, Heating, Ventilation and Air-Conditioning (HVAC) upgrades, draught sealing, thermal envelope improvements and LED lighting.

With successful project management processes, Council was able to successfully deliver these projects to budget, with the outcomes expected to be avoided costs of over \$100,000 a year. Greenhouse gas emissions are expected to be reduced by of over 1,700 tonnes a year, equivalent to taking over 450 average Victorian cars off the road.

Key learnings of the project which have been shared with other councils and industry stakeholders are;

- retrofit projects involve a high level of planning and hands on project management to deal with uncertainties
- stakeholder engagement is crucial to maximise the benefits of the activities
- a good understanding of the project risks and an appropriate risk management strategy are essential to keep projects within scope and budget.
- Cogeneration projects take longer to deliver than expected due to low market capability together with unclear expectations and delays by electrical distribution business.
- Low energy tariffs will result in cogeneration systems having very long payback periods.

Throughout the project, Council communicated with residents to promote the project activities and encourage them to take up energy efficiency initiatives in their homes and workplaces.

With all upgrades successfully delivered, these projects will deliver benefits to council and the wider community for many years to come.

The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information or advice contained herein.

2. Project Objectives

This project was an integral step in Darebin Council achieving our goal of being carbon neutral by 2020. We focused on our two aquatic centres as these types of facilities have high energy use due to the long operational hours and high heat demands for pools and showering.

The objectives of the “Pooling Our Energy Savings” project were to deliver energy and financial savings at our two aquatic centres, the Northcote Aquatic and Recreation Centre (NARC) and the Reservoir Leisure Centre (RLC).

These objectives were aligned with the objectives of the Community Energy Efficiency Program (CEEP), which were to;

- support a range of local councils and community organisations to increase the energy efficiency of different types of non-residential council and community-use buildings, facilities and lighting; particularly where this would benefit low socio-economic and other disadvantaged communities or support energy efficiency in regional and rural councils.
- demonstrate and encourage the adoption of improved energy management practices within councils, organisations and the broader community.

The energy efficiency objectives were;

- reduce the annual energy use of RLC by 538,571MJ per year through the implementation of a 75kW cogeneration onsite power generation system and the energy efficiency upgrades,
- reduce the annual energy use of NARC by 2,240,886MJ per year through the implementation of a 122kW cogeneration onsite power generation system and the energy efficiency upgrades.

The communications objectives were to

- promote the activities of the project to demonstrate Council’s and the Australian Government’s leadership in reducing greenhouse gas emissions and tackling climate change,
- educate our residents about practical action they could take at home and work to reduce their energy use,
- share our learnings of this complex project with other Councils and industry stakeholders to improve their project outcomes.

As a culturally diverse and low socio economic municipality¹, our aquatic centres provide an essential resource for community networking and encouraging healthy lifestyles. The affordability of these centres is a key priority to ensure accessibility to our community. The opportunity to implement a significant energy savings project with assistance from the Australian Government was keenly received by Council and our community.

3. Darebin City Council community profile

Darebin City Council is located five kilometres north of the Melbourne CBD and is home to around 150,000 people living in over 50,000 households. We have a significant proportion of our population who are disadvantaged¹ as determined by the SEIFA Index of Disadvantage. Through community surveys our community has told us that they expect Darebin City Council to demonstrate leadership in sustainability.

Another important community issue which is addressed by this project is the high rating of our community's heat wave vulnerability². With the density and number of houses increasing and an ageing population, we are rated as one of the most vulnerable municipalities in Melbourne to suffering serious health problems or death during heat waves. This program as well as others we have implemented over the years, assists our community to deal with these events as detailed in this report.

¹ <http://profile.id.com.au/darebin/seifa-disadvantage>

² <http://www.mappingvulnerabilityindex.com/home/melbournevi>

4. Project Energy Efficiency Activities

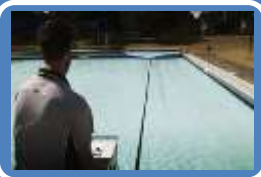
Figure 1 below provides an overview of the energy efficiency activities we completed.

Figure 1 Overall energy efficiency measures



Cogeneration

- installed natural gas powered generators at each site which generate most of the sites' electricity and also use the waste engine heat to heat the pools.



Thermal pool blankets

- deployed overnight to reduce the evaporation and heat loss from the pools.



Heating, Ventilation and Air-Conditioning (HVAC) upgrades

- high efficiency heat recovery system for the change rooms at NARC, as well as improved use of fresh air and remote monitoring.



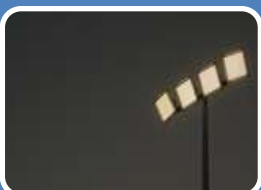
Draught sealing

- as with many older buildings, there are significant gaps around doors, windows and building envelope in general. We sealed as much of this as possible.



Thermal envelope improvements

- improving the insulation value of walls and doors to pool hall to reduce heat loss (RLC).



LED lighting

- significant energy and maintenance savings due to LEDs longer life compared to traditional lamp technologies.

4.1 Cogeneration

At which sites did we implement this activity?

 Northcote Aquatic and Recreation Centre

 Reservoir Leisure Centre

Activity description

Cogeneration is a system which generates two outputs which are usable. In this instance our cogeneration



Figure 2 Schematic of cogeneration operation

systems involved using natural gas as the fuel source, with the two outputs being electricity from generator and heat from the engine. Every engine produces heat, usually this heat is considered a 'waste' or 'by-product' of the electricity generation. In applications such as aquatic centres and other operations with high thermal heat demand, this heat can be captured and used in the facility. With correct system integration, this 'free' heat will reduce the energy required from the existing heating system, thus reducing energy use, bills and greenhouse gas emissions of the heating load.

The technology we used and reasoning

We were keen to implement an onsite low carbon energy generation system. We assessed installing a large solar power system on the facility roofs and compared this to a cogeneration system. A key reason for this comparison was that we were aware of the poor reputation of cogeneration performance throughout Australia, so the risk of this technology appeared quite high. As a result of our analysis, we identified that the potential greenhouse gas savings achievable from cogeneration was significantly higher than that from a large solar power system. The payback for cogeneration though somewhat longer than solar, was still considered acceptable given the significant greenhouse gas savings possible. Based on weighing up the risks and the potential benefits, we decided to proceed with cogeneration on the basis that our project structure was suitable to control the risk exposure.



Photo 1 RLC cogeneration system

Island mode?

Once we had assessed the preference to implement cogeneration, we also assessed the possibility of using the cogeneration system as a backup in 'island mode' to run the whole site. This modelling indicated that to achieve this, a much larger capacity electrical generator would be needed to cater for the peak electrical demand. However a system of this size would not run efficiently most of the time as it would be oversized and rarely run at full load. Our advice was that a cogeneration unit should run at full load every day. Under-loading the engine leads to inefficient operation and increased wear and tear. Thus we decided to proceed with a grid connected system, with the

cogeneration providing base load electricity and the grid power supplementing higher demand.

Based on the electrical and thermal interval data assessment, the following engine sizes (electrical) were selected for each site;

- 122 kW(e) at NARC
- 75 kW(e) at RLC.

As NARC is a larger centre with more electrical demand, the cogeneration is a higher capacity. Both units are designed to operate 24/7.

There are two main cogeneration technologies available being 'turbine' and 'reciprocating'. At both of our aquatic centres we installed reciprocating engines.

What is the difference between the two engine technologies?

A reciprocating engine is the same as a traditional car/truck engine. In fact many cogeneration units are based on truck engines. These are called reciprocating as they use pistons which move up and down within a cylinder.

There are many moving parts in a reciprocating engine which means that the quality, proven track record and maintenance of the machine and service provider are critical.

A turbine is mechanically a much simpler design which uses one spinning rotor (turbine) to generate the electricity. Globally, turbine systems are less common than reciprocating engines which have been used in Europe and North America for many decades.

Prior to a decision to proceed with cogeneration we undertook extensive research with consultants, industry suppliers and other organisations with cogeneration experience to build a knowledge base which would facilitate our ability to make an informed decision. Although it became clear early on that the turbine technology was far less common than reciprocating system, we felt it was important to ensure we consider all options.

In order to ensure we were able to consider all options the market could offer, we issued a performance based tender. Within the tender we provided an indicative design and operation schematic however the key information provided was the performance requirements of the system. Our key parameters were that the system would be assessed on the business case and carbon reductions which could be achieved.

Providers were required to provide detailed performance analysis based on the 12-month site gas and electrical interval data which was issued with the tender.

The full assessment criteria used to assess the tenders were;

- Tender price
- Business case assessment, modelling and performance
- Proven relevant project management experience
- Ongoing maintenance costs
- Methodology of implementation
- Local business content
- OHS systems

All tender submissions were assessed by an expert consultant who then reported the findings and recommendations. In a number of instances, the proposed performance as submitted in a tender submission was assessed as being overly optimistic and more realistic outcomes were reported by the consultant.



Photo 2 NARC cogeneration system

As a result of this process, reciprocating engines were selected for both sites as being the best value proposition.

Site	Brand	Model	Electrical capacity kW(e)	Thermal kW(th)
NARC	Schmitt Enertec	FMB-155-GSK	122	196
RLC	Schmitt Enertec	FMB-85-GSK	70	103

Method of implementation

In line with our recognition of the level of risk involved with cogeneration systems we structured the procurement process as 'turn-key' contract. This means that it is the contractor's responsibility to ensure the system is installed and performs as stated in the tender submission. Although there have been a number of instances where organisations have constructed a system themselves, this would only be feasible where the organisation has a high level in-house specialist electrical and mechanical engineering skills. There are many components which are required to work together such as heat exchangers, heat dumping, remote monitoring and control and most importantly, the interface with the electricity grid.

The project was managed by an experienced project manager from our Major Projects unit and was supported by Council's Climate Change Action Officer to provide technical input in relation to the energy efficiency.

One head contractor was appointed for each project who then appointed and coordinated the sub contractor specialists as required.

We also engaged a mechanical and electrical engineering consultant to provide both Council and the contractor with advice and to ensure quality and compliance of the project installation.

Site or technology-specific problems and responses

Northcote Aquatic and Recreation Centre

As with any building retrofit project, there were unknowns which were only identified once works were underway. Our experienced project team had allowed for these issues in both budget and time.

Our main problems were related to the connection approval from the natural gas and electrical distribution authorities.

At time of commissioning, the gas authority would not approve the connection and operation of the cogeneration system as a gas system pressure test had identified a small leak somewhere within the gas system on site.

Finding a small gas leak in an older aquatic centre is akin to finding a needle in a haystack. None the less, with thorough investigations by our plumbers, we were able to isolate the leaks to some faulty valves which were subsequently replaced. Gas authority connection was approved after this.

The electrical distribution authority proved to be very difficult to work with. Although we had engaged with them well before our cogeneration system installation, we still found it difficult to get a clear understanding of what was going to be required from us to receive approval to connect to the grid and operate the engine. Initially we were advised that there were no known network issues and that an engine of this size should not pose any issue for the grid stability. We were very surprised then to find that we were required to undertake detailed electrical analysis with a distribution network specialist consultancy. Significant additional hardware such as a fault limiting reactor was required in order to provide required grid protection and approval. This process resulted in many months of delay as well as tens of thousands of dollars in additional costs. As we had allowed a realistic budget for variations, we were able to fund these additional works and secure approval to operate the cogeneration unit from the electrical distributor.

Reservoir Leisure Centre

The Reservoir Leisure Centre did not have any technical issues or problems with the utility authorities. The main problem with this project was the project management by the head contractor. This lead to time delays in project completion. Our response to this was to ensure that we proactively supported the contractor to 'push' the project along. Without our competent and enthusiastic project team within Council, the project would certainly have been delayed even further.

Learnings from this activity

As cogeneration is a relatively niche technology in Australia, there are only a handful of providers and probably even less experienced consultants. A key to success is to ensure that prior to embarking on such a project the organisation has a highly competent in-house project team particularly in;

- Construction management
- Energy efficiency.

From our research, we determined that the common theme in the many systems around Australia with 'poor' performance was that they did not have rigorous up front feasibility studies, with a lack of detailed review by in-house experts and often flawed consultant design and business case analysis.

With a competent and fully informed project team, it should then follow that the project should have

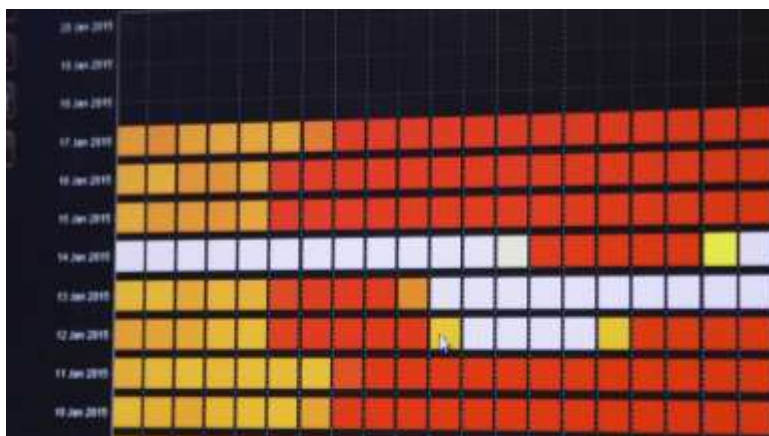


Photo 3 Screenshot cogen monitoring

a suitable level of both time and financial flexibility to suit the project type.

Without the implementation of our monitoring system, energy savings would have been reduced. The system allows us to view the performance of the system in real-time as well as analyse historical data. With this information we were easily able to identify opportunities to improve the performance. For example, Photo 3 provides a simple visual of the thermal energy which has been captured from the cogeneration system and transferred in the pool heating water system. At a glance we can see here that the white areas show when there has been low or no thermal transfer. Although this may occur on warmer days when the pools do not require any heating, generally overnight, pools will require heating. With this information, we can then easily overlay the temperature data to quickly identify if high ambient temperatures could explain the lack of thermal transfer. In some instances it may be that the cogen had shut down, which would require action from the site operator or the maintenance contractor to investigate. Without this monitoring and graphical interface, the cogen unit could remain offline a lot longer until it's next scheduled staff inspection. Through this system we were also able to identify that a valve to one of the pools was not operating in a way which was compatible with the cogeneration system. We then were able to optimise the valve operation to increase the amount of thermal energy we could capture from the cogen, thus increasing energy and greenhouse gas savings.

An easily usable real time monitoring interface is an essential component to optimizing a cogeneration system.



Photo 4 Manager checking system operation is optimal

4.2 Thermal pool blankets

At which sites did we implement this activity?



Northcote Aquatic and Recreation Centre

Activity description

This activity involved the installation of insulated pool blankets to the heated indoor and outdoor 25 metre pools to be applied overnight. Aquatic centres typically heat pools to around 28 – 30 Celsius. Having these pools uncovered all night leads to significant heat loss through thermal loss to the air and also energy required to heat make up water due to evaporation.

The technology we used and reasoning

Through a competitive quotation process, Sunbather was selected as providing the best value for money. The blankets selected were a 3mm foam material and had a proven track record of installations around Australia. We contacted a number of aquatic centres which already had similar blankets installed to ensure the ease of use and quality was acceptable.

A key process we undertook in our assessment was to engage the centre management to ensure that the chosen technology was practical and would be used by the staff each night. With this consultation a number of key design elements were which were preferred by the centre;

- Blankets should be fixed in place not on mobile frames. Having to manually wheel blanket rollers in to place and remove each morning would result in significant extra labour costs and also risk the occupational health and safety of staff.



Photo 5 Blanket deployment



Photo 6 Outdoor pool bench

- An electrical winder system would make the blankets much easier to deploy and retrieve as well as provide safer work duties for pool staff.
- Blankets should be designed to be incorporated in to new bench seats so that existing seating would not be lost.

Method of implementation

The blankets were implemented by way of a competitive quotation process and the project was awarded to a specialist contractor, Sunbather, to design and install the equipment.

The project was managed by an experienced project manager from our Major Project unit and was supported by Council's Climate Change Action Officer to provide technical input in relation to the energy efficiency.

Site or technology-specific problems and responses

A key challenge for this project was to schedule the works to ensure minimal disruption to the centre and its users. With long operating hours one solution was to undertake the works overnight. After discussion with the supplier and the centre, it was agreed that the issues involved with night works were more problematic than trying to install during opening hours. Issues included access and supervision as well as safety of contractors working unusual hours with heavy materials and construction equipment. As part of the tender evaluation process, we assessed the supplier's project management experience in active facilities. With clear communication between the supplier, project manager and the centre manager, a plan was agreed to undertake the installation during the day. With specific isolation zones established and approved work times to avoid peak user traffic, the work was completed without incident.

Another problem was encountered after the project was complete. This was due to user error. The electric 'slave' winder was damaged by a staff member using it inappropriately as they had not been trained. The issue was resolved by confirming with the centre management the importance of user training in addition to extra signage on equipment which was provided by the supplier to highlight correct usage techniques.



Photo 7 Staff member with electric winder

Learnings from this activity

Key learning from this activity was the importance of including the site manager as a key member of the project team. Without engagement and support from the site management and staff there may be resistance to embracing the extra work due to a lack of understanding of the benefits or valid operational concerns due to poor system design.

Installing integrated benches are a great option where possible as this reduces operational risk of injury to staff and also provides generous sitting area for parents and carers.

4.3 Building envelope improvements

At which sites did we implement this activity?



Activity description

Building envelope improvements include;

- Thermal insulation
- Draught sealing

In Melbourne's climate, aquatic centres use heating all year round. With pool water and pool hall air temperatures usually around 28 – 30 Celsius, the ambient temperature outside is lower than the 'set point' most of the year, which means mechanical heating is required.

As both NARC and RLC are over 20 years old, the old envelope specifications allowed for significant improvement by using modern materials and techniques.

The range of works undertaken included;

- Draught sealing around building junctions such as windows and walls
- Improving performance of doorways to reduce air leakage and thermal losses



Photo 8 RLC air leakage testing

The technology we used and reasoning

Draught sealing gaps is one of the simplest actions that can be taken to reduce energy use of a building. To seal the gaps around various windows we used foam strip and poly urethane gap filler. This was a very simple job process which could easily be undertaken by our Council building contractor. One of the surprising opportunities for significant energy savings was the leakage from the box gutters running all the way around the pool hall at RLC. In order to determine the opportunity for improvement, a specialist building air leakage contractor was engaged to test the building. The results were astounding. The testing indicated that the permeability rate was over 62 cubic metres per hour per square metre ($\text{m}^3/\text{hr}/\text{m}^2$) of envelope area, versus the target based on best practice benchmarks of under 10 ($\text{m}^3/\text{hr}/\text{m}^2$). With this result we were sure that significant savings could be achieved through reducing this air leakage.



Photo 9 Sealing box gutter RLC

Investigations by Council's building contractor identified that the box gutter running the whole way around the pool hall was poorly sealed to building, with an average gap of around 5mm the whole way around. This added up to 1 square metre of gap, the same as having a 1 square metre window open all the time or 50 bricks missing from a wall! We engaged our building contractor to seal the gap the whole way around the building with polyurethane filler. In some parts the gutter did need to be pulled in to place using screws because the gap was too large for the sealer to be practical.

Our consulting mechanical engineer identified that due to the envelope design with corrugated sheets and flashing, significant air leakage was likely occurring under the metal flashing. The current upper metal wall around the pool hall was also identified as not being insulated which would be leading to significant energy loss.



Photo 10 RLC facade

A number of possible solutions were considered including sealing the gaps with some kind of filler. After meeting with Council's building contractor, mechanical engineer and consulting architect, it was deemed that it would be very difficult to access the areas. This would result in high risk to installers and would challenge the quality of the work. We identified that a product was available; Kingspan architectural wall panel (AWP). This could be retrofitted and included a high energy efficiency design with built in weather seals between the panels.



The issue of the poor insulation was also addressed by

Photo 11 Air leakage evidence by corrosion

the Kingspan AWP's which could provide a high insulation R rating of 4.3 versus the existing wall which was estimated to be well under R 0.5. This represented an improvement of insulation by a factor of over 8.

With detailed consultation between our builders, technical experts, product supplier and the site manager, it was agreed to proceed with the Kingspan product to replace the existing metal façade material.

Method of implementation

With consultation with our architect, Council's builder and the Kingspan technical representative, detailed construction drawings were created to clearly specify the work required. Council's building contractor was engaged to undertake the works as a 'turn-key' contract. With engagement from centre management, we were able to undertake the works without any closure of the centre through careful works scheduling and a focus on safety procedures.

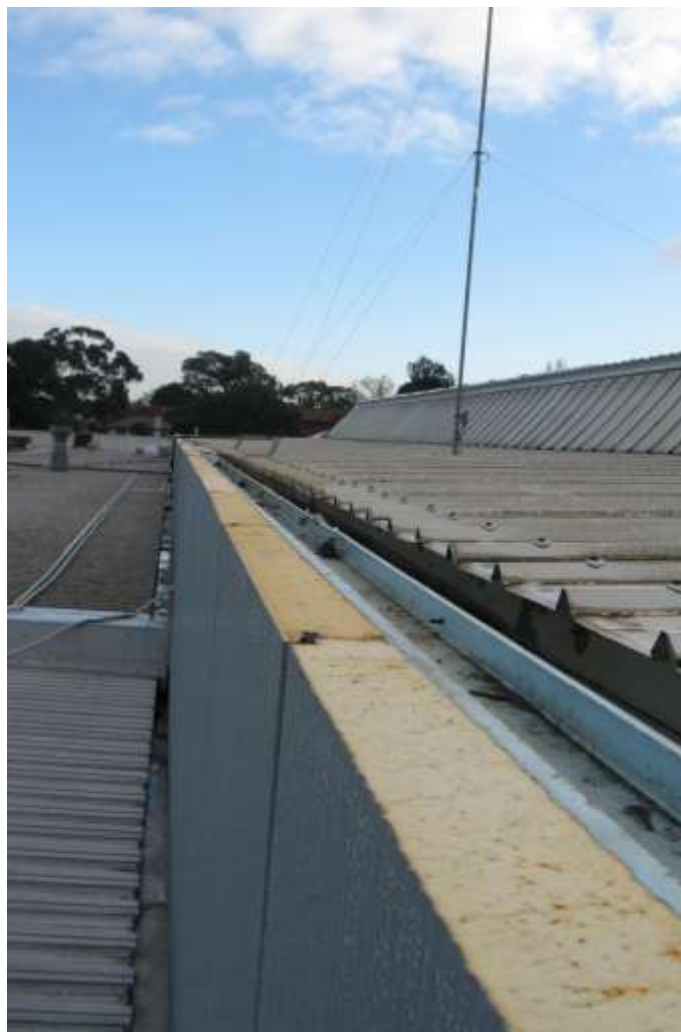


Photo 12 Insulated wall panel

Site or technology-specific problems and responses

As with any retrofit project, there is a high risk that assumptions made about concealed structural design could prove to be incorrect and render a major project issue. As the retrofit product was not designed to be directly retrofitted to the existing area we undertook very detailed site inspections. Our builder removed key sections of

existing panelling and provided detailed photos and measurements of the underlying structure. An architect was engaged to provide technical drawings of how the installation should be undertaken based on advice from our builder and the supplier's technical representative. This in depth early design work and ground truthing resulted in the project being able to be delivered without any technical issues of compatibility.



Photo 13 Sealing tape strips under panels

Although we did not have any technical issues with the installation, we did experience major installation issues. As part of our quality control procedure, the specification clearly detailed the photographic evidence which was required to demonstrate compliance with the specifications; the contractor did not provide this evidence during construction. In particular, this was required to verify that concealed works such as the sealing tape and the fixings were installed as per the

specifications. Our response to this was to have the works inspected by an independent building contractor to ensure compliance with the specifications. This confirmed that the panels had not been installed with the sealing tape. As a result we instructed the contractor to completely re-install the panels and highlighted the importance of the photographic evidence. The panels were completely removed and re-installed with detailed photographic evidence provided to verify the works were compliant with the specifications.

Learnings from this activity

A key learning from this activity is that the most effective energy savings may not be easily identifiable through visual inspection. In this case the doors around the pool were easily identifiable as being leakage points, however with the advice of expert consultants and technicians we were able to identify previously unknown opportunities. Certainly we would recommend air leakage testing to enable an understanding of the level of leakage through unknown areas which could justify further investigations.

In our experience, building contractors have a relatively low level technical understanding in relation to energy efficiency. Although the specifications may detail the works to be undertaken, contractors may not understand the importance of details, such as the draught sealing tape under the insulated wall panels, and may omit them on the belief that “the panels won’t fall off so it’s not really needed”. Very detailed induction and context understanding is an important first step to ensure contractors understand not just the works required, but also why they are undertaking the works. Quality control assessment criteria and methods should be carefully detailed at the start of the project to ensure that the works have been completed to specification. This is especially important in projects such as this where critical work elements are hidden once the project is complete.

Through our rigorous quality control procedures the works were completed to specification.

Improving performance of doorways to reduce air leakage and thermal losses

The technology we used and reasoning

A number of different approaches were taken to seal doorways. As indicated in Photo 14, simple PVC strips were installed on the NARC change room doors to reduce cold air flowing through from the nearby front doors. Other doors with more standard undercuts were fitted with high quality commercial door seals.



Photo 14 Change room wind barriers strips

One of the most significant opportunities to save energy was



Photo 15 RLC existing pool hall door

presented by the old aluminum single glazed doors at the RLC. The five doors around the pool hall had large gaps between the panels of the door, as well as around the perimeter. This resulted in significant heat loss from the pool hall as identified by our consulting mechanical engineer. As well as the air leakage losses, the doors also had extremely poor thermal performance, being aluminum with single glazed clear acrylic paneling.

We assessed the options to retrofit these doors with better seals and sealing the gaps between the panels. After a number of meetings with builders and investigations of products available, we formed the opinion that there would not be a solution which we could be sure would deliver the quality of sealing we were trying to achieve.



Photo 16 New energy efficient doors RLC

Even if we could identify a way to seal the doors, the doors would still have very poor thermal performance due to the aluminum framing and single glazing. Another consideration was advice by centre management that the doors were already very old and starting to fail, so any upgrade would probably have limited life with the doors being at 'end of life'. With all these considerations in mind we agreed the best way forward would be to install new doors with high energy ratings and long life to realize the energy savings.

As a result of a competitive quotation process, Envisage Building Systems (EBS) was selected to supply and install high quality energy rated doors. These featured double glazing, aluminum panels with thermal breaks and dual weather seals around the perimeter. The new doors are extremely air-tight, and have an insulation R value of at least 0.3 which is at least double the original doors. To maximize the energy efficiency, we also specified the doors with the top and bottom panels to be solid section with foam insulation. Only the three middle sections clear. This decision was made in consultation with centre management who approved the new design with slightly less clear area.

At NARC a major source of air leakage was the two automated front doors. These doors did not have any 'air-lock' system. Such a system could not be implemented due to the lack of separation space required to enable effective use of dual door air locks. The centre staff had advised us that the air infiltration through these doors was significant as evidenced by the chilling air blowing in and the amount of leaves and debris which could be seen inside these doors. As a relatively simple response, we designed a wind barrier screen to be located outside the existing entry and exit doors. This measure does not provide an air tight seal by any means, but does disrupt the direct airflow, particularly from the south-west cold winds.



Photo 17 NARC front door wind barrier

Method of implementation

The smaller doors which required draught seals were sealed by our contract builder. With a desire to up skill our contractors, we asked them to investigate which seals would be the best, then refer the selection to Council's Climate Change Action Officer for review. The contractor then installed the seals.

The pool hall doors at RLC were implemented through a competitive quotation process. Quotes with specifications were issued to a number of short listed suppliers and were then assessed for price, quality and experience. A single contractor was awarded the works to undertake the installation. Some after hours works were required with the majority of works being able to undertaken while the centre was in operation.

The NARC front door wind barriers were designed by our architect in consultation with the centre management, builder and structural engineer. The barriers were installed by Council's building contractor.

Our quality control process involved Council's Climate Change Action Officer undertaking inspections to ensure energy efficiency attributes were optimised. This process identified minor adjustments which were required of doors and seals to ensure a tight fit.

Site or technology-specific problems and responses

In regards to the NARC change room doors, initially we planned to install longer doors to reduce the undercut and fit commercial door seals. When we installed the first door we discovered that the floor was not level and the door would open without a certain amount of undercut. As a solution, we designed a PVC flap system which could be flexible with the floor level but also provide a reasonable barrier to unwanted air leakage and draughts. It was a simple, low cost and effective solution.

There were no technical issues with installation of the RLC pool hall doors with the contractor having extensive experience in installation of this product. A challenge was presented with the modifications required to the existing door tracks which extended over the pool water surface area. These rails required cutting with power tools and welding which could obviously not be undertaken with users in the area. As there was a high level of uncertainty as to how the doors would be installed by the successful contractor, our tender specification clearly stated that the works would have to be scheduled to ensure no shut down of the pools was needed. If works could not be safely scheduled during opening hours, then contractors were required to undertake the works after hours. The contractors were required to undertake a site inspection so we could be sure they had a full understanding of the work required and the access situation. As a result of these measures, the contractors completed the over-pool works after hours, and then completed the rest of the installation during opening hours.

Learnings from this activity

Although sealing doors can appear simple initially, careful planning should be undertaken to ensure that the proposed methods will work in a retrofit scenario. Another important consideration is the impact on the centre to have the works completed. With an aquatic centre, if a shutdown is required this could add significant cost to the project in terms of lost patronage and refunds which may be required to members if they cannot access the services.

The technologies we used may not be well understood by trades and suppliers so relying on contractors to provide suitable solutions may not be successful. We were able to identify the optimal products to use through the expertise of Council's Climate Change Action Officer who has expert knowledge in energy retrofits to commercial buildings. It is very important to have a solid quality control process in place to ensure that works of this nature are completed to specification and in a way which will provide the outcome of saving energy.

4.4 LED lighting

At which sites did we implement this activity?



Northcote Aquatic and Recreation Centre



Reservoir Leisure Centre

Activity description

This activity focused on a major upgrade of indoor and outdoor lighting at both of our aquatic centres. The majority of the existing lights were 400 watt metal halide for flood-type lights and twin 36 watt fluorescent for the dry areas and plant rooms. The upgrades included LED and higher efficiency T5 Fluorescent lighting. Table 1 and Table 2 below provide a summary of the upgrades undertaken at each site.

Table 1 RLC lighting upgrade summary (including ballast loss)

Linear T8 LED	Existing			LED upgrade		
	Quantity	kw/lamp	Total kw	Quantity	kw/lamp	Total kw
Cycle Room	24	0.044	1.056	24	0.02	0.48
Disabled Change	30	0.044	1.32	30	0.02	0.6
Activity Room	56	0.044	2.464	56	0.02	1.12
Studio 2 Boxing room	28	0.044	1.232	28	0.02	0.56
Main pool store	8	0.044	0.352	8	0.02	0.16
Main pool High bay	10	0.3	3	10	0.154	1.54
Car Park T5	4	0.052	0.208	4	0.12	0.48
Car Park Floods	10	0.175	1.75	10	0.1	1
	170	0.747	11.382	170	0.474	5.94

Table 2 NARC lighting upgrade summary

Area	Existing				LED / T5 Upgrade			
	Light Type	kW	Qty	Total kW	New Light Type	kW	Qty	Total kW
Outdoor Pool	Flood Light	0.45	24	10.8	150W LED flood lights	0.172	26	4.5
Indoor Pool	Suspended Low Bays	0.45	14	6.3	150W LED Low bays IP65	0.155	15	2.3
Indoor Pool	Surface mount square	0.3	5	1.5	2x26W T5 Eco fixtures	0.057	17	1.0
LED tubes to replaces 36W fluoro	2 x 36W Surface mount	0.045	34	1.5	19W LED tubes	0.02	34	0.7
Total				40.26				9.1

The technology we used and reasoning

All the high bays and flood lights were replaced with LED technology as this technology is expected to deliver significant energy and maintenance savings. With long operating hours of aquatic



Photo 18 NARC LED outdoor pool LED



Photo 19 NARC indoor pool LED

centres, the energy savings would be higher than for a site with less operating hours. Maintenance of lighting in aquatic centres can be a complex and expensive process with the long operating hours and lights usually situated in areas requiring patron access and also over the pool at height. The cost to replace just one light globe could easily be \$500+ with the cost of high access equipment and more than one contractor required due

to access challenges. The existing metal halide lights were expected to have a life of around 12,000 hours, whereas the LED lights are expected to function at the required light level for at least 30,000 to 50,000 hours.



Photo 20 RLC 140 watt LED high bay

Method of implementation

In contrast to most of the other major upgrades we undertook we did not implement the works as a turnkey contract to one supplier. As Council was already experienced in energy efficient lighting upgrades, we had a good

understanding of the capabilities of the market and our ability to play a direct role in the works. As this project was assessed as being medium to high risk due to critical nature lighting in an aquatic centre, it was important that we had confidence in the design and implementation of the upgrade.

The quantifiable object of the lighting upgrade, apart from the energy use which was easily calculated, was to provide lighting levels to the relevant areas which was compliant with the tender designs and particularly the Australian Standards.

As described in Figure 3 below, while the supply and design was tendered to the market to lighting suppliers, Council managed the baseline designs, tender specifications and the installation process.

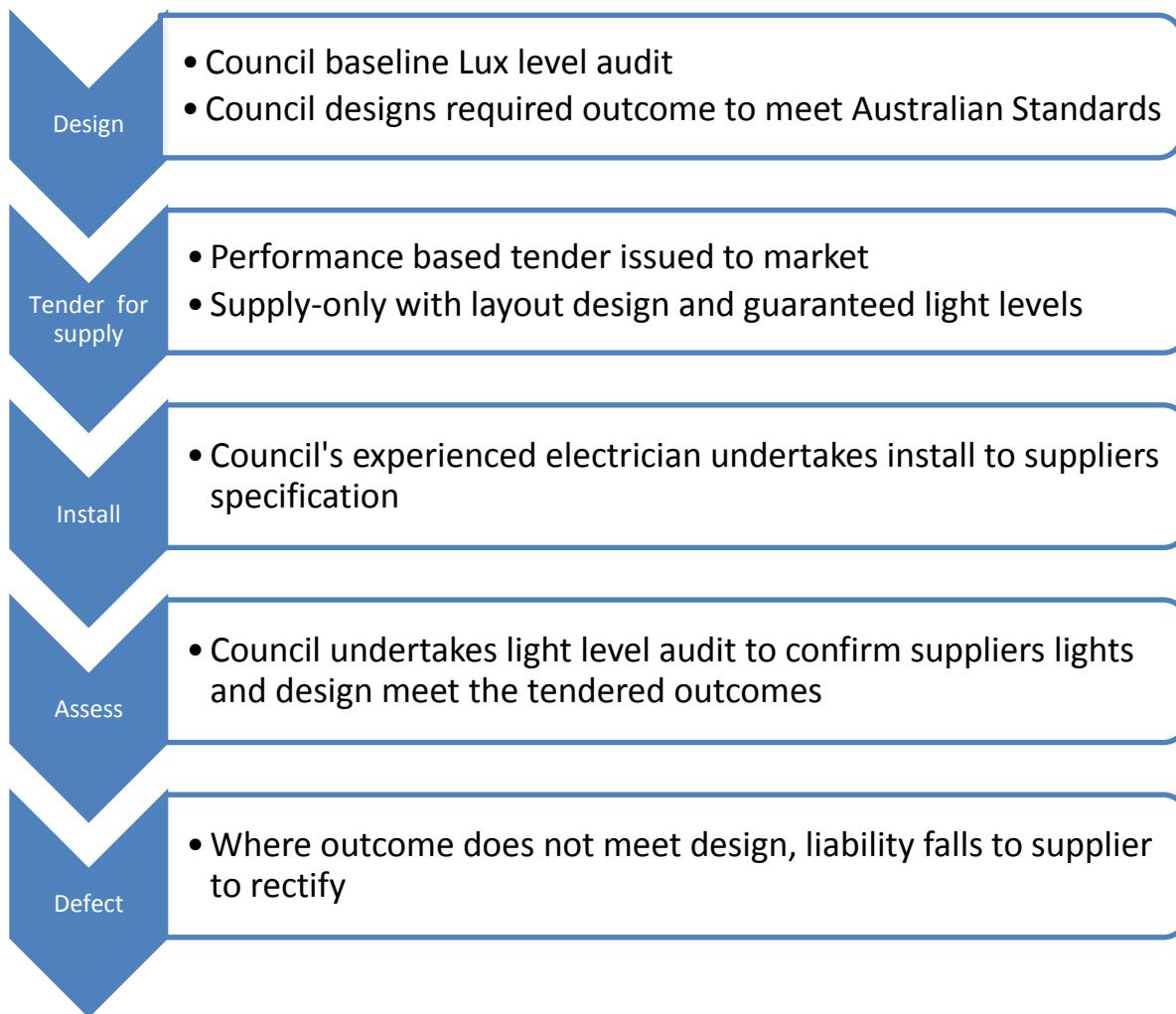
The key driver to this was the level of comfort we had in an untested contractor undertaking the installation works in an operating aquatic centre. A high level of coordination and attention to risk control was required as well as careful scheduling to minimise site disruption.

We were fortunate that we had a very competent electrician who was familiar with the sites and the key personnel at the sites. As this project required a high level of coordination with site managers we decided that the best option for installation was to use our own electrician.

As part of the tender process, suppliers were required to provide a quote for specific luminaires and also provide a lighting design which confirmed and guaranteed the outcome was compliant with the specifications and the Australian Standards.

After the installation process, Council's Climate Change Action Officer undertook light measurements to confirm the light level achieved the requirements or to initiate rectification works if a problem was identified.

Figure 3 Lighting installation process



Site or technology-specific problems and responses

At both sites, installation was the main identified issue, with long operating hours and lighting being in high use areas. Our response to this challenge was to ensure that we worked closely with centre management to ensure a workable solution which balanced site operation, cost and safety. For both sites this involved installation works both during the day and overnight.

A particular challenge for aquatic centres is to address the method of safely changing lights when they are located above the pool, with associated risks of working near water and access for lifting equipment. With a project team including the contractors and site managers, we were able to fully understand the issues and risks involved and then



Photo 21 Challenging installation over pools

agree on an approach which was acceptable to all parties. This involved a combination of scaffold in the pools and poolside lifters.

Learnings from this activity

At the NARC indoor pool, the main challenge we faced here was that despite all of our efforts in confirming the lighting design with the supplier, when we installed the lighting, we found that the light levels were significantly lower than the Australian Standards and the level submitted in the suppliers tender. Our risk control strategy was crucial at this point to;

- a) Quickly address the lighting issue so the pool could be used that same evening
- b) Deliver a solution which was compliant with the Australian Standards and the tenderers lighting design.

The issue of quickly responding to the low lighting to ensure the pool could be operated that night was addressed by having a trusted electrical contractor undertake the installation, who we knew would be able to think quickly and critically to resolve unplanned issues. In this case the contractor immediately contacted the project manager and was able to source additional lighting from local wholesalers and from stock held at their nearby warehouse. As a result of this quick thinking, we were able to operate the pool and its associated programs that evening while the bigger issue of rectification was considered.

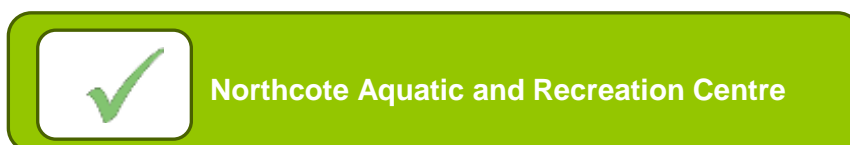
The rectification of this lighting was a major issue and was a result of the supplier incorrectly calculating the Lux levels that would be delivered. Once again, due to our early assessment that this was a high risk project and costs to undertake rectification would be significant we structured our contract to pass responsibility to the contractor if the design did not meet the tendered outcomes. In addition to this, we assessed the suppliers' financial capacity to address such a situation in the tender evaluation. In this case the supplier bore all the costs to redesign the lighting system and undertake the installation works.

Our risk management strategy was key to a successful outcome of this project.

As noted in Table 1 and Table 4 the energy savings achieved were significantly different at each site. This was due to each site having a different baseline of lighting level. At RLC, the current lighting of all areas was not significantly above the Australian Standards, so the new lighting upgrade had to ensure light levels did not drop. In contrast, at NARC, the light levels of both the indoor and outdoor pool were significantly above the Australian Standards for the pools. With consultation with centre management, it was agreed that it would be acceptable to reduce the light levels from the existing levels given the significant energy and carbon emissions savings. A crucial learning from this is that early consultation and engagement of site users is essential to ensure the planned outcome is expected by all parties.

4.5 Heating, Ventilation and Air-conditioning (HVAC)

At which sites did we implement this activity?



Heating, Ventilation and Air-conditioning (HVAC) was undertaken only at the NARC. The object of these upgrades was to improve the energy efficiency of the systems to save money and reduce greenhouse gas emissions. HVAC upgrades included

- NARC change rooms heating system
- Gymnasium air conditioning system
- Building Management System with remote monitoring

The technology we used and reasoning

NARC change rooms heating system

The change rooms at NARC were heated by an old gas fired boiler which then reticulated hot water to an air handling unit. One hundred per cent fresh air was drawn in at all times with 100% exhaust of the supply air. The impact of this is that in Melbourne, the gas boiler would be required to operate most of the year due to the low ambient temperatures. The system operated every day of the year, 24 hours a day. In addition to the energy use, the conditions in the change room were always very cool despite the heating system being in operation. The gas unit was decommissioned and replaced with a higher efficiency electric heat pump system. We identified that due to the positioning of the supply and exhaust air vents, which were very high, the warm heated air was travelling directly from the supply air outlet to the exhaust air inlet. This resulted in minimal heating effect of the patrons at floor level. The technology we used to improve the performance and comfort of the this system was,

- Heat recovery ventilation system. This system captures up to 75% of the heat from the exhaust air and uses it to pre heat the incoming fresh air. This provides a system which still delivers 100% fresh air, which is important in change rooms for mould and odour control, but uses a fraction of the energy. This system is an electric heat pump system with variable speed drives on the fans.



Photo 22 NARC Heat recovery system



Photo 23 NARC new supply air droppers

- To improve the delivery on warm air to the ground level, outlet ducts were modified to direct the air down to the ground level, with swirl diffusers being used to optimise the mixing of warm air.
- Our consulting mechanical engineer confirmed that the ventilation should not need to run 24/7. To establish control of this, we installed a building management system with remote access back to Council's head office. The Climate Change Action officer can monitor the system for performance and easily fine tune the operating schedule to maximise energy savings while ensuring user amenity is maintained.

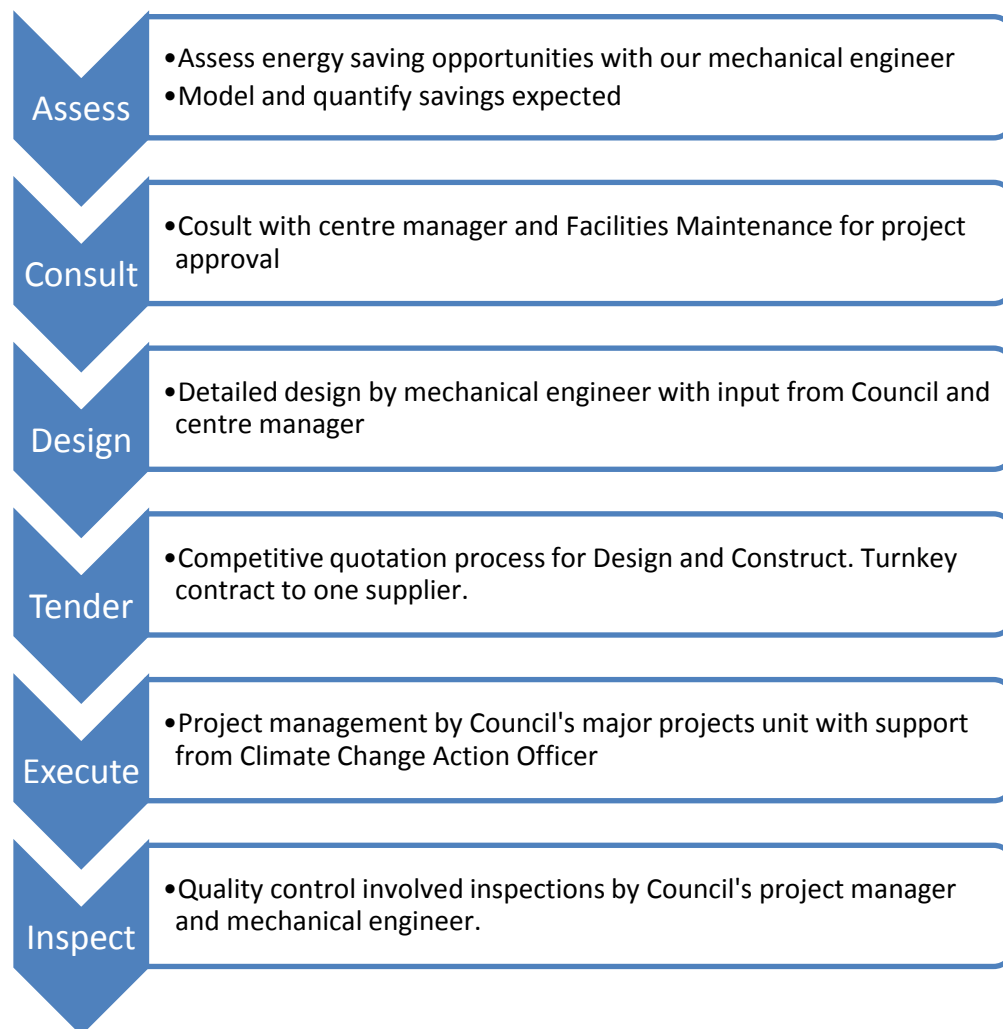
Gymnasium air conditioning system

The Gymnasium air conditioning system comprised of three roof top electric package heat pump units. The overall system was retained however we identified that significant energy savings and amenity could be gained from implementing an economy cycle. This is the process by which during mild weather, the

system can run in full fresh air mode and not need heating or cooling. The existing system, which is a common configuration, does not have large enough vents to allow full fresh air and always uses a portion of recycled air in the mix. This increases energy use as the air that is recycled will have been heated up by the users in the Gym, and therefore requires cooling before being cycled through the system again. Modifications were implemented which provided the capacity and control to enable economy cycle.

Method of implementation

The HVAC upgrades were delivered by the following method.



Site or technology-specific problems and responses

Installation of the change rooms' heat recover system provided a significant challenge due to,

- Limited outdoor space with a driveway very close
- Managing significant internal duct work modifications whilst the change rooms remained operational.

Both of the above problems were addressed by having a strong project team with a variety of skills to brainstorm solutions. Through this process of team work and collaboration, we were able to implement a plan which enabled the change rooms to stay open whilst still undertaking major duct works in a safe manner. This involved responses such as,

- After hours work when it was not possible to undertake the works with people in the change rooms
- Careful scheduling of works and proactive communications with staff and users to ensure buy in for the works and understanding of the benefits

- Works undertaken in the change rooms with careful consideration of access and safety to the public.

Learnings from this activity

In addition to the savings which can be achieved from upgrading to more efficient equipment, there were also opportunities to be realised from optimising the operational parameters of the systems. For example with the change rooms heat recover system, savings would have been realised just from upgrading the system to a heat recovery system. We were able to further increase the savings by controlling the run time to the operational hours rather than 24/7. Although not an energy saving directly, the new vents which were directed downwards provided more comfort to users with no increase in energy consumption.

In any project in an operational building, communication and collaboration with the site management is crucial to successful outcomes. Engaging all stakeholders at an early stage sets realistic expectations for all involved and also increases the pool of knowledge and ideas to resolve problems.

5. Project Demonstration and Communications Activities



Activity description

Community surveys have consistently indicated that our community expect council to demonstrate leadership in sustainability. In response to this, from the very start of this project through to completion, we focused on how we could demonstrate and communicate the project, the benefits and the applicability to our community's home and work lives.

In addition to engaging our local community, we also engaged with the energy efficiency, local government and public sector industries to share our learnings and assist others in similar projects.

The target audience

The target audiences for our communications activities included,

- Wider community in general
- Users of the aquatic centres
- Local schools

- Facility managers
- Other local councils

Informing the local community about our project and its energy efficiency benefits

Signage

Throughout the project we informed our local community about the project, the outcomes and the benefits.

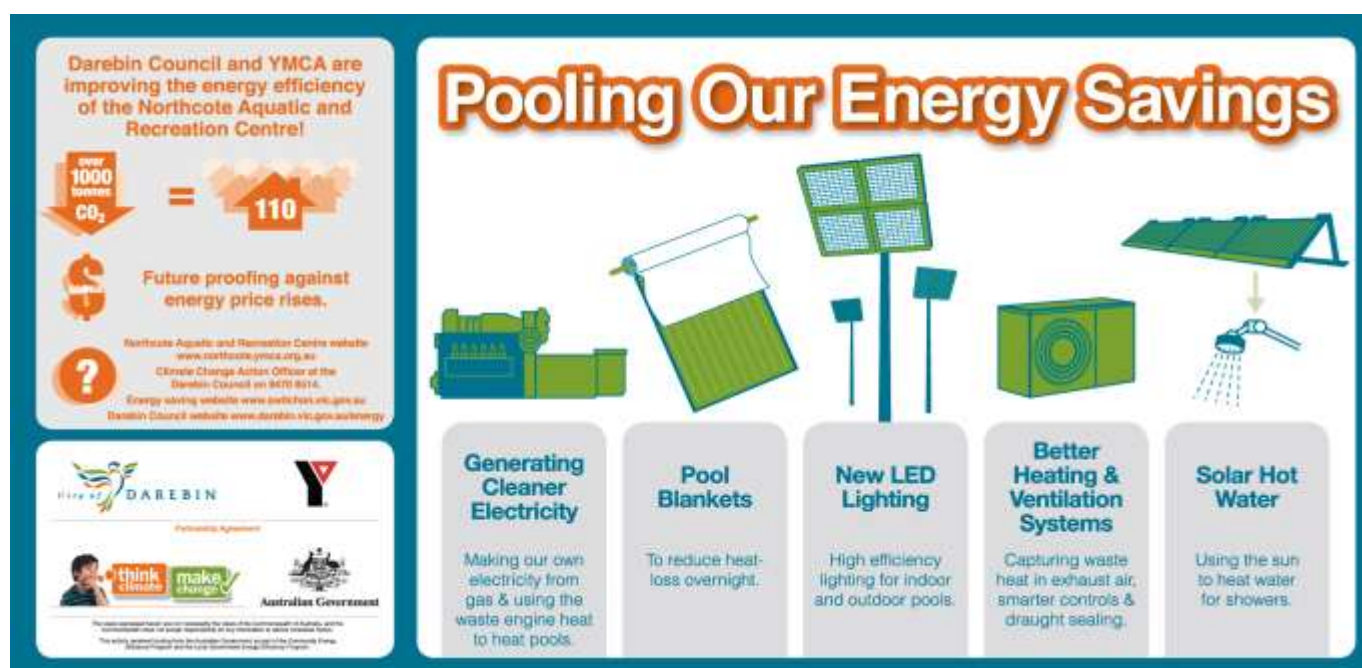


Photo 24 Main centre signage

At the front of each centre we installed a 2.4m wide sign promoting the activities of the project with the estimated carbon savings. The posters also highlighted that there was a financial benefit to delivering these projects.

Project updates were also posted on both the NARC and RLC websites throughout the project.

During project implementation, we provided the public with more detailed information so they could understand the works being undertaken which may have resulted in some inconvenience. See images below of some of the communications material installed at the centres.

Short video

The centre piece of our communications to our community was through the short video we produced which highlighted the projects and the expected benefits.

This video link has been sent to all schools in our municipality and promoted through our communications channels such as newsletters and websites.

The video can be viewed at www.darebin.vic.gov.au/savingenergy



Photo 28 RLC Launch festivities

How we educated the community about energy efficiency in general

As we rolled out the project, we produced signage which informed residents about the projects being undertaken at the centres but also how these kinds of projects related to actions they could take in their homes. The posters on the next page were produced in A3, laminated and installed around the buildings. (See following page)

Darebin Council and YMCA are improving the energy efficiency of the Northcote Aquatic and Recreation Centre!



Pooling Our Energy Savings



What are the benefits?

Lower gas usage, lower greenhouse gas emissions, lower energy bills.

What can you do at home?

Insulation is considered one of the best value steps you can take in your home to save energy. Make sure your ceiling, walls and floor are insulated. Also insulate your hot water pipes and have a hot water tank with good insulation.

For more information

www.darebin.vic.gov.au/energy

Pool Blankets

To reduce heat-loss overnight, insulating the pool.

Darebin Council and YMCA are improving the energy efficiency of the Northcote Aquatic and Recreation Centre!



Pooling Our Energy Savings



What are the benefits?

Lower electricity usage, lower greenhouse gas emissions, lower energy bills and lower maintenance costs as LED lights last much longer than traditional lights.

What can you do at home?

Avoid incandescent globes and halogen globes eg. low voltage down lights. Low voltage does not mean low power! Excellent energy saving LED and compact fluorescent alternatives are now available!

For more information

www.darebin.vic.gov.au/energy

New LED Lighting

High efficiency lighting for indoor and outdoor pools.

Pooling Our Energy Savings



What are the benefits?

Lower greenhouse gas emissions, lower energy bills and lower overall operating costs.

What can you do at home?

All around the world people are generating their own cleaner electricity at home, and are also heating their own hot water. You can do this with solar panels and solar hot water. Do not install your system today!

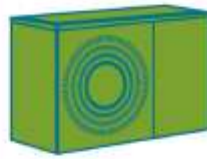
For more information
www.darebin.vic.gov.au/energy

Generating Cleaner Electricity

Darebin Council and YMCA are improving the energy efficiency of the Northcote Aquatic and Recreation Centre!



Pooling Our Energy Savings



What are the benefits?

Greater comfort, lower energy usage, lower greenhouse gas emissions, lower energy bills.

What can you do at home?

Ensure your air conditioning / heating is set to 18-20 degrees in winter and 24-27 degrees in summer. Don't overheat or overcool, as it uses a lot more energy! Always turn your systems off when you are out and during the night. Dress appropriately. Use door snakes. Zone your home - only cool/heat used areas. Close your doors and windows.

For more information

www.darebin.vic.gov.au/energy

Better Heating & Ventilation

Capturing waste heat in exhaust air, smarter controls & draught sealing.

6. Outcomes and benefits of the Project

6.1 Energy efficiency activity outcomes

Table 3 and Table 4 provide a summary of the energy outcomes which have been estimated from the upgrades at each site.

How did we determine the energy outcomes of the project?

The energy outcomes stated in this report have been provided by an independent energy auditing consultancy. Where possible, energy savings were calculated using the appropriate measurement and verification option from the International Performance Measurement and Verification Protocol (IPMVP). The IPMVP presents a framework and for measurement and verification options for transparency, reliability and consistency of project savings. Where sufficient data was not available, such as sub meter data, baseline estimates were analysed and adjusted to provide an estimated saving.

NARC: The estimated energy savings are less than our expected outcomes at around 780,000MJ/year versus our original estimate of 2,240,000 MJ/year energy reductions. The main activity which is responsible for this is the cogeneration system. Due to our innovative remote monitoring system which was implemented as part of this project, we have been able to identify that the system was not effectively transferring heat to the outdoor pools (only the indoor) and required some additional valve and flow control. As a consequence, the gas savings have not achieved expectations as the system has been dumping heat rather than reducing outdoor pool boiler use. We expect once this fine tuning is complete that we will be achieving savings in the vicinity of the original proposal. In the following "Issues and learnings" section this will be discussed further. In the long term we expect the target energy efficiency improvement proposed to be achievable as we finalise fine tuning of the cogeneration system.

RLC: The estimated end-use energy savings at RLC are on track with our expected outcomes, with an estimate of around 542,000MJ/year versus our estimate of 538,571MJ/year energy reductions. Due to the RLC cogeneration system only being started late March 2015, it was not possible to get operational performance data. Based on the fact the system is the same brand and is appropriately sized as demonstrated by the NARC unit, we are confident that the actual performance will be close to the modelled performance after fine tuning is completed. Table 4 summarises the outcomes from the projects at the Reservoir Leisure Centre.

Overall we are confident that the energy efficiency improvement will be very close to the proposed target with all projects successfully implemented and operational.

6.1.1 Cogeneration

At which sites did we implement this activity?



Energy savings

By generating most of the site's electrical power from the 122 kW(e) gas fired cogeneration plant we have been able to reduce the greenhouse gas emissions at NARC by just over 900 tonnes a year.

At RLC, with a smaller 75 kW(e) system, we are expecting to save around 600 tonnes a year in greenhouse gas emissions.

Although the end-use energy use in mega joules (MJ) actually increased as a whole for each site, we were able to reduce our greenhouse gas emissions by switching this portion of electricity for the sites from mains electricity which is mostly generated by brown coal, to cleaner natural gas. In other states where the greenhouse gas intensity of mains electricity may be lower than Victoria's, a similar project may yield lower greenhouse gas savings. The energy intensity of the natural gas fuel source also needs to be assessed.

As energy is now being produced on-site, significant overall energy savings are made by reducing losses associated with centralized production of electricity, including generation and distribution losses.

The greenhouse gas and energy savings were verified via an independent energy auditor who used regression modeling and the data available from our performance interface portal. This portal allows us to extract all key gas, electrical and thermal data to analyse the end-use energy savings.

See Table 3 Summary energy outcomes Northcote Aquatic and Recreation Centre and Table 4 which summarises the energy and greenhouse outcomes of each site.

Non-energy financial benefits

During the installation it was identified that the existing main switchboard was non-compliant with current safety standards. It was a very old switchboard which had already had reliability issues. The new switchboard was required to legally connect the cogeneration system and provides the benefit of reduced future capital expenditure. Within the next few years Council would most likely have been required to replace the switchboard either for compliance or reliability issues.

Ancillary benefits

Cogeneration provides greater in built redundancy for the Centre's pool heating systems. For example, should a boiler on the existing heating system fail, the cogeneration would still be able to provide heat which reduces the risk of disruption to the pool users.

By generating a significant portion the site's electricity from the cogeneration system, we are reducing the electrical load on the local power grid. This means there is a reduced risk of power outages not only for the centre, but also for residents within that distribution network. This area is seeing a high level of development which is adding to the load on the electricity network and increasing the chances of power outages. A key issue faced by our residents during power outages is the risk to their health and safety during heatwaves, with lack of power meaning cooling systems cannot be operated. Darebin is committed to supporting our vulnerable residents including the young and old in relation to heat stress. By reducing load on the power grid, we are providing greater confidence that our vulnerable community members will be able to operate their cooling systems during times of heat waves. Our community has been identified as having the highest level of heat wave vulnerability in Melbourne.³ The image below is a screen shot from the Mapping Heatwave Vulnerability website which shows the Darebin area in the blue circle.

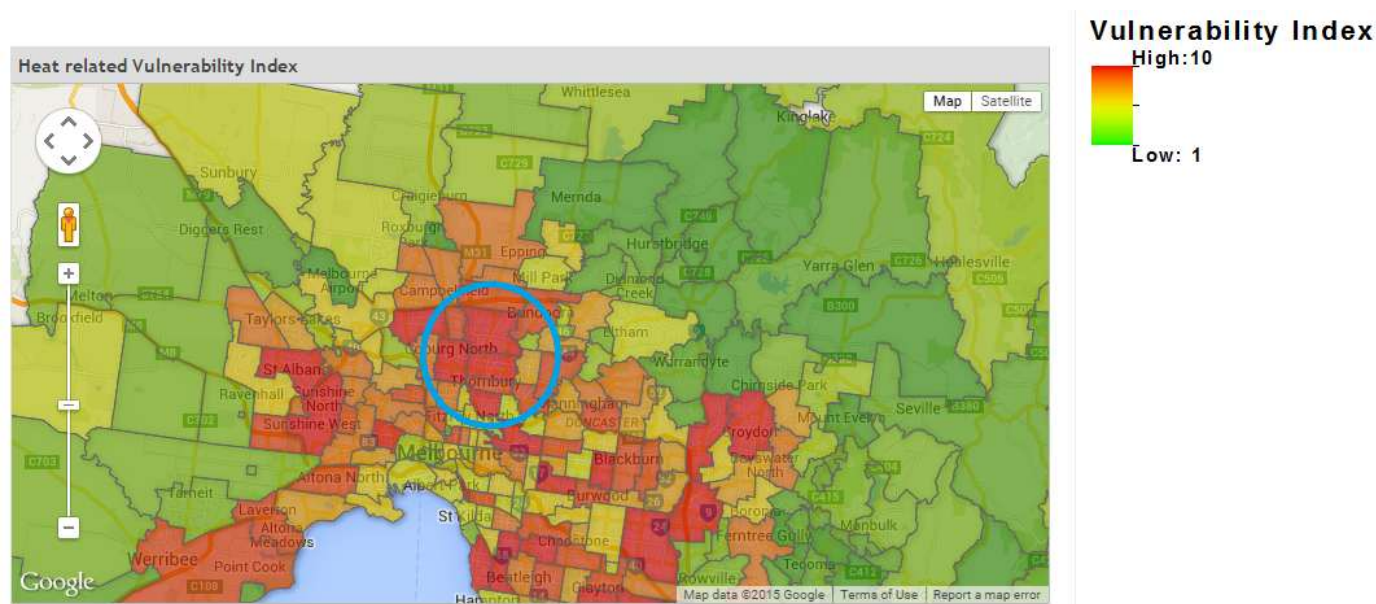


Photo 29 Darebin in the blue circle - highest vulnerability rating

Another ancillary benefit of this project has been the stronger bonds established between the staff and management at the centre and the Council's environment and project's team. This flows through to other projects which we now work more closely on. An example of this is our connection to our local community and engagement with sustainability. With the high profile works here, we have been able to leverage this to engage and educate our community about energy saving in general.

³ <http://www.mappingvulnerabilityindex.com/home/melbournevi>

6.1.2 Thermal pool blankets

Energy savings

The savings of the thermal pool blankets have been modelled by an independent energy auditor using regression analysis to estimate the savings. It is impossible to provide an exact saving of this initiative as there are many factors which could influence gas used by the pools. No sub-meters were installed on the existing boilers with analysis being limited to whole of site regression analysis with adjustments being made for the cogeneration impact on gas usage. Our original estimate of savings was 1,300,000MJ of gas a year from installation of the pool blankets. The independent audit estimated that the savings based on regression analysis are around 1,129,000MJ/year. The level of confidence in the accuracy of this figure is quite low due to the savings being only a very low percentage of the site's overall energy use being at about 4.5% of the site's overall gas consumption. According to the International Performance Measurement and Verification Protocol (IPMVP), where the energy measure being assessed is less than 10% of the site's overall energy use (of the same fuel source), the reliability of regression analysis become lower.

Figure 4 Pool Blanket savings - extract from auditor report

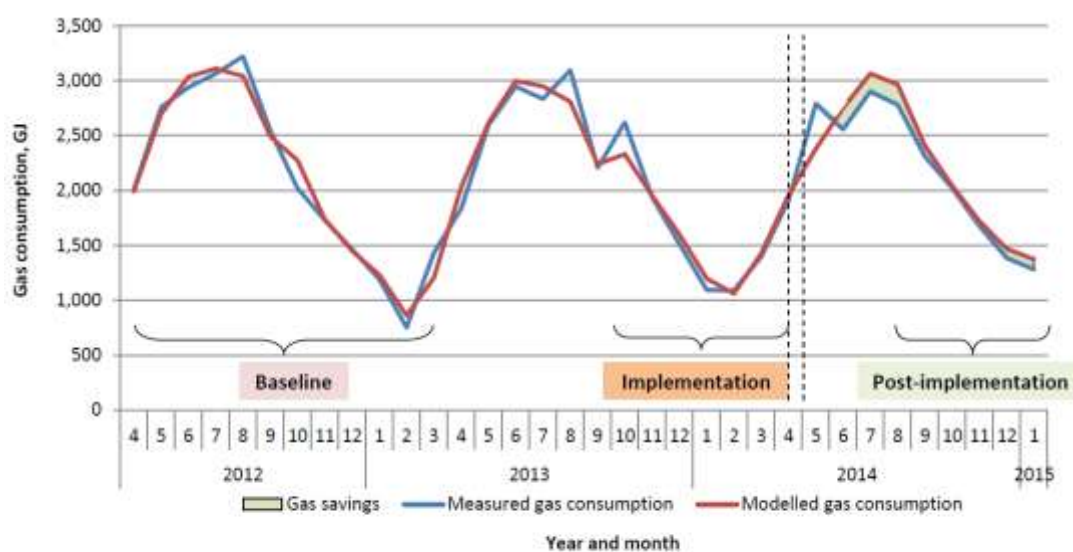


Figure 2: NARC - Baseline and post-implementation of thermal pool blankets, gas consumption

Based on this finding, we are confident that the pool blankets have delivered savings in the region of the original estimation.

Non-energy financial benefits

With the Northcote area becoming higher density, with a number of large residential developments very close to the centre, patronage is expected to continue to increase. Lack of seating had already been identified as an issue at the centre for parents who take their children for swimming lessons. In the near future we expect that additional seating would have had to have been purchased and installed. As the pool blankets were integrated in to a bench design, the future cost of upgrading seating has been avoided.

Pool blankets also reduce evaporation which saves water. Water savings have not been quantified in the scope of this project however water savings will definitely be realised. This benefits the centre by reducing water bills.

Ancillary benefits

As well as the financial benefit of the avoided future cost of installing new seating, the blankets have provided an immediate benefit of more seating for people when taking children for swimming lessons. This seating is very well used.



Photo 30 Installation outdoor pool seating above blankets

The works to install the pool blankets were highly visible and required support of patrons to accept some restricted access and removal of some existing seating. We were able to take this opportunity to engage with our community to explain why we were doing this work and also educate them about how they could save energy at home. This was achieved by the installation of signage around the centre as detailed in Section 5.

See Table 3 Summary energy outcomes Northcote Aquatic and Recreation Centre for a summary of the energy and greenhouse emissions outcomes.

6.1.3 Building envelope improvements

At which sites did we implement this activity?



Energy savings

Due to the expected savings from envelope upgrades being only a small percentage of the overall sites energy consumption, it was not possible for energy auditor to provide an accurate measurement of savings achieved. The savings were estimated using calculations and data provided from our mechanical engineer as well as gas and electrical interval meter data which were then analysed as far as practical by our energy auditor.

The savings at RLC are estimated to be around 1,265,043MJ with the savings at NARC unable to be separately quantified due to the relatively minor extent of works at that site.

As the upgrades at RLC were more significant those at NARC, we attempted to undertake regression analysis to determine if savings could be verified. In this instance, the gas interval data indicated that energy had actually increased at the centre after the insulated wall panels and new pool hall doors were installed. As increasing insulation and draught sealing cannot increase energy use, the auditor advised that this analysis did not provide any useful information. However in our efforts to provide a level of independent verification, we extracted the data from the building management system and analysed the fans for the pool hall ventilation system. This analysis indicated that after the works were completed, the energy use for fans, which are controlled by variable speed drives, was around 8.5% lower than prior to the envelope works. The auditor confirmed that this indicated a reduction in air volume (heating demand) at the site which could reasonably be attributed the reduction in heat loss from the envelope works.

The increase in gas use, which has happened in the past, would be assumed to be related to other gas plant at the site or faulty controls or equipment of the heating system.

See Table 3 and Table 4 for summary of the savings and original targets.

Non-energy financial benefits

Due to the high amount of condensation forming on the inside of the building façade at RLC, the building materials were being damaged by this corrosive liquid. This corrosion as evidenced in Photo 11 leads to increased maintenance costs and materials required for repair and replacement. The new insulated panels to not form condensation on the inside which means we will see reduced repair and maintenance costs.

Ancillary benefits

At both centres, a key benefit of the draught sealing is the level of comfort for users. At NARC, the change rooms were always very cool with cold air from the front door being able to easily blow through the large door undercuts right through the change room and out the rear door in to the pool hall. This upgrade has reduced the draughts which increase the comfort of users.

Similarly at RLC, the leaky doors and façade permitted significant cold airflow directly over the pool users and staff. With the energy rated doors and sealed façade, the level of comfort has significantly increased for users.

6.1.4 LED Lighting



Energy savings

As opposed to the challenges in verifying savings in envelope upgrades, lighting upgrades are much simpler. The only assumption which has been made in the energy savings for lighting is the hours of operation per day. It was not practical to sub-meter the circuits as the cost is very high to trace the circuits and then install dedicated metering software. Savings were calculated using the watts of each luminaire before and after.

The savings from this project equate to 50,443 MJ/year and 18 tonnes of Co2 reduction at RLC and 168,259 MJ/year and 61 tonnes of Co2 reduction at NARC.

See Table 3 for summary of the savings and original targets.

Non-energy financial benefits

At both centres, the longer life of LED lighting will result in lower maintenance costs. Existing technology lighting had a life of around 12,000 hours whereas the LED technology is expected to last for at least 30 to 50 thousand hours. With high costs of access to the lights in aquatic centres, these maintenance savings will be significant.

Particularly at NARC, all of the indoor pool hall lights had reached end of life. With about 14 lights, mostly over the pool water surface, the cost to replace these would be very high. At the time of this upgrade some lights had already failed and due to the age and corrosion, they could not be opened to repair. By undertaking this LED upgrade we have avoided significant future costs to replace this lighting.

Ancillary benefits

The demonstration that council is actively working on energy efficiency and greenhouse gas reduction is a valuable outcome for council and the community. While council has been very active in this field for many years, most of the work is not seen by residents as it is often behind the scenes upgrades. This helps to build strong relationships between our community and council.

At both sites, the opportunity to upgrade lighting was also an opportunity to redesign the lighting system. At both sites, the quality of lighting on the ground has been much improved with an increase in uniformity and a focus on improving lighting in darker areas. The benefit of this is that the facilities look more attractive and our community feels safer.

6.1.5 Heating, Ventilation and Air-conditioning (HVAC)



Northcote Aquatic and Recreation Centre



Reservoir Leisure Centre

Energy savings

The independent energy audit for this measure was undertaken by using estimates, calculations and data provided from our mechanical engineer. Due to the lack of sub-metering, the interplay of other upgrades undertaken at a similar time and the relatively low amount of savings in relation to the overall site energy consumption, meaningful regression analysis was not possible. Using the mechanical engineer's energy assessment data as a base, the auditor estimated the expected savings.

The HVAC upgrades are expected to deliver savings of around 515,000MJ of energy savings a year and greenhouse gas savings of over 70 tonnes a year.

See Table 3 for summary details of the savings.

Non-energy financial benefits

The existing heating system for the NARC change rooms was at end of life and would need to be replaced in the near future. The implementation of the high efficiency heat recovery system has avoided the large costs which would have been incurred by council to replace the existing system.

Ancillary benefits

The HVAC upgrade has delivered improved comfort and amenity for our community and staff at the centre. The change room HVAC system now directs warm air directly down to the ground level so people feel much warmer now when getting changed. On cold days, with the heat recovery system, there is plenty of capacity to keep the change rooms warm whereas in the past the system would not be able to heat the change rooms on very cold days.

The gymnasium upgrade with economy cycle mode now provides more fresh air than the previous system which improves energy levels and the satisfaction of experience for our community who use this facility.

6.2 Demonstration and Communication outcomes

Figure 5 Overview of community engagement



Our communications activities were focused not only on promoting the activities at each aquatic centre but also educating and encouraging our community to embrace energy saving at home and work. Throughout this project we;

- Held launch days at each site where we had experts on hand to talk to residents about energy efficiency in their homes and work. We provided written and verbal information about council resources available such as fact sheets, bulk buy programs and free workshops
- Produced and installed signage throughout the centres to communicate the works underway and the actions they could take at home
- Video produced and posted on numerous websites to show our leadership and also provide a link to council resources where residents can find detailed information about energy saving at home
- Through updates on websites, raised the community's awareness and "social norming" that energy efficiency is a smart thing to do. This will in turn increase the likelihood that residents will take their own action at home.

- With energy metering reports being able to generated and emailed to residents, this offers the potential to increase their engagement in energy efficiency and enthusiasm to take action at home
- School tours have been booked to develop a closer relationship with Council. On these tours, the activities will be associated with similar activities they can do at home.

6.2.1 Evaluating the impact of our energy efficiency activities on the community

The design of this project did not include evaluation of the effectiveness of our communications to the community. As with any education campaign it is very difficult to verify the impact one campaign has on community behaviour. Certainly the feedback has been very positive from our community. One resident wrote to us after seeing the video saying;

“Thanks for the link [to the video], and great work! Significant changes have been made on many fronts; environmental, safety and economical. Congratulations on achieving these outcomes!!! Many people of all age groups will benefit from the improvements! The video showcases what you have achieved beautifully!

Well done to you and all those involved!”

With the extent of works being much greater at NARC, there was a lot more awareness about the project at that site. Feedback from staff at NARC indicated that some members of the community have taken steps to improve their energy performance at home, with a resident relaying to staff that as a result of seeing the works, she had proceeded with purchasing a solar hot water system for her house.

Our promotion to local schools has also confirmed that this project is expected to have value in terms of encouraging and educating our community. At the time of this report, a local high school has confirmed a group of year 12 students to visit NARC for a tour of the energy efficiency upgrades and to learn about why we did it. Council's Climate Change Action Officer will lead the tour and provide information to the students including written material acknowledging the Australian Government's support.

These activities complement the numerous other activities undertaken by council to educate and engage our community and reinforce the importance for all of us to reduce our energy use.

6.2.2 Extent of communications reaching our community

Throughout the project we produced and delivered information to our community via print and website updates. With a population of around 150,000, and the assumption that at least 5% of the wider community would have seen some of our promotions, we estimate that at least 7500 in our community would be aware of the project through media distribution. With large signs at the front of each aquatic centre and updates with smaller signs and on the aquatic centre websites, we estimate that around 5000 aquatic centre users would be aware of the project. In total we estimate our communications have been noticed by around 10,000 members of our community.

7. Budget

7.1 Project delivered within budget

This project has been delivered within the projected budgeted cost of \$2,189,500 excluding GST. Of the total cost, Darebin City Council contributed 60%, \$1,256,783, with the Australian Government contribution of \$837,856.

Retrofitting of existing buildings present a higher level of cost uncertainty than a new build as there are many unknown pre-existing conditions which can add to cost and time. As Darebin is highly experienced in energy retrofit projects, we were able to allocate realistic risk and change budgets which allowed for the level of uncertainty in these types of projects.

One of the key high cost areas of uncertainty is in relation to grid connection of cogeneration system. The uncertainty of processes from electrical distribution companies creates a high degree of cost and time risk to these projects. Clearer guidelines and communication from electrical distribution businesses would provide greater cost certainty for cogeneration projects.

8. Project Issues and learnings

A project of this nature requires strong teamwork and collaboration. Relationships and support of people with key skills such as project management, construction management, energy efficiency and engineering are critical to successful outcomes. It is also crucial to have the support of facility managers who will be affected by the works and be responsible for ongoing monitoring and maintenance. If site managers are not engaged and supportive, then it is more likely that some measures which require user input will not perform in the long term. As site managers are very busy with day to day operations, a dedicated “energy officer” such as Darebin’s Climate Change Action Officer can ensure that measures are performing in the long term.

Quality management and acceptance criteria are very important considerations for this kind of project. The energy efficiency field is one which has a poor level of understanding by most trades. At the time of specifying upgrades, careful thought should be given to what the expectations are for the quality of work and how this will be verified. Contractors should be made clearly aware of the expectations of their work and the responsibilities if quality or performance criteria are not be achieved. Often this is not considered at the start of a project which leads to unclear responsibility if there be issues.

The key learning in relation to retrofit projects is to ensure as much ground truthing is done as possible. This means having a team of capable and trusted electricians, gas and water plumbers, HVAC technicians, engineering and energy efficiency consultants. With poor ground truthing, the risk is very high that planned measures may not be able to be implemented due to unknown existing conditions at the site.

9. Project operation, mechanisms and processes

9.1 Project delivery structure

Darebin City Council has a high level of in house capability to deliver energy efficiency projects. With our energy efficiency capital works upgrade program active since 2007, we have extensive experience of commercial retrofit projects.

All of the activities of this project were project managed by either Council's major projects unit or the Climate Change Action Officer.

Risk and quality control was a key focus in our project management and is a key factor in the success of our projects. During the project we were contacted by a number of councils who were having difficulties implementing similar projects due to their project management capabilities and experience. Our approach to these projects was to be highly familiar with the details ourselves rather than rely purely on consultant designs and specifications.

The project process placed a high priority on collaboration with all stakeholders. Consultation and information was undertaken early on in the activities to ensure that stakeholder feedback and concerns could be addressed.

9.2 Reflections on project delivery structure

The delivery structure chosen has been successful in delivering the desired outcomes. This project has strengthened our already strong capability and experience in project management of energy efficiency retrofit projects. A key factor in our success was our willingness to become heavily involved in the design and specifications of projects. Numerous times we were able to identify improvements to consultant designs which resulted in projects being delivered in a more streamlined manner. We certainly recommend engaging expert consultants however having the skills and knowledge to critically assess their work is crucial.

With our in house capability, we feel this structure gave us the ability to implement a robust and achievable quality control system for all of these projects. This is a key process which is often overlooked in such projects but which is crucial given the low level of capability by the building trades. The poignant example of this was the activity to install the insulated wall panels at RLC. Without our experience in working with contractors on energy efficiency upgrades, we may not have implemented the quality control process which identified they were all installed without the draught sealing under the panels.

With numerous positive changes we were able to make throughout this project and the high level of quality control we were able to oversee, we were very pleased with this project structure.

It is important to highlight though that this project structure relied on strong in house capabilities, a culture of collaboration and willingness to develop robust quality and risk management strategies.

10. Conclusion

The pooling our energy savings project has been a great success through a strong partnership with the Australian Government.

The energy and greenhouse gas savings have been significant at our two largest energy using buildings, the Northcote Aquatic and Recreation Centre and the Reservoir Leisure Centre with expected operational avoided costs of over \$100,000 a year and greenhouse gas savings of over around 1700 tonnes a year. This is equivalent to taking over 450 average Victorian cars off the road.

In addition to the energy savings, we have been able to use this project to educate and engage our community in energy saving and greenhouse emissions reduction. We have had positive feedback from our residents and anecdotal evidence that this project has inspired them to take action at home.

The successful outcomes of these projects have generated interest from other local governments and commercial building operators who have approached us for advice to assist their efforts to deliver similar projects. We have keenly provided advice and also presented at a number conferences to share our learnings and experience. This collaboration has increased the capability of others to undertake energy and greenhouse gas reduction projects on their own buildings.

Importantly, we have been able to demonstrate leadership to our community in taking action on climate change which our community expect from us.

Darebin City Council and our community will benefit from these projects for many years to come, with lower operational costs ensuring better accessibility, greenhouse gas reductions and benefiting the world as a whole in reducing our contribution to climate change mitigation.

Table 3 Summary energy outcomes Northcote Aquatic and Recreation Centre

	Energy improvement (MJ/yr)		Greenhouse Gas reduction (tonnes/yr)		
Activity	Original Proposed	Energy Audit	Original Proposed	Energy Audit	Brief commentary
NARC Gas-fired cogeneration	187,000	-982,134	992	926	Lower energy improvement is primarily due to the system using about 35% more natural gas than modeled. This is attributed to: <ul style="list-style-type: none"> • Cogeneration system excess heat dumping, • Modeling did not take in to account higher gas consumption at lower load such as overnight, • Existing boilers required tuning to enable optimal use of waste heat. All issues have been or are being optimised to improve performance.
NARC Thermal pool blankets	1,300,000	1,079,014	72	60	Within accuracy of energy audit, pool blankets appear to be delivering the savings in the vicinity of the proposed savings.
NARC HVAC and draught sealing	536,345	516,311	80	73	Higher savings expected over winter as the audit was carried out post installation November 2014 where heat recovery savings are lower.
NARC LED lighting	217,541	168,259	79	61	Some additional lighting was required over and above the original design to ensure compliance with Australian Standards.
	2,240,886	781,450	1,223	1,120	With tuning of the cogeneration and higher HVAC savings over winter it is expected the actual energy improvement will achieve the original target.

Table 4 Summary energy outcomes at Reservoir Leisure Centre

	Energy improvement (MJ/yr)		Greenhouse Gas reduction (tonnes/yr)		
Activity	Original Proposed	Energy Audit	Original Proposed	Energy Audit	Brief commentary
RLC Gas-fired cogeneration	-773,646	-773,646	569	569	Cogeneration has only been running since late March 2015. Expecting performance should closely match the proposal after fine tuning. Audit is based on estimated performance.
RLC Building envelope upgrades	1,265,043	1,265,043	70	80	Higher audited estimated savings due to electricity reduction of air handler fans not originally considered.
<i>Energy efficient section doors</i>	390,241				Not possible to audit savings of this measure alone due to low energy use as a portion of total site use. Included in total of envelope upgrades
<i>Insulated walls, panels gutter, & draught sealing</i>	874,802				Not possible to audit savings of this measure alone due to low energy use as a portion of total site use. Included in total of envelope upgrades.
RLC LED lighting	47,174	50,443	17	18	Fewer lights required in pool hall with careful modeling yet still meets Australian Standards.
	538,571	541,841	657	667	

Table 5 NARC business case summary

Activity	Cost to Council \$	Avoided future capital expenditure \$	Annual operational energy savings \$	Simple payback including avoided future capital expenditure - Years	Brief commentary
NARC Gas-fired cogeneration	501,595	35,000	18,940 (91,536)	24.6 (5.1)	Long payback due to unexpected reduction in energy rates of site operator. Figures in brackets show business case based on Council energy rates.
NARC Thermal pool blankets	34,723	0	7,500	4.6	Additional savings of reduced water consumption and less condensation damaging building not included.
NARC HVAC and draught sealing	100,140	10,000	5,683	15.8	Expect higher savings in winter with heat recovery. Avoided capital expenditure is for new gas heater which was at end of life.
NARC LED lighting	28,059	7,500	6,238	3.2	Avoided capital expenditure for new pool hall lights which were already at end of life, had started failing and were unserviceable due to corrosion.
	\$664,517	\$52,500	\$38,362 (\$110,957)	15.9 (6)	Amounts in brackets are for business case if NARC cogen was operating at Council energy rates not the very low rates at NARC.

Table 6 RLC business case summary

Activity	Cost to Council \$	Avoided future capital expenditure	Annual operational energy savings	Simple payback	Brief commentary
RLC Gas-fired cogeneration	390,000	0	53,484	7	Cogeneration has only been running since late March. Expecting performance should closely match the proposal after fine tuning. Audit is based on estimated performance.
RLC Building envelope upgrades	71,302	36,000	8,918	4	Avoided future capital expenditure for pool hall doors which would have needed to be replaced in the near future due to age.
<i>Energy efficient section doors</i>	(included in envelope upgrades)				Not possible to audit savings of this measure alone due to low savings as proportion of overall site energy use. Included in total of envelope upgrades
<i>Insulated walls, panels gutter, & draught sealing</i>	(included in envelope upgrades)				Not possible to audit savings of this measure alone due to low savings as proportion of overall site energy use. Included in total of envelope upgrades
RLC LED lighting	23,105		3,227	7	Energy savings and maintenance savings from longer life LED
	\$448,407	\$36,000	\$65,629	7	

11. Declaration

DECLARATION

The Authorised Officer of the organisation makes the following declarations:

- ☒ I declare that I am authorised to submit this Final Report (including any attachments) on behalf of
..... DAREBIN CITY COUNCIL (Name of organisation)
- ☒ I declare that the information provided in this Final Report is true and accurate.
- ☒ I understand, and acknowledge that giving false or misleading information in this Final Report is an offence under the *Criminal Code Act 1995*.
- ☒ I understand that final payment will only be made in accordance with the Funding Agreement including on satisfactory completion of Milestones.

Authorised Officer Signature: Date: 28 / 5 / 15

Name: RASIAH DEV

Position: CHIEF EXECUTIVE Organisation: DAREBIN CITY COUNCIL

Witness Signature: Date: 28 / 5 / 15

Name: Anna Giuliani

Position: Executive PA to CEO Organisation: Darebin City Council

The use and disclosure of information provided in this Final Report is regulated by the relevant provisions and penalties of the *Public Service Act 1999*, the *Privacy Act 1988*, the *Freedom of Information Act 1982*, the *Crimes Act 1914* and the general laws of the Commonwealth of Australia.

Information contained in the Final Report may be disclosed by the Department for purposes such as promoting the program and reporting on its operation and policy development. This information may also be used in answering questions in Parliament and its committees. In addition, the selected project information will be made publicly available. Public announcements may include the name of the grant recipient and of any project partners; title and description of the project and its outcomes; and amount of funding awarded.

Project Energy Efficiency Improvement Template

PROJECT TITLE	Pooling Our Energy Savings	PROJECT ID	CEEP1109
FUNDING RECIPIENT	Darebin City Council	DATE	15 May 2015
Building, Facility or Site 1			
Name of Building, Facility or Site 1	<i>Northcote Aquatic and Recreation Centre (NARC)</i>		
Location (address)	180 Victoria Road, Northcote, Victoria		
Type of building, facility or site	Aquatic and Recreation Centre with indoor and outdoor pools (all heated), Gym, Aerobics room, Crèche and café. Outdoor 50m pool heated all year. Smaller 25m outdoor pool and play pool not used in winter.		
Activity Type and Measure	Whole building including - HVAC upgrade, air leakage sealing, lighting upgrade, pool blankets and cogeneration		
Energy Efficiency Estimate Method	<p>Baseline energy measures have been calculated by Darebin City Council using accurate energy data and measurement tools including GIS and AutoCAD and Carbonmetrix utility bill management. CarbonetiX has undertaken a review of energy demand at the site and these figures were used as the basis for calculating the energy intensity baseline and efficiency outcomes. Assistance with analysis of energy efficiency measures has been provided by CarbonetiX. CarbonetiX is a member of the Energy Efficiency Council and the Director, Bruce Rowse, has a Bachelor of Engineering (Mech), MBA and is an Australian Institute of Refrigeration, Air-conditioning and Heating (AIRAH) accredited energy Auditor with a Class D electrical licence.</p> <p>CarbonetiX energy consultants have assessed projects for both of the sites proposed in this project as per our original submission. CarbonetiX uses the IPMVP (International Performance Monitoring and Verification Protocol) for measuring savings.</p> <p>The NARC HVAC upgrades have been scoped in detail by Medlands Metropolis</p>		
Baseline Energy Usage	<p>1,024,296 kWh per annum (11/12FY) (Electricity)</p> <p>20,951 GJ per annum (11/12FY) (Natural Gas)</p> <p>Total: 24,638 GJ per annum (11/12FY) (Electricity and natural gas)</p> <p>8,927 MJ/Sq.m/Year</p>		

Baseline Energy Efficiency	8,927 MJ/Sq.m/Year 24,638 GJ / 750,000 * 1000 = 32.85 MJ /visit/annum
Energy Efficiency Improvement	Reduction of total 2,241,360 MJ/annum = 2.99 MJ/Annum/Visit (Reduction/annual visitations) 812 MJ/Sq.m/year occupied floor area
Reporting Data (Measuring Energy Efficiency and Additional Data)	2760 sq.m floor area (excluding plant rooms) Annual visitations of 750,000 per annum Daily hours of operation: Mon to Fri from 6am - 10pm Sat from 7:30am - 8pm Sun from 8am - 8pm Building construction date 1991
Cost of Activity	\$913,000
Estimated Cost Savings	\$18,940 based on NARC very energy tariff \$91,537 based on Council tariffs which may be more representative of wider business rates.
Building, Facility or Site 2	
Name of Building, Facility or Site	Reservoir Leisure Centre
Location (address)	2C Cuthbert Road, Reservoir, Victoria
Type of building, facility or site	Aquatic and Recreation Centre, Indoor pools, outdoor pools (summer only, not heated), Gym, Crèche and cycle room.
Activity Type and Measure	Whole building including – Building envelope air leakage sealing, lighting upgrade and cogeneration
Energy Efficiency Estimate Method	<p>Baseline energy measures have been calculated by Darebin City Council using accurate energy data and measurement tools including GIS and AutoCAD and Carbonmetrix utility bill management. CarbonetiX has undertaken a review of energy demand at the site and these figures were used as the basis for calculating the energy intensity baseline and efficiency outcomes. Assistance with analysis of energy efficiency measures has been provided by CarbonetiX. CarbonetiX is a member of the Energy Efficiency Council and the Director, Bruce Rowse, has a Bachelor of Engineering (Mech), MBA and is an Australian Institute of Refrigeration, Air-conditioning and Heating (AIRAH) accredited energy Auditor with a Class D electrical licence.</p> <p>CarbonetiX energy consultants have assessed projects for both of the sites proposed in this project as per our original submission. CarbonetiX uses the IPMVP (International Performance Monitoring and Verification Protocol) for</p>

	measuring savings.
Baseline Energy Usage	<p>790,836 kWh per annum (11/12FY) (Electricity)</p> <p>9,865 GJ per annum (11/12FY) (Natural Gas)</p> <p>Total: 12,712 GJ per annum (11/12FY) (Electricity and natural gas)</p>
Baseline Energy Efficiency	$12,712 \text{ GJ} / 450,000 * 1000 = 28.25 \text{ MJ/Visit/annum}$
Energy Efficiency Improvement	<p>Reduction of total 537,608 MJ/annum =</p> <p>1.2 MJ/Annum/Visit (Reduction/annual visitations)</p>
Reporting Data (Measuring Energy Efficiency and Additional Data)	<p>Annual visitations of 450,000 per annum</p> <p>Daily hours of operation:</p> <p>Mon to Thurs from 6am – 9.30pm</p> <p>Friday from 6am – 8.30pm</p> <p>Sat from 8am - 6pm</p> <p>Sun from 9am - 6pm</p> <p>Building construction date 1988 with extension in 2008 to include Hydrotherapy Pool</p>
Cost of Activity	\$1,181,000
Estimated Cost Savings	\$65,629

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