Buildings

Getting Wise About Cogeneration – A Case Study of Cogeneration Versus Boilers and Solar

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Moreland City Council and Ironbark Sustainability assessed the financial, environmental and operational performance of two main options for heating and powering indoor aquatic centres using Fawkner Leisure Centre as a case study. The options assessed include:

1. Cogeneration (as installed at the Centre);
2. High efficiency condensing boilers (as installed on a second pool at the Centre) with photovoltaic solar (PV) (considering 100, 200 and 280KW of capacity, spread across 6 buildings in the precinct).

Findings revealed that:

- High efficiency boilers and PV's provide the best payback period, at more than half that of the cogeneration unit;
- The largest PV system assessed (280kW) combined with the boilers provides better greenhouse savings and more than twice the cost savings;
- The project risks also favour option two (PV and boilers). Based on actual outcomes at Fawkner Leisure Centre, the risks for cogeneration are far higher than boilers and PV's, particularly in the delivery and servicing stages.

** If current trends persist actual savings could be significantly lower. Scheduled maintenance costs included.*

This case study does not conclude that cogeneration should never be considered. It does emphasise, however, that the best approach is to weigh up all possible options for delivering heat and power to a site efficiently and effectively and reducing greenhouse gas emissions rather than putting all your eggs in one (very complex) basket.

Had Moreland City Council had this information at hand during the feasibility phase, then boilers and PV panels would have been chosen over cogeneration.

Background: Why this Comparison?

The Fawkner Leisure Centre, owned by Moreland City Council, won the 2013 Aquatics & Recreation Victoria Sustainability Award. Council has actively sought to reduce energy and water use at this site for many years and it is considered a leading example for what can be done to existing sites to improve sustainability. Council recently installed and commissioned a cogeneration plant for the indoor pool and high efficiency boilers for the outdoor pool.

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Two pool heating systems – cogeneration and high efficiency boilers – were installed at the same site, each as a separate project that occurred more than 12 months apart with no other efficiency projects carried out during that time. Both the gas boilers and the cogeneration plant were designed to be optimised for size and compatibility with the site. These factors gave Council an opportunity to closely and accurately compare the performance of each system.

Accuracy of the Comparison

The comparison process was involved and included analysis of over 2 years' worth of data.

The calculations were put together by:

- Paul Brown, Ironbark Sustainability;
- Stuart Nesbitt, Moreland City Council; and

were independently reviewed by technical officers from 3 other municipalities.

Real and estimated data was used to compare the 2 options, including:

- Capital cost based upon the best-fit cogeneration plant;
- Cogeneration savings based on estimated long term performance;
- Gas usage data and efficiencies of the boilers and the cogeneration system based on manufacturers information;
- Boiler costs based on actual costs;
- Three PV scenarios using 100, 200 and 280kW of installed capacity. A conservative cost of $2 per Watt was used;
- Maintenance of the cogeneration system based on scheduled data from the contractor. Unscheduled maintenance was not included (although will and has occurred);
- PV and boiler maintenance was based on experiences with similar sites and systems.

Project Risks

Table 2 below summarises the project risks from the two project types. This is based on actual outcomes from the Fawkner Leisure Centre which compares the delivery of cogeneration on the inside pool and the high efficiency boilers on the outside pool. Council has extensive experience installing PV's at other sites and these were considered in this analysis.

There were no high risks associated with the boiler and PV project and only 2 medium risks. For the cogeneration project 5 high risks and 6 medium risks were identified. Risks were considered to be high if they were likely and of high consequence.

The high risks for the cogeneration project were:

- **Timeframes** – Delivery of the cogeneration project ran 6 months over time which has impacted on the Centre's operation and the cost savings to Council;
- **Additional works** – There were several costs not predicted in the feasibility study. For example, cogeneration at this site required significant trenching for underground services. During the project this resulted in cost increases due to 'finding things' under the ground. The amount of civil contractor issues associated with this can be large and this may be considered a usual outcome for cogeneration project;
- **Integrating with existing site** – Cogeneration requires the installation of an additional plant area for all the new equipment. Locating the new plant is critical and can be difficult to fit in already crowded plant rooms. At this site the cogeneration plant had to be installed in an external stand-alone structure and the hot water and electricity fed into the existing plant room;
- **Servicing** – The cogeneration plant requires regular maintenance and servicing. Over the cogeneration plants' 20 year depreciated life the engine requires 4 high cost major overhauls. Care in assessing cost benefits and including maintenance contracts is important for the long-term success of the plant;

Why did Moreland City Council Decide on Cogeneration and What Has Changed Since Then?

The key project drivers were to save greenhouse gas emissions and costs. In 2009, a feasibility study indicated that cogeneration would be the best way to achieve this.

However, since the 2009 feasibility study, several key influences have changed:

- The cost of PV's are significantly cheaper than in 2009;
- Gas and electricity prices have risen significantly;
- Future predictions of pricing trends indicate that gas will continue to increase and PV's will continue to decrease (and thus a PV/Boiler option will continue to be more cost effective).

Moving forward, Moreland City Council's position is to continue to thoroughly investigate all energy generation and carbon abatement options before pursuing cogeneration projects in the future.

Of note, Moreland has recently opted to install high efficiency gas boilers and a 57 kW hybrid PV-T system to produce the desired carbon abatement & cost saving outcomes at an aquatic centre previously earmarked for cogeneration, and expects a significantly lower natural gas consumption profile.

Can We Use These Figures for Other Aquatic Centres?

Generally speaking, cogeneration projects are a lot more complex and can be more risky than a comparatively simple boiler and PV installation. With that said, the best approach is to consider that there are several options available beyond the two options profiled to deliver the preferred outcomes, namely the saving of money and greenhouse gases.

This study should not be used to say that cogeneration is not a viable option for aquatic centres. It should be used to thoroughly question any analysis that says it is the only option available to meet the needs of organisations or specific facilities.

Some councils are beginning to adopt policies to move away from the installation of fossil fuel infrastructure. These councils are recommending the choice of renewable sources (such as PV's) and not fossil fuels (such as gas fired cogeneration). At Fawkner Leisure Centre, the boilers and PV project would save approximately 2,500 GJ of natural gas annually when compared with the cogeneration project.

Over the last 5 years in Victoria, many cogeneration projects have either been attempted and delayed, or abandoned all together due to unforeseen complications. Those that have succeeded have done so through very careful planning, and more commonly through persistence and hard work to overcome the myriad of challenges to successful projects. And many of these projects are still experiencing reliability, commissioning and installation issues.

In 2012, Ironbark surveyed Victorian aquatic centre managers and found that 50% indicated that they were planning to deliver cogeneration in the next 12 months. Two years on in 2014, Ironbark conducted a similar survey with New South Wales aquatic centre representatives and found that 30% of those surveyed had already installed them, while 13% were planning to install them in the next 12 months. It will be interesting to hear how these projects go.

Key Lessons

For this site, despite the initial 2009 feasibility study recommending cogeneration as the best option, it was determined in 2014 that high efficiency boilers with PV's would be a more cost effective energy saving and carbon abatement option over cogeneration.

and technology options;

3. Weigh up the benefits and risks of different approaches. Each site has a range of factors that can influence outcomes and key risks for each project must be carefully identified and planned for;
4. All this can be done at the feasibility stage, but be careful about who provides advice (cogeneration is very complex so consultants can make lots of money from this).
5. Keep in mind it was found that in some sites cogeneration is performing as per feasibility and when part of an Energy Performance Contract (EPC) there is a guaranteed saving for councils. In many other locations they are not performing either at all or close to the feasibility figures and in these cases the outcomes are inevitably worse.

There is good information available for councils considering cogeneration in the Cogeneration Feasibility Toolkit and information on measuring and verifying energy savings found through the International Performance Measurement and Verification Protocol.

And Finally, What Comes Next?

This is a very useful case study. Assessing the performance of two key technologies is vital to determining what to deliver in the future. But more analysis needs to be done. Below is a list of specific questions we would like more research to be completed on:

1. How do heat pumps perform (instead of or in combination with the boilers)?
2. How much of cogeneration heat load is wasted? Typically models assume all the heat from the cogeneration plant is being used, but in reality (especially in summer where more heat is not needed) some of the heat load is dumped.

Ironbark run sustainability courses for Aquatic Centre managers. We also conduct business cases for a range of technologies. To learn more please contact us to discuss your options.