SUBMSSION TO THE ENQUIRY INTO RENEWABLE ENERGY INNOVATION IN THE ACT

From Canberra Solar Hot Water Repairs

For further information contact

Robert Edwards

0408 438 888

rob6star@tpg.com.au

P.O. Box 437 Curtin, ACT 2605

Contents

Foreword

Canberra Solar Hot Water Repairs, 6 Star Hot Water and Plumbing, and Canberra Hot Water Repairs undertake repairs, installations, and replacements of all types of hot water systems. We have been operating in the Canberra region since 1991. Our team comprises of plumbers, gas fitters, solar hot water and heat pump technicians and licenced electricians.
We have two service vehicles operating all year round and we attend an average of 1,100 individual job sites per year to render assistance. We tend to residential and commercial hot water installations. We also provide advice on choosing hot water systems, hot water efficiency and how to couple existing electrical resistance hot water systems to household renewable energy systems.

I was on the Technical Advisory Committee (TAC) responsible for developing Australia's first nationally recognised Vocational Education Training (VET) package for upstream of the gas meter hydrogen work. It included water electrolysis, distribution, transmission, and hydrogen storage. I am on Energy Skills Queensland's Gas Industry Working Group for hydrogen skills and the working group to determine hydrogen skills for downstream of the gas meter hydrogen work. I am the chair of Master Plumbers Australia and New Zealand's (MPANZ) Hydrogen Training Committee. I also publish the Hydrogen Skills Snapshot that covers all industries across Australia.

From my work experience and interactions with people within the natural gas and hydrogen sectors, it's clear that the ACT Government needs to do more to accurately determine whether the ACT should transition to a full electrification pathway, a full hydrogen pathway or a combination of both. The ACT Government needs to do more to determine the best path for transitioning to zero emissions.

Regardless of my involvement with hydrogen skills, I am open to all renewable energy technologies. I support the ACT Government's zero emissions target by 2045. However, I have a number of apprehensions about the ACT's current path towards zero emissions that I would like to make known and propose recommendations for each.

Part 1 - The electrification path to achieve zero emissions has not been tested

The ACT Government is signalling to the community that it favours electrification

Full electrification, including megawatt battery storage, appears to have stronger ACT Government support than decarbonising the ACT's existing gas networks. However, there is insufficient evidence at this stage to support the full electrification pathway, or whether it is possible.

The ACT Government has continually signalled its intent to phase out gas in the ACT and sends signals to the community that it is focused on the electrification pathway. But the Environment, Planning and Sustainable Development Directorate (EPSDD) has only just announced it is seeking consultants to determine the impacts of electrification on Evoenergy's electricity networks and whether the end result will be a complete shutdown of the gas networks or a transition to green hydrogen (ACT Government, 2021).

The benefits of maintaining or expanding the ACT's gas networks have not been properly considered

The benefits of maintaining the ACT's existing gas network, and the benefits of mandated gas infrastructure in new suburbs have not been properly considered in regard to transitioning to zero emissions and using the gas networks as a long life, no to low-cost battery for the storage of renewable energy.

Tests by Evoenergy in Fyshwick ACT, and similar tests by other gas network operators in Australia and overseas, to determine the compatibility between hydrogen and existing gas networks, are proving promising. The ACT's existing gas network is one of the newer and more hydrogen-compatible networks in Australia. With little modification, it has the capacity to store 32 hours of green hydrogen without additional cost of a battery to the ACT public. The ACT is connected to a much larger gas distribution network - the Eastern Gas Network. When compatibility issues are resolved, this vast network will have the capacity to store up to 96 hours of hydrogen; again, without the additional cost of a battery. The proposed 250megawatt battery has been reported to cost around $100 million and how it will be used most effectively is currently unknown (Mazengarb, 2020).

Electricity consumption will increase significantly if we transition away from gas. The lifecycle of the proposed new 100megawatt battery is unknown. We can be sure that it only has the capacity to store a small fraction of the renewable energy reserves that may be possible via the ACT's gas networks and the Eastern Gas Network.

Insufficient collaboration and coordination

There have been numerous announcements about electrification and battery storage. However, there appears to be little collaboration or coordination between EPSDD and the ACT's energy networks operator, Evoenergy. Both parties agree that we need to reach zero emissions by 2045 and both are willing to make this happen. However, it appears so far, that both parties have not come together to agree on the best way to achieve that goal.

Recommendations 1a, 1b & 1c

a) The ACT Government puts a hiatus on continuing down the electrification pathway and, in collaboration with Evoenergy, undertakes a comprehensive study to determine the full impacts on the ACT's energy networks and consumers of a full electrification pathway, a full hydrogen pathway, or a combination of both.

   i. *The CSIRO has developed an interactive tool called the H2City Tool. The H2City Tool was developed specifically for this purpose* (Australian Renewable Energy Agency, 2020)*. It will require collaboration between Evoenergy and EPSDD.*

b) The ACT Government, in collaboration with Evoenergy, undertakes a comprehensive study of the ACT's existing energy networks to determine how they can be used to their full potential to help the ACT transition to zero emissions and reduce the cost of renewable energy storage.

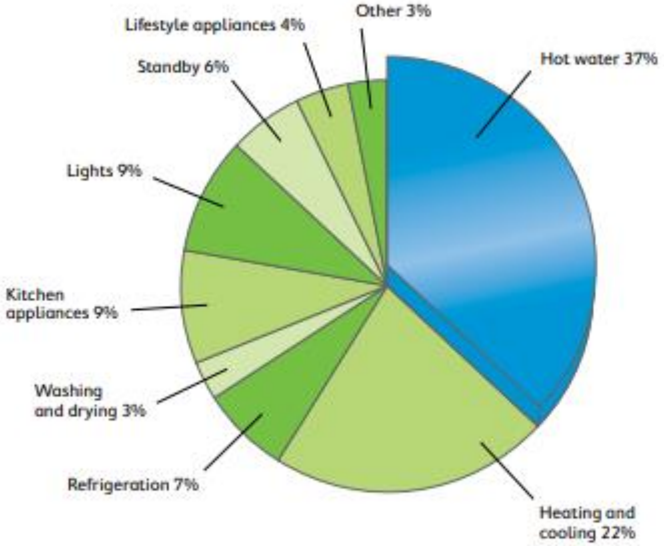
c) The ACT Government puts a pause on promoting any energy pathway towards zero emissions, until the above studies are complete.

Part 2 – Lack of viable alternatives to gas hot water systems for commercial and residential use

Heating water for showers, laundry and washing makes up approximately 37% of an average household's energy use; heating makes up another 22%*. According to one supplier (who has asked not to be named in this document) of commercial and domestic hot water systems, gas makes up 51% of their hot water heaters sold and installed in the ACT. The same supplier said, "Sales of gas continuous flow hot water systems is showing no signs of decline."

*As we (Canberra Solar Hot Water Repairs) are hot water experts and not heating experts, we cannot make further comment about heating.

Figure 1: Average household energy use



(Ausgrid, 2018)

There are many types of hot water systems and configurations. Choosing the right system and configuration is based on the volume of hot water required, peak hot water demands, frequency of use, varying temperature requirements, available energy source, available network capacity, health regulations, available space, building design, reliability, and climate.

Gas continuous flow hot water systems can consistantly produce more hot water per hour than any other type of hot water system, in any climate. This makes them popular among homeowners and they are well suited to commercial, government, public, sporting, and apartment buildings.

To date there has been no work done by EPSDD to establish the full implications of phasing out gas hot water system installations across the ACT and whether it is actually possible to do so.

A widely held view in the plumbing industry is that in the majority of commercial, government, public and apartment buildings there are no feasible alternatives to gas hot water systems. While in many detached residential buildings, it would be very difficult and expensive to replace gas hot water systems with an alternative.

The following is a small snippet of a much larger hot water picture, and why gas hot water systems are so prevalent, especially in the ACT:

Table 1: Typical hot water types by % sold in the ACT 2020 – 2021

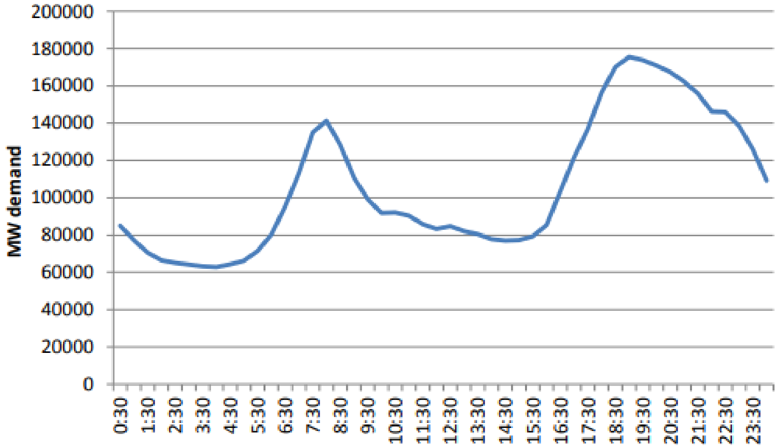
Hot Water System Type	Gas Storage	Continuous Gas Domestic & Commercial	Domestic Heat Pump	Commercial Heat Pump	Evacuated Tube Solar Hot Water	Tank on Roof Solar Hot Water	Electric Storage	Continuous 3 Phase Electric	Triple Element Electric Storage
ACT Sales 2020 -2021	12%	39%	10.8%	0.2%	0.9%	0.4%	33.5%	3%	0.2%

The figures regarding ACT sales figures in Table 1 are indicative only and were provided, under confidentiality for commercial in confidence reasons, by one of the ACT's largest plumbing retailers to domestic and commercial customers. They reflect their sales of hot water systems from April 2020 until April 2021 and may be indicative of the numbers and types of hot water systems currently installed and likely to be operational in the ACT for the next 10-20 years.

Hot water consumption patterns and weather affects peak and overall consumption of energy

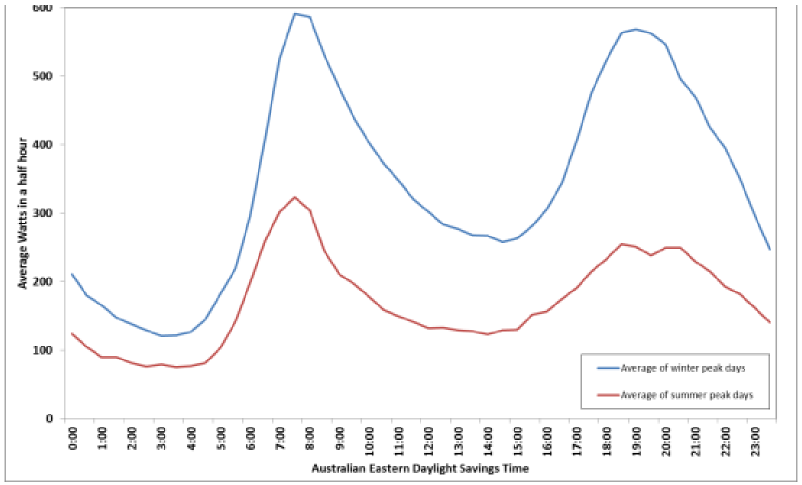
Hot water and heating influence the peaks and troughs in demand for gas and electricity on a seasonal and daily basis. This load is shared between the gas and electricity networks. Currently in the ACT, the gas network does most of the heavy lifting during periods of peak hot water usage. Figures 2, 3 & 4 shows the role that hot water plays in the energy demand cycle. Daily peaks for energy demand in the ACT, corresponds to average load profiles for hot water. Then there are seasonal changes in the demand of energy. Graph 3 shows that energy consumption increases when the temperature drops.

Figure 2: Net system load profile (electricity demand by households and small businesses) in Winter



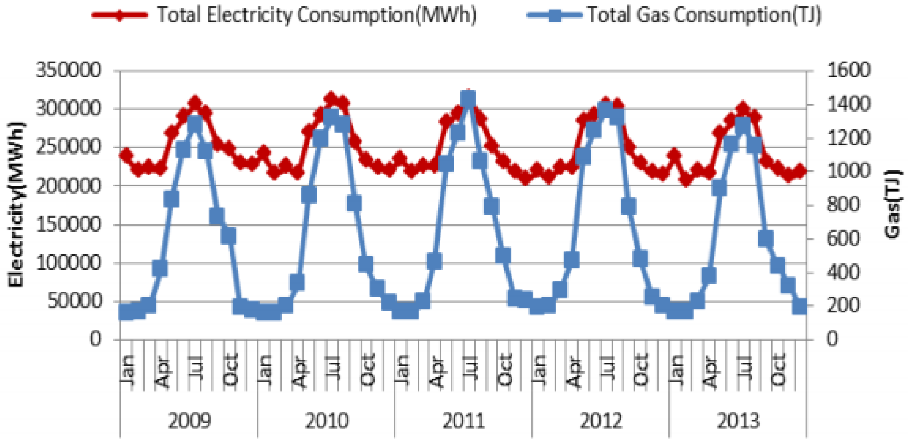
(Environment, Planning and Sustainable Development Directorate, 2015)

Figure 3: Average uncontrolled hot water load profiles



(Ausgrid Demand Management, 2016)

Figure 4: Seasonal peaks for energy demand in the ACT



(Environment, Planning and Sustainable Development Directorate, 2015)

Changing from gas will increase the height and length of peaks and overall consumption of electricty in the ACT

Table 2 below, shows the electrical power usage per hour in kilowatts and the corresponding hot water output capacity in litres across each of the most common types of hot water systems installed in the ACT. This table, combined with table 1, and figures 1, 2 and 3 above, shows how changing from gas hot water systems to electric hot water systems, including heat pump hot water systems, could significantly increase the peak load on the electricity network and overall consumption of electricty.

For example, if we compare the load of a standard domestic gas continuous flow hot water system with that of a domestic heat pump hot water system, the load applied on the the electricty network, by that system, increases by 850%. If we compare the same gas continuous flow system with an electric continous flow hot water system the load applied on the network by the electric system increases by 11,000%. With this in mind, what will be the accumalative effects on the network?

Table 2: Peak electricity load and hourly hot water capacity of all hot water heater types typically found in the ACT

Hot Water System Type	Gas Storage	Continuous Gas Domestic/ Commercial	Domestic Heat Pump	Commercial Heat Pump	Flat Panel Split	Evacuated Tube Solar Hot Water	Tank on Roof Solar Hot Water	Electric Storage	Continuous 3 Phase Electric	Triple Element Electric Storage
Peak Electricity Load kWh	0	0.1	.85	1.6	3.6	3.6	3.6	3.6	11	14.4 3 x 4.8
Hot Water Output Per Hour *	200 Residential 400 Commercial	960 1200	75	132	62	62	62	62	600	195

Numbers from manufacturers' technical specifications. May vary between brands.

*Heat pump hot water output per hour is based on a 40°C rise in water temperature and assumed air temperature of 20°C. For every 10°C drop in air temperature, hot water output from the heat pump will drop by aproximately 25%. Heat output and performance varies from manufacturer to manufacturer. These figures are indicative only. Hot water systems with an 3.6kWh electric element output are based on on a 50°C temperature rise, and cold water inlet temperatue of 14°C. Triple element systems require a temperature rise of 61°C for compliance with food standards.

Gas continuous flow to heat pump hot water system comparison

This however, is not the complete picture. Given gas continuous flow hot water systems can produce a lot of hot water quickly, consistantly, and in any climate, overall consumption of electricity is very low when compared to all other types of hot water systems – even domestic and commercial heat pumps and solar hot water systems.

Heat pump hot water systems can increase electricty consumption by 14,400% and peak loads by 1,600%-2,400%.

For example, commercial gas continous flow hot water systems can provide 1,200 litres of hot water per hour. Under similar conditions as a commercial heat pump hot water system, the commercial gas continous flow hot water system can provide 9 times the amount of hot water. Therefore, given the hourly consumption of electricity for the commercial heat pump is 16 times higher than the hourly electricity consumption of the gas continuous flow system, the overall electricty consumption of the heat pump is 14,400% higher to produce 1,200 litre of hot water.*

*Heat pump hot water output per hour is based on a 40°C rise in water temperature and assumed air temperature of 20°C. For every 10°C drop in air temperature, hot water output from the heat pump will drop by aproximately 25%. Heat output and performance varies from manufacturer to manufacturer. These figures are indicative only.

Given air temperature and water temperature's significant impact on hot water output from heat pump hot water systems, the winter peaks in demand for electricty will become wider and higher.

Gas continuous flow to solar hot water system comparison

Relying on solar hot water systems will not reduce the height of the peaks in demand for electricity and overall electricity consumption, especially in winter.

Solar hot water systems can increase electricty consumption by 18,000% and peak loads by 3,600%.

This is because in winter, solar hot water systems are just as likely to boost in the morning and evening as a standard electric hot water system. Their load will be 36 times higher than the load of a gas continous flow hot water system. When compared to a gas continuous flow hot water system, the solar hot water system's overall electricity consumption in winter is likely to be around 10,000% to 18,000% higher for the average 4 bedroom home.

There are other reasons that heat pumps and solar hot water systems should not be too-heavily relied upon when forcasting electricty network demand cycles and consumption in the ACT. These are covered in part 3 of this document.

Load shifting/off-peak. Is it compatible with heat pumps, solar, electric continous flow hot water systems, or with high hot water usage?

In domestic situations, hot water is primarily used in the mornings and evenings. Boosting at night or in the middle of the day are the most inefficient times to boost a solar hot water system. The optimum time to boost in winter is during the evenings, between 3pm and 7pm. This is achieved via a time clock installed before the booster thermostat. This configuration gives the solar hot water system the best opotunity to gain as much energy from the sun during the day as possible. If the water is not hot enough by 3pm, the thermostat will turn the booster on to lift the temperature and provide sufficent hot water in the evening when it is needed, with sufficient hot water in reserve for the next morning.

Winter nights in Canberra can be extremely cold and negative temperatures can last late into the mornings. Heat pump hot water systems rely on the ambient heat in the air that surrounds them. The colder the air, the less heat can be extracted from it, and the longer it will take to heat a given quantity of water. However, the energy consumption per hour will remain constant. For every 10°C drop in air temperture below 20°C, hot water output from the heat pump will drop by aproximately 25% to 30%. It may prove difficult to load shift for heat pump hot water systems in winter due to a lack of suffient daylight hours outside of peak electricity demand periods. Heat pumps combined with load shifting, are incompatible with high usage or prolonged demand in most circumstances.

Electric continous flow hot water systems cannot be load shifted but standard electric storage hot water systems are suitable for load shifting. Tanks suitable for load shifting are large and cannot be retrofitted in many existing residential apartments, because of limited space. Standard electric storage hot water systems are not suitable for high usage or prolonged hot water demand, and require approximately 18 hours, using 64kW of electricity, to produce the same amount of hot water as a gas continuous flow hot water system could produce in one hour, using 0.1kW of electricity. This is an increase in consumption of electricity of 64,000%.

Why space limitations, hot water output capacity and temperature requirements govern choice

Gas continuous flow hot water systems take up little room and can provide large quantities of hot water for both very short and very long periods. Heat pump, solar and electric continuous flow hot water systems cannot do the work of gas continuous flow hot water systems. This is particularly the case for many commercial, government and apartment buildings across the ACT.

When installed in manifold packs, gas continuous flow hot water systems are also ideal for providing large amounts of hot water during periods of peak demand and prolonged hot water demand.

Figure 5: Typical multi-storey apartment block hot water system

(Rinnai, 2020)

At present there are no comparable alternatives to manifolded commercial gas storage and gas continuous flow hot water systems. If there was, the amount of electricity each would consume would be in the hundreds of kilowatts per hour.

Tables 3 and 4 below, show the difference in the peak flow rates and temperatures of the largest electric and gas continuous flow hot water systems. The gas system easily outperforms the electric system for hot water output and temperature.

Table 3: Peak flow and temperature for the largest continuous flow electric hot water systems

Temperature Rise (415 volt)	DHE 18 AU	DHE 27 AU
6L/min	+46°C	-
8L/min	+34°C	+52°C
10L/min	+27°C	+41°C
12L/min	+23°C	+34°C
14L/min	+19°C	+29°C

Table 4: Peak flow and temperature for the largest gas continuous flow hot water system

Models (Pre-set Temperatures ≥ 60°C)	Temp Rise (°C)	85				
	Approx. Min/Max Gas Input (MJ/hour)	L/sec	L/min	L/hr	Min Water Pressure (kPa)	Approx. Gas Consumption (MJ/h)
Rinnai HD250E (REU-V3232WC)	21-250	0.16	9.6	576	29	250

Electric continuous flow hot water systems cannot be load shifted via. In many cases it would not be possible to replace the commercial gas continuous flow systems with heat pumps or solar hot water systems. Where it would be possible, the costs would be in the tens of thousands, if not, hundreds of thousands of dollars for alterations to plumbing and electrical systems, and it would require major alterations to the buildings that house them.

Few electric hot water systems are compatible with Food Standards Australia New Zealand (FSANZ) recommendations

A change away from gas hot water will significantly impact the hospitality industry. Food Standards Australia New Zealand (2016) says, “For manual sanitation using hot water, a minimum temperature of 77°C for at least 30 seconds (as per US Food Code 2013) or equivalent is recommended.”

Given the ACT has average cold inlet water temperatures of 14°C, it is unlikely that continuous flow electric and heat pump hot water systems will be suitable for use where food preparation takes place. The maximum output for electric continuous flow is +52°C of incoming water temperature at 8 litres per minute whereas, a gas continuous flow is +85°C at 9.6 litres per minute. The temperature setting of the Quantum Titan Commercial heat pump is 60°C.

Triple element electric storage hot water systems for commercial purposes are available for high water temperature requirements. The hourly electricity consumption is 14,400 watts. This is significantly higher than the 100 watts required by gas continuous flow hot water systems used for similar purposes.

As previously stated, the calculations and figures above are indicative only and show that more work needs to be done to determine the precise impacts on converting away from gas hot water systems. There has been no work done by EPSDD to establish the impacts of phasing out all gas hot water system installations across the ACT and whether it is even possible.

Recommendations 2a, 2b, 2c & 2d

a) EPSDD to undertake an audit of commercial, government, public and apartment buildings, and single residential dwellings to better understand the existing numbers and types of hot water systems that are installed across the ACT. The audit should also determine what purposes the hot water is used for in commercial, government and public buildings.

b) EPSDD to model impacts of full electrification of hot water systems on electricity peak demand loads and total consumption of electricity across the ACT.

c) EPSDD to model conversion costs to owners with gas hot water systems if the full electrification pathway is adopted.

d) EPSDD to determine what impact load shifting, for the production of hot water, will have on renewable electricity storage.

Part 3 – Over-reliance on heat pumps and solar hot water systems to reduce emissions

Our 30 years of servicing and installing all types of hot water systems in the ACT suggests that supporters of the electrification pathway have placed too much faith in heat pumps, solar hot water systems and load shifting, to help meet current energy reduction targets in the ACT.

Manufacturers' stated hot water efficiencies versus actual efficiencies

There are as many types of hot water systems as there are factors that influence a hot water system's lifespan, stated efficiency and a hot water system's suitability for a particular installation. The expected lifespan and efficiencies of all hot water systems are based on best-case scenarios of proper installation techniques, water quality, optimal location and conditions, hot water demand, new system, regular servicing, and climate. Change any of these conditions and the stated efficiencies and output can drop dramatically - no more so than with heat pump and solar hot water systems.

The ACT suburbs of Coombs and Macgregor are prime examples of the widespread failures and steady decline in the efficiency of solar hot water systems.

Figure 6: Example of split copper heat pipe in solar

Figure 7: Another example of split copper in solar

From 2019 until present there has been an increasing number of failed heat pipes in evacuated tube solar hot water systems that were installed post 2014. When heat pipes fail, little or no solar hot water is produced. Hot is provided by the electric booster

The DUX Airoheat and Rheem heat pumps that were installed in huge numbers throughout the ACT from 2010 to 2013 are another example of low energy hot water systems that often do not meet their stated efficiencies.

How installation requirements for heat pump hot water systems affect efficiency

Heat pump hot water systems rely on the ambient heat and airflow around them. The most efficient location for heat pump installations in Canberra are on north or north-west facing walls with good airflow. However, for various reasons, these aspects are not achievable in more than 50% of cases.

Installing heat pump hot water systems in Canberra in the optimum location is not always possible. Many have been installed in locations that severely compromise the manufacturer's stated efficiencies.

Homeowners usually do not want their hot water systems installed near primary outdoor living spaces, so they are commonly found tucked down the side of the house, out of the way. Issues arise because of the narrow spaces and overshadowing between residential dwellings. In newer suburbs with smaller blocks, this dramatically restricts airflow. Additionally, finding suitable locations for the efficient operation of heat pumps is not always possible due to real and perceived noise pollution.

Bad heat pump and solar hot water system installations will affect demand for electricity

When boosting, a solar hot water system requires 3,600 watts of power. This is 30 times more than the amount of power required, when it is working correctly as a solar hot water system and the booster is not active.

We visit many homes where the solar hot water systems have been improperly installed and most, if not all, heat is derived from the electric or gas booster. This is because many installers simply do not understand what mistakes they have made or what they can do to improve the efficiency and longevity of the system.

There are many installation practices than can be adopted that would increase solar and heat pump efficiency. Providing a proper handover to the client, where they are instructed on how to conduct periodic checks and how to use the booster is rarely done. Simple things like installing time clocks on electric boosters and setting them correctly can dramatically increase the efficiency of electric-boosted solar hot water systems.

Ownership of heat pumps and solar hot water systems affects demand for electricity

What happens with a heat pump or solar hot water system after installation is just as critical to their efficient operation as the installation. The manufacturer's stated efficiencies can decline rapidly, even for those systems that have been installed correctly.

Solar hot water systems are not set-and-forget. Most homeowners are oblivious to the operation of their solar hot water system and in many cases the booster switch is never turned off.

Across the ACT, we have found that the majority of hot water is provided by the electric booster because it is left on all day and night. These same homeowners do not realise that their electric booster is operating at the same time the sun is shining on the collectors.

When the solar collector stops working because of a breakdown, the booster will continue to provide hot water. Therefore, solar hot water systems will operate as electric hot water systems for many years while the homeowner remains oblivious as they are still getting hot water. It is only when the booster stops working that they realise they have an issue with the solar hot water system.

Frequent breakdowns of solar hot water systems will affect demand for electricity

Because of the higher repair costs of solar hot water systems and continued breakdowns, we are regularly asked to convert solar hot water systems back to continuous tariff electric hot water systems. Our experience shows breakdowns of solar and heat pump hot water systems is 2 to 3 times more likely than for gas and electric storage hot water systems. The suburbs of Macgregor and Coombs in the ACT are again, good examples of this.

When the solar components breakdown, many systems rely solely on electric boosting for hot water. When electric boosting, a solar hot water system requires 3,600 watts of power. This is 3,000% the amount of power required when it is working correctly as a solar hot water system.

Recommendations 3a & 3b

a) EPSDD to undertake audit to determine how many heat pump and solar hot water systems are working at their stated efficiencies and what impacts these and future heat pump and solar hot water system installations will have on the electricity network; and forecasted peak demand and overall consumption of electricity.

    i) *Coombs, Wright, and Macgregor would be the best suburbs to conduct such an audit, as these suburbs have the highest concentration of heat pump and solar hot water systems in the ACT. One of our technicians can advise on how to test the hot water systems during the audit.*

b) EPSDD to determine if an awareness campaign for households with solar hot water systems is required to reduce the effects of boosting on peak loads and consumption of electricity.

Part 4 - Higher financial and social costs for residential consumers

Typically, heat pump and solar hot water systems have high capital costs, high maintenance costs and lower life expectancies when compared to other types of hot water systems. They rarely meet their manufacturer's stated efficiencies.

Table 5: Capital and operational expenditure of common hot water systems in the ACT

Hot Water System Type	CAPEX Like for Like Changeover ($100)	5 - Year Servicing Cost ($100)	Avg Services Over Lifetime of System	Avg Breakdowns Over Lifetime	Breakdown ($100)	Typical Time Before Conversion Back to Standard Electric (Years)	Typical Life Expectancy (Years)	Annualised Cost Over Lifetime ($) *
Conventional Electric Storage	20	5	3	2	4	0	20	215
Conventional Gas Storage	24	3.5	3	2.88	4	0	20	230
Gas Continuous Flow	20	2.2	2	1.2	2	0	12	223
Airoheat Heat Pump	40	3.5	1	3	5	2.5	5	1170
Other Heat Pump Hot Water	40	3.5	2	2.16	5	0	15	385
Evacuated Tube Solar Hot Water	85	5.5	2	3.3	14	10	11	1293
Roof-mounted Tank Solar Hot Water	70	11.1	4	3.75	5	0	25	533
Flat Panel Tank on Ground	75	5.5	1	2.7	7	8	9	1104
3 Phase Electric Continuous Flow	20	2.2	1	1	2	0	7	346

*Gas appliances are rarely serviced every 12 months as recommended by manufacturers. A typical annual service of a gas hot water system would cost $200.00

Costs of changeover: Gas continuous flow to electric continuous flow hot water systems

Approximately 30 - 39% of ACT homes have gas continuous flow hot water systems, mainly because of limited space, high hot water demand or long distances between wet areas.

Gas continuous flow hot water systems typically use less than 0.1kW of electricity when in operation. Electric continuous flow hot water systems require 11kW of electricity and typically deliver lower temperatures and flow rates (Stiebel Eltron, 2020).

The replacement of a gas continuous flow hot water system with an electric continuous flow hot water system will require the installation of a 415volt power supply. Most existing homes in the ACT are only connected to the electricity network via a 240volt power supply. The cost to provide suitable wiring from the pole to the meter and from the meter to an electrical continuous flow hot water system would likely be many times more than the cost of the hot water system installation itself.

Upgrading wiring to existing buildings and the internal wiring would be extremely expensive if possible, at all. The ACT Government may have to consider subsidies.

Cost of changeover: Gas to heat pumps and solar hot water

Unlike solar photovoltaic (solar PV), the cost of heat pumps and solar hot water systems has increased year on year. The capital cost for heat pumps and solar hot water systems is between 200% to 400% of gas and electric systems of similar hot water output, used for residential purposes.

Our experience in the hot water business suggests being forced to convert from gas or standard electric to solar or heat pump hot water systems will impact medium to low-income households significantly. And it is more likely they will be forced to purchase inferior solar and heat pump hot water systems or inefficient electric hot water systems.

Higher costs for servicing and repairing solar hot water systems

The general servicing costs of a solar hot water system is 2 to 3 times higher than the servicing costs of a standard electric hot water system. The general servicing costs for heat pump hot water systems is similar to gas storage hot water systems. Repair costs for heat pump hot water systems are 1.25 times higher than for standard electric hot water systems.

Unfortunately, with solar hot water systems, a breakdown in one component usually causes a domino effect of breakdowns in other components. For example, a faulty roof sensor can lead to a frozen and split manifold. Therefore, repair costs on average for solar hot water systems, are 4 times the cost of breakdowns of standard electric hot water systems. Additionally, breakdowns of solar hot water systems (excluding tank-on-roof solar hot water systems) are frequent and common across entire suburbs. Macgregor and Coombs in the ACT for examples. Many homeowners in these suburbs have disconnected their solar collectors because of the high cost of repairs and frequency of breakdowns. They are now relying on their gas or electric booster to provide all their hot water.

When damaged by weather events, solar experts are unable to replace just the damaged component. For example, Hills was a popular brand of evacuated tube solar hot water systems. They were installed in the ACT from 2009, until the local distributor went out of business in 2011. New spare parts for these systems are no longer available. Therefore, for warranty purposes, if only the collector manifold was damaged, complete systems including tanks and control stations need to be removed and replaced with completely new systems.

I believe forcing ACT residents to switch to continuous flow electric, heat pump, and solar hot water systems will place a huge financial burden on many ACT households. My experience suggests many households simply will not be able to afford the cost of the changeovers. The government may choose to subsidise the cost of the changeover for these households. However, if the government does not also subsidise the additional ongoing costs, many households may revert back to standard electric hot water systems or go without hot water.

Recommendations 4a & 4b

a) ACT Government to consider all financial and social implications for all ACT consumers if the full electrification pathway is chosen.

b) ACT Government to consider how weather events will impact ACT households in regard to solar hot water installations, if the full electrification pathway is chosen.

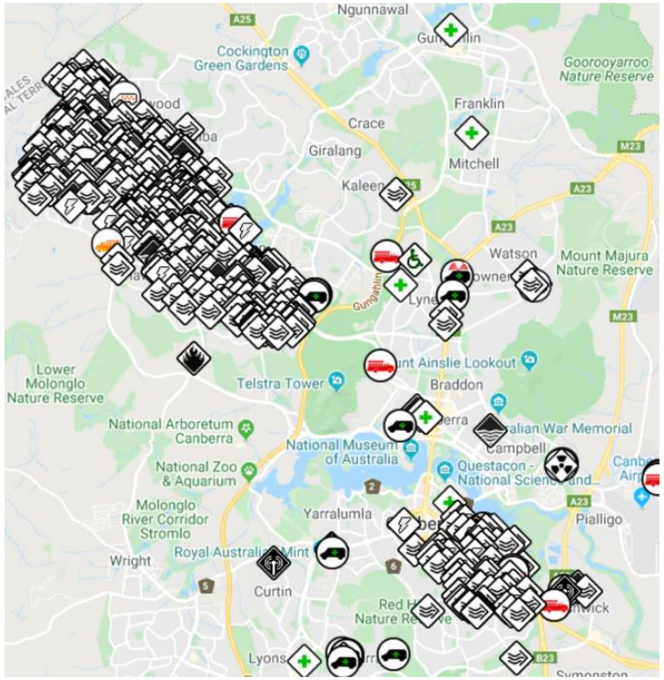
Part 5 - Extreme weather events and their effects on solar hot water systems in the Canberra region

Based on the repair work Canberra Solar Hot Water Repairs is hired to perform, we have found that solar hot water systems particularly, are very vulnerable to extreme weather events. This impacts their efficiency and longevity.

The January 2020 hailstorm that hit Canberra destroyed a significant number of evacuated tube solar hot water systems. While we cannot provide exact numbers, we can confidently say it was well over 300 systems and possibly even 500. The cost for repairs averaged $4,500.00 per system and many are still broken as homeowners have either still not realised or were uninsured.

Figure 8: Evacuated tubes damaged by Canberra's January

Figure 9: 2020 hailstorm map



(ABC News, 2020)

On the 23rd of July 2018, the temperature in Canberra dropped to -8°C. By 11am we stopped taking calls. We later counted over 100 phone calls for assistance for burst solar hot water manifolds. We cannot provide exact numbers for damaged systems across the ACT that day, but again, it was likely in the hundreds.

Excessive heat in summer also causes damage to solar hot water systems – particularly evacuated tube solar hot water systems. Excessive heat damages roof sensors, joints, heat tubes, pumps, and valves. This reduces the life and efficiency of the solar hot water system.

When damaged by weather events we cannot just replace the damaged component. For example, Hills was a popular brand of evacuated tube solar hot water system, installed in the ACT from 2009, until the local distributor went of business in 2011. New spare parts for these systems are no longer available. Therefore, for warranty purposes, if only the collector manifold was damaged, complete systems including tanks and control stations had to be removed and thrown away and replaced with completely new systems.

Recommendation 5

EPSDD to be made aware that climate change will impact on the performance and longevity of solar hot water systems when forecasting demand cycles and consumption of electricity in the ACT and the impacts on the community.

Part 6 – Lack of skilled and knowledgeable heat pump and solar hot water technicians

Skills and knowledge shortage's impact on heat pump and solar hot water system efficiency

Even though solar hot water installations are taught at the Canberra Institute of Technology (CIT), there is a lack of plumbers in Canberra who are capable or willing to undertake solar hot water installations and repairs. This is because of the financial risks associated with a misdiagnosis during repairs, as solar hot water systems are very time-consuming to install, and it is easy to make mistakes during the installation process.

We visit many homes where the solar hot water systems have been improperly installed, and most if not all, heat is derived from the electric or gas booster. This is because many installers simply do not understand what mistakes they have made or what they can do to improve the efficiency and longevity of the system.

There are many installation practices than can be adopted that would increase solar and heat pump efficiency. Providing a proper handover to the client, where they are instructed on how to conduct periodic checks and how to use the booster is rarely done. Simple things like installing time clocks on electric boosters and setting the time clocks correctly can dramatically increase the efficiency of electric-boosted solar hot water systems.

Requirement for additional skills and knowledge for renewable energy storage

Combining conventional electric storage hot water systems with rooftop solar PV systems can create a cheap mechanism for energy storage. A conventional hot water system can provide the equivalent of 4.5kW up to 14.4kW of electrical storage. This option is rarely ever given to homeowners as an alternative to solar hot water heaters, heat pumps or conventional battery storage.

Recommendations 6a, 6b & 6c

a) MPA, CIT and EPSDD to work together to develop Continuing Professional Development (CPD) for heat pump and solar hot water installations.

b) MPA and EPSDD to determine if a special licence category for plumbers to undertake solar hot water heater and heat pump installations is required in the ACT.

c) MPA and CIT to work together to develop courses to increase skills and knowledge for using electric storage hot water systems as renewable energy storage systems.

Summary

While achieving zero emissions before 2045 through the reduction in use of natural gas is preferable; given the current high concentration of gas hot water systems in the ACT, the changes required will be significant and expensive. The OPEX and CAPEX cost to commercial and residential consumers will be higher for the hot water they use than they are today. Moving away from gas hot water systems will change the peaks in demand for electricity and overall consumption of electricity too. Whether the electricity networks and planned battery storage can cope remains unknown. Until the required studies are completed, the question remains: is electrification the right pathway, and have we put enough consideration into how a transition that includes gas, could help achieve zero emissions sooner, while at the same time, providing cheaper and more efficient storage capacity for renewable energy?

Bibliography

ABC News. (2020, January 20). *Hail storm sweeps through Canberra, damaging countless cars and smashing windows*. Retrieved from ABC News: https://www.abc.net.au/news/2020-01-20/hail-storm-in-canberra-damages-cars-smashes-windows/11882472

ACT Government. (2021, April 1). *Display GS0306076*. Retrieved from Tenders ACT: https://www.tenders.act.gov.au/tender/view?id=231538

Ausgrid. (2018). *Hot Water*. Retrieved from Ausgrid: https://www.ausgrid.com.au/-/media/Documents/energy-use/Hot-water-guide.pdf

Ausgrid Demand Management. (2016, August). Retrieved from Ausgrid: https://www.ausgrid.com.au/-/media/Documents/Demand-Mgmt/DMIA-research/Ausgrid-Hot-Water-DMIA-Projects-Final-Report.pdf

Australian Renewable Energy Agency. (2020, July 10). *Hydrogen Communities & H2City Tool*. Retrieved from Australian Renewable Energy Agency: https://arena.gov.au/knowledge-bank/hydrogen-communities/

Environment, Planning and Sustainable Development Directorate. (2015, March 31). Retrieved from Electricity and Natural Gas Consumption Trends in the Australian Capital Territory 2009-2013: https://www.environment.act.gov.au/__data/assets/pdf_file/0006/711699/Electricity-and-Natural-Gas-Consumption-Trends-in-the-Australian-Capital....pdf

Food Standards Australia New Zealand. (2016, November). *Standard 3.2.3 Food Premises and Equipment.* Retrieved from Food Standards Australia New Zealand: https://www.foodstandards.gov.au/publications/Documents/Safe%20Food%20Australia/STANDARD%203.2.3%20Food%20Premises%20and%20Equipment.pdf

Mazengarb, M. (2020, September 8). *ACT secures two big batteries for Canberra and record low price for wind*. Retrieved from Renew Economy: https://reneweconomy.com.au/act-secures-two-big-batteries-for-canberra-and-record-low-price-for-wind-27676/

Quantum. (2021). *340L Solar Heat Pump*. Retrieved from Quantum: https://www.quantumenergy.com.au/product/340l-solar-heat-pump/

Rinnai. (2017, August). *Commercial Hot Water.* Retrieved from Rinnai: https://www.rinnai.com.au/wp-content/uploads/2017/09/Commercial_Reference_Guide.pdf

Rinnai. (2020, January 13). *Infinity 26*. Retrieved from Rinnai: https://www.rinnai.com.au/online/hot-water/continuous-flow-hot-water/infinity/infinity-26/#product-information

Stiebel Eltron. (2020, February). *Data Sheet*. Retrieved from Stiebel Eltron: https://www.stiebel-eltron.com.au/dhe-au-instantaneous-3-phase-water-heater#downloads