Picture : Nearmaps

Heating & Energy Options at North Sydney Olympic Pool.

A 20-year history from 2002 to 2021
- Lessons learnt
+
Proposed Pool Heating & Energy Options (Opening from around Summer 2023 - currently under construction)

Old pool energy systems

Pool originally opened 1936
Since 2002, the pool has had the following energy systems:

Heat pumps (3 units) (Pool heating only)	1000 kW heat output (250kW electrical input)
Gas boilers (7 units) (space heating, domestic HW, & 50M pool)	1020 kW heat output (1370kW equiv. energy input) (4900MJ/hr)
Flat-panel solar hot water system – (solar thermal)	100kW approx.
Cogeneration – (since 2014) Heat for pools + electricity	100kW electrical, 140kW thermal

Energy audit in 2016

To determine the following operational aspects:

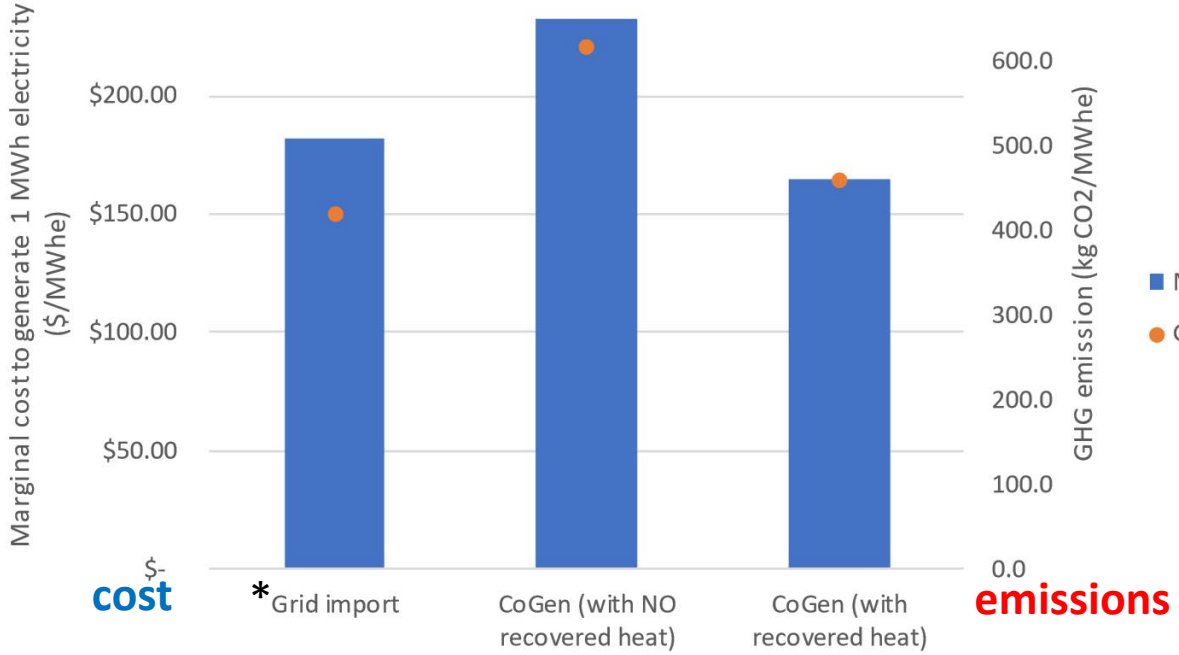
- Most cost-efficient
- Most energy efficient
- Lowest emissions path

- All while maintaining ideal user conditions – *with a very fine band of tolerance!*

- The ideal path would determine the ideal operational regime with the diverse heating equipment.

& Learnings from audit would inform the design of pool energy systems for proposed pool

Comparison of cost & emissions for electricity generation $/GJ (with Cogen system)



Note. 'marginal cost' excludes capital costs

Figure 6 - Cost of electricity from cogeneration compared to grid-import (with GreenPower)

- *50% Greenpower – was an extra 5.3 c/kWh
- Since 2016, electricity has become cheaper & cleaner
- Gas is tending to be more expensive & its fugitive emissions are not fully accounted for.

Chart source: Energy audit – Northmore Gordon

Comparison of Cost & emissions for heat generation $/GJ

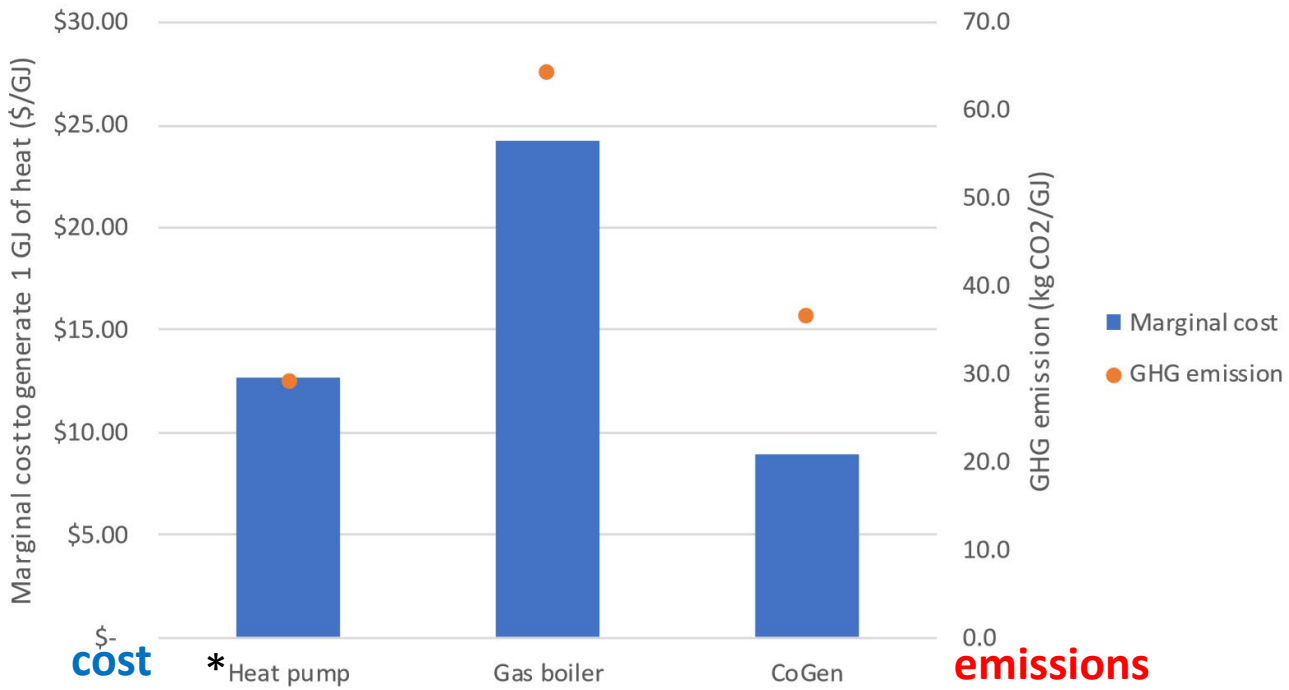


Figure 5 - Cost/benefit of generating 1 GJ of heat for the pool from the various heating systems (with GreenPower)

Note. 'marginal cost' excludes capital costs

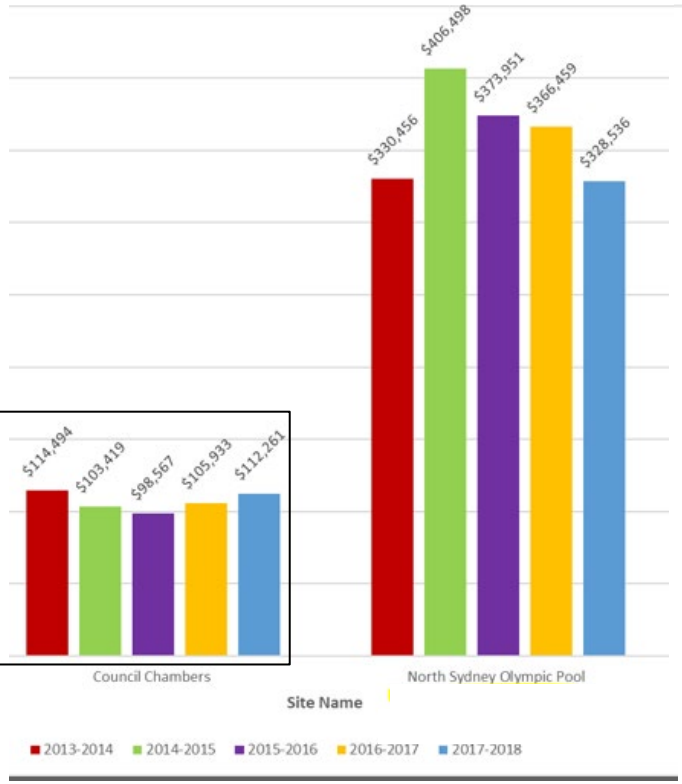
Chart source: Energy audit. – Northmore Gordon

- *Including 50% Greenpower at a cost premium of 5.3c/kWh
- (The solar HWS contribution was difficult to calculate exactly, but was the cheapest & lowest emissions, though not a major heat contributor)

Pool energy trends - pre-Cogen to 2018

- After Cogen installed, energy increased by $76,000 & 4700 GJ annually
- After audit implementation $77,000 annually & reduced energy 2300 GJ
- Net energy consumption couldn't be brought back down

Checked against another building to see if weather influenced consumption



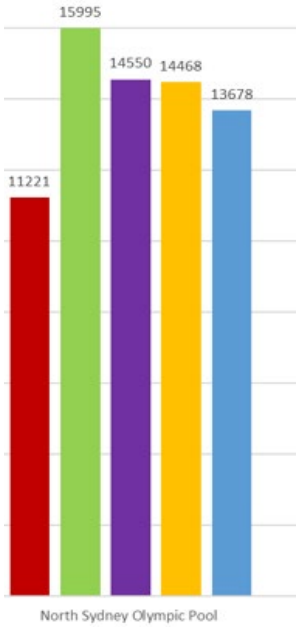


Chart source – Azility

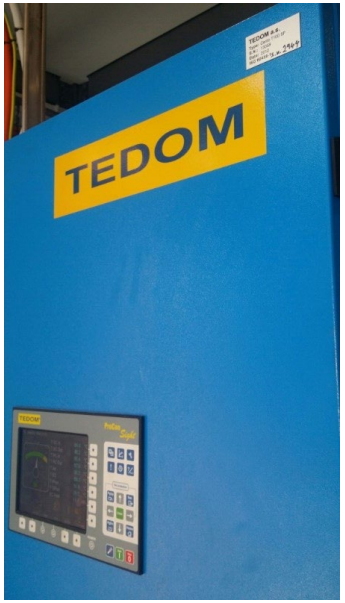
Cogen – so was it worth it ?

…Excerpt extracted from audit report on the effectiveness of the cogen

"6. Conclusion"

"At the specified electricity price, gas price, GreenPower price, and percentage of carbon abatement, and based on the current performances of the cogeneration system, if the Council turns off the cogeneration system it will generate the following savings:

- *80 ton CO2-e/year carbon emission savings*
- *$20,600/year energy cost savings*
- *4,854 GJ/year energy savings."*

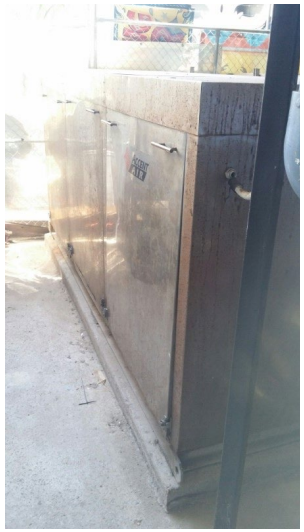


So generally, NO.

- Might have been OK for cost savings when gas was cheap-
- Gas prices started to skyrocket soon after installation
- Cogen was purchased with the assistance of a State gov't grant. *(trialing then - new tech & applications)*

Other Lessons learned

Definitely worth getting a good quality energy audit!



20y/o Heat pump

We found the following:

The ideal operational regime & heating systems to call on, in this order:

1. Solar thermal
2. Heat pumps
3. Cogen (not suitable for future pool)
4. Gas boilers (not suitable for future pool)

However, the operational regime was in reality- less straightforward…
With maintenance problems due to very old equipment
Cogen was occasionally useful for reducing demand & demand charges
But the main demand control was by load-shedding during peak periods
(the pool could be preheated before 2 & generally negligible heat loss till 8, so heat pumps were switched down by the BMS during that time. The idea was to keep the demand <250kW)

New pool setup -Based on the current specification 9/2021

Pool heating

- **3 x water source heat pumps** each 425kW output = total 1275kW
- **Solar hot water.** A new system called PVT Photovoltaic/ Thermal - *backing* panels only – (cooling PV, warm water)
  A water-filled aluminium wafer is affixed to he back of the PV panels
- **(Backup pool-water heating** - **Gas boiler** (Designed to NOT to be used at all))

Space heating & cooling

- Electric reverse-cycle air conditioning

Hot water for showers

- Q-ton MHI CO2 heat pumps

Electricity

- **Solar electricity -**120kW (initially)
- Space for ~400kWh battery storage for after PV expansion
- **Grid electricity -** 100% renewable electricity from 1/2023

Link to pool webpage

General Comments about specifications

Initial intentions were to have:

- **An ammonia heat pump** for maximum efficiency & to utilise refrigerants that had zero GWP.
  - Up-front costs prevented Council from utilising this technology. (More information & understanding around life cycle & operational costs & benefits would assist)
  - ESCs (energy savings certificates) would help!

- Bigger PV system –
  - Given it is by far the lowest cost electricity, expansion onto other roof space seems obvious as funds become available.
  - Currently insufficient PV to operate all heat pumps simultaneously during winter
  - Likely plenty for summer. (normally no outdoor pool heating required during summer)

Redevelopment of pool & -incorporating sustainability

Our experience:

- Critical for expertise in sustainability to have early input.
- Important to have engineers who are well versed in heat pump technology

The importance of operational records – they determined:

1. Cogen was not suitable for the new pool
2. Gas boilers were not suitable for future pool due to operational cost or high emissions. (only retained for risk aversion).
   - Could be removed after trial gas free operational period?
3. Heat pumps were by far the most efficient means of heating compared to gas.

Heat-pumps for showers & general hot water

- Upon request - engineers did a cost benefit on heat pumps compared to gas boilers

- Finding – **that a high-spec, high efficiency industrial quality HW heat pump would recover its cost premium in under 5 years.**

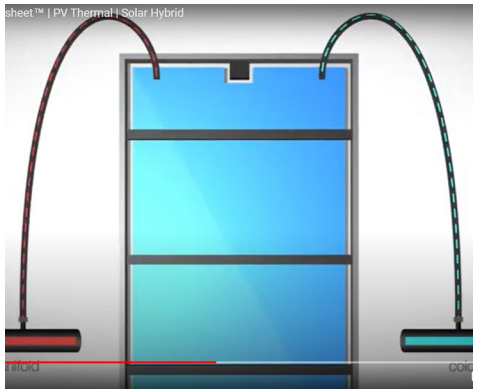
  (That was based on relatively expensive grid power. Rooftop solar around 1/3 the price of grid power)

Solar hot water?

- Roof space is better dedicated to PV than traditional hot water panels. (better economics, & electricity has multiple uses & benefits all year)

- Standard solar PV panels will be exposed directly to sun.
- Clip-on hot-water panels will be clipped to underside of PV panels
- Heat extracted for pools

- PV panels are cooled by incoming water
- PV panels have higher output when kept cool



Link to solar thermal backing panels

Overcoming the entrenched gas (& energy) thinking – -Some observations…

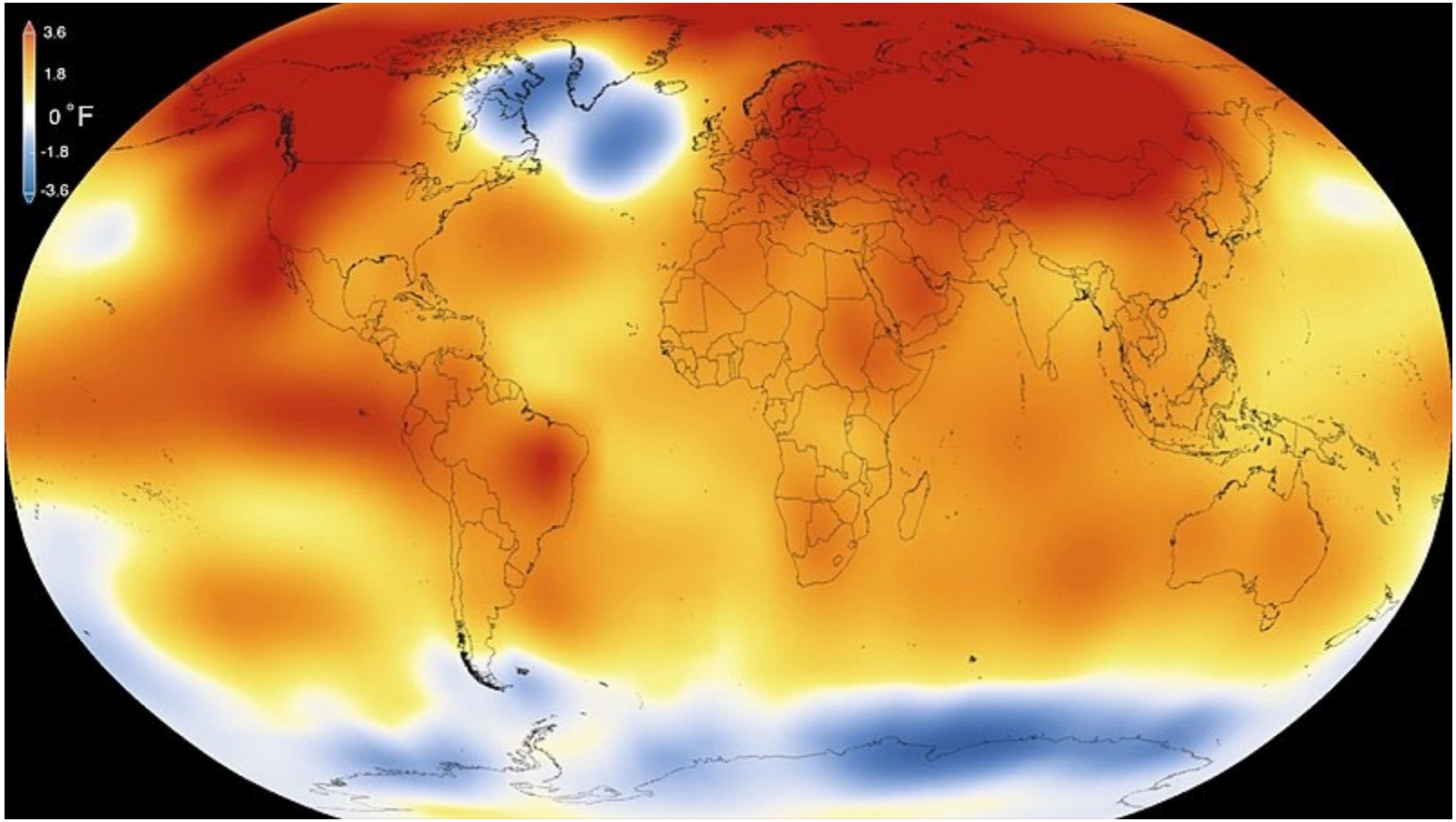
Barriers to change appear to be in the following areas-

- Many engineering, Architects & tradies still like to install gas equipment by default.

Barriers around heat pumps

- General lack of understanding the multiple benefits of going all- electric
- Up front costs of high-efficiency heat pumps – (better illustration of long-term economic benefits would be very beneficial)

- **Rooftop Solar** lack of understanding about the capacity & compelling economic benefits of electricity supply from rooftops



Ambient heat availability for heat pumps

Image credit NASA, via Wikimedia Commons

Thank you

progressive *vibrant* diverse