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LUMEN

Aged care and retirement living

New technology opportunities for demand reduction

EECA

DECARBONISATION PATHWAY

AGED CARE AND RETIREMENT LIVING

Table of Contents

1. Introduction

The Aged Care sector has a variety of energy end-uses which are required to maintain a comfortable and consistent environment for residents. Significant end-uses include space heating and cooling, domestic hot water systems, and climate control of indoor swimming pools.

There are several technology opportunities identified in this document, which have been implemented either in New Zealand or overseas, with the ability to reduce the energy demand and carbon emissions of the end-uses.

While some of the technologies included in this document are not “new” per se, they are not currently widely utilised within the sector, so have been included here to provide operators of existing facilities with some “alternative” options to consider.

2. Swimming pools

Swimming pools are a major energy consumer for any Aged Care facility. They require regular heating of not only the water in the pool itself, but also heating of the air in the space. The air must be controlled so that it is warm enough and humid enough to prevent excessive evaporation and cooling of the pool water.

2.1 Reducing swimming pool energy usage

There are several ways to reduce the energy usage of heated indoor swimming pools by the adaptation of control systems and minor CAPEX improvements. Some of the key opportunities are listed below [1]:

1. Reduce pool water temperature set point
2. Increase relative humidity set point (indoor pools only)
3. Optimise filter backwashing
4. Insulate pipework
5. Increase pool hall air temperature (indoor pool only)
6. Use pool covers overnight – reduces energy loss by 50%–70%
7. Insulate pool walls
8. Don’t over-cool or over-heat the space - room temperatures should be set to 24-25°C in summer and 18-20°C in winter

Indoor pools attribute 70% of their energy losses to evaporation and 27% to ventilation [2]. So, as mentioned previously, maintaining appropriate air temperature and humidity relative to pool settings is vital.

2.2 Heat pump pool heaters

An alternative to conventional gas pool heaters are heat pump pool heaters which are powered by electricity. Heat pumps generally cost twice as much as an equivalent gas heater but due to significant energy efficiency differences, heat pumps may be worth the investment. Heat pumps can have COPs of around 4 (400% efficient) while gas heaters are usually around 75% efficient and up to 95%. This means heat pumps can be up to 5x more efficient than gas heaters or use 80% less energy.

2.3 Opportunity Summary

Table 1: Heat pump pool heaters opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX reduction
Up to 80% less energy consumption than conventional gas heaters	Up to 88% less emissions than conventional gas heaters	2x an equivalent gas heater	Up to 80% less in pool heating energy costs

3. Ozone use in laundry

Ozone can be used in laundry to dramatically decrease hot water requirements in washes (over 90%) [3]. This also allows ozone systems to run shorter cycles as they do not need to wait for water to heat up while the ozone also speeds up the work done by detergents.

3.1 Energy Savings

Christeyns has developed a Rapid-O system which can replace a 60°C normal wash with a 15°C wash taking just over half the time (65 mins vs 35 mins). Each cycle uses 0.925kWh as opposed to 5-8kWh for the normal 60°C wash [4].

A case study of an EcoTex ozone system implemented at a 104-room hotel in the US that averages 20 loads of laundry a day showed a decrease in hot water usage by 85% and an electricity consumption reduction of 30% [5].

3.2 Investment & Operation

ELS, a New Zealand laundry solution supplier, recommends only investing in Ozone for facilities which service +50 beds as each system costs between $20,000 to $40,000, inclusive of install costs. Ozone becomes more affordable for larger laundry systems with a 50kg capacity unit costing approximately $25,000 (i.e., $500/kg of capacity) and a 200kg capacity unit costing approximately $35,000 (i.e., $175/kg of capacity), inclusive of install costs. They also expect systems to last approximately 10 years under an annual maintenance schedule [6].

3.3 Ozone characteristics

While there have been concerns in the past regarding odours, at the correct doses, Ozone should not smell foul but rather leave washing with a pleasant clean fragrance. It also effectively eliminates odours from faeces and urine [6].

Ozone may also reduce drying times which is understood to be a result of Ozone opening the fabric fibres more than conventional laundry systems [7].

3.4 Opportunity Summary

Table 2: Ozone use in laundry opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX
30%-88% of washing cycle energy	30%-88% of washing cycle energy	$175-$500 per kg of washing capacity	30%-88% reduction

4. Cool roofs & green (vegetation) roofs

Cool roofs and green roofs can drastically reduce the cooling required by a building compared to conventional roofs. Aged Care facilities are likely to have significant roof areas which can result in a 10°C temperature difference inside depending on what type of roof is installed [8].

4.1 Cool roofs

Cool roofs are roofs with a light colour and/or reflective coating which reflects heat energy from the sun reducing the heat gain of the building. White roofing products stay coolest in the sun, reflecting over 60% of sunlight compared to 10-20% on a traditional asphalt roof [9]. Cool roofing products usually cost no more than comparable conventional roofing products – meaning a required roof upgrade/replacement may as well include a cool roof coating.

Benefits of cool roofs include decreasing air conditioning energy consumption (up to 15% less), making it possible to downsize new or replacement air conditioning equipment as well as decreasing roof temperature, which may extend roof service life. Furthermore, by reducing surface temperatures, cool roofs can boost the efficiency of solar installations by up to 16% [10].

Cool roofs may only be appropriate in the warmer parts of NZ with a CAPEX of <0.1% of the relevant building's value and a less than 5-year payback [11].

4.2 Green roofs

Green roofs are cooled primarily by the evaporation of water from plant surfaces rather than by reflection of sunlight. The soil layer also provides additional insulation as well as thermal mass. While green roofs provide vibrant natural looks, if not carefully designed, the roofs are susceptible to leaks which are also much more challenging to find and difficult to repair compared to standard roofs [9]. This may result in extensive OPEX costs and so, green roofs are primarily recommended for new builds which can be suitably constructed to handle a green roof.

Beyond energy savings, studies on green roofs have demonstrated a positive impact on resident health and comfort. They improve air quality and remove carbon emissions from the atmosphere due to the sequestration ability of the vegetation. They also aid with stormwater management [12].

Green roofs fall just short of cool roofs with an ability to reduce HVAC energy consumption by around 12% [13]. However, this study was performed in Boston, so warmer regions of New Zealand may experience greater energy savings. Green roofs are generally significantly more expensive than cool roof coatings at a CAPEX of <0.5% of the building, this results in long paybacks of +20 years.

4.3 Opportunity Summary

Table 3: Cool roofs opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX
Up to 15% reduction in HVAC energy consumption	Up to 15% reduction in HVAC energy emissions	<0.1% of the building’s value (same cost as conventional roof coatings)	Saves up to 15% of HVAC energy costs

Table 4: Green roofs opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX
Up to 12% reduction in HVAC energy consumption	Up to 12% reduction in HVAC energy emissions	<0.5% of the building value	May result in significant OPEX when installed on older buildings but can save up to 12% of HVAC energy costs in new builds

5. Heat recovery from shower water

A significant wastewater stream in the Aged Care sector comes from the use of showers. This wastewater enters the shower drain at upwards of 25°C meaning it has a potential to transfer a substantial amount of heat energy to the cold incoming water stream. This can be achieved by using a heat exchanger situated right after the wastewater enters the drain and which is also connected to the cold-water inlet just before it reaches the shower (Figure 1).

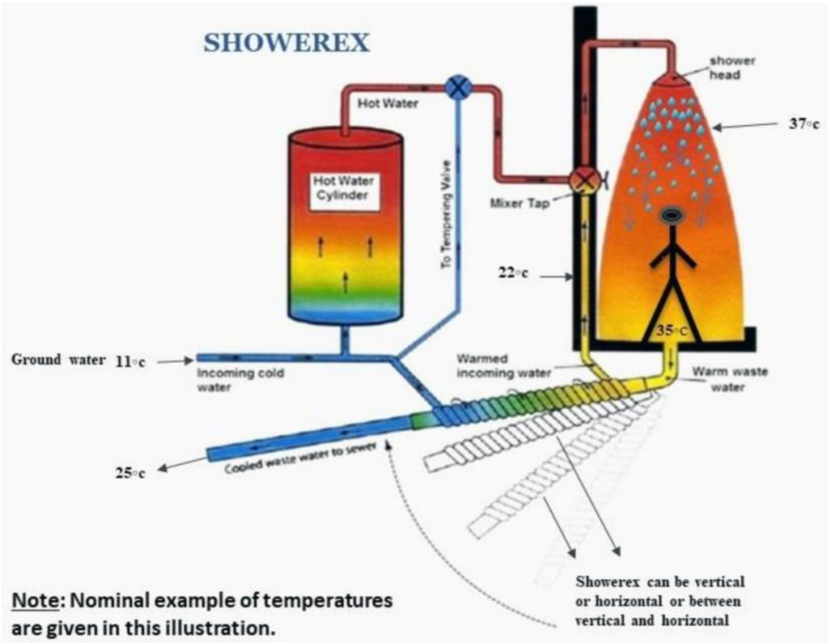

Figure 1: Illustration of heat exchanger transferring heat from shower wastewater to cold inlet water [30]

These heat exchangers are typically around 60% efficient, meaning they convert 60% of the potential energy in the wastewater back into the incoming cold water [14]. This efficiency will vary depending on the orientation of the device as shown above. The feasibility of this opportunity depends on the location of water tempering valve (either near the shower or a centralised location). There must also be adequate room available to install the heat exchanger, which may particularly be an issue in retrofitting projects. New builds are likely more suitable for this opportunity as it can be incorporated into the design and wouldn't require the significant building works (penetration, painting, rerouting) that a retrofit would.

5.1 Showerex Energy Saver

Located in Napier, Vaportec have developed a heat exchanger specifically for regaining heat from shower wastewater. It comes in two sizes, 900mm and 1400mm at individual order prices of $658.00 and $736.00, respectively. Using Vaportec's calculator, it can be seen that installing a single Showerex unit on a 10L/min shower (1,120 kWhpa), will save between 310-499 kWhpa per shower (28%-44%).

5.1.1 Aged Care Example

A theoretical, newly built, Aged Care facility with 50 showers (each with a 1,400mm heat exchanger installed) and averaging 1.5 washes per shower per day, was entered into the calculator. This resulted in an estimated 37,500 kWhpa energy savings, which if powered by natural gas, lead to an emission saving of 7,840 kg CO_2-e and an annual cost saving of $2,430 (assuming a gas rate of $18/GJ).

Assuming no discount in unit price, the total cost would be $36,800 plus installation costs.

5.1.2 Installation & Operation

Due to the simple design, these units can generally be installed anywhere an equivalent size PVC pipe would be installed and have the same basic maintenance requirements (e.g., drain cleaning). They are also not limited to showers but may be suitable for basins with high usage as well as any other high temperature high usage wastewater stream.

There are a variety of factors which impact the energy savings from these heat exchangers (including orientation, flow rate, and flooring material). The floor of the shower has the greatest impact on the losses between shower output water and heat transfer – as such, consideration should be given to using a surface with low heat conductivity (e.g., porcelain over stainless steel [15]).

To reduce costs, there are opportunities to utilise one heat exchanger for multiple showers. This is limited by the maximum flow rate tolerable by each unit as well as requiring the showers to be nearby to limit transportation losses. Otago University has shown this is possible by successfully installing and operating one heat exchanger for every two showers for 16 of their new showers [16].

5.2 Opportunity Summary

Due to the varying nature of how showers are utilised in the Aged Care sector - depending on the levels of aged care beds, serviced apartment and independent living units, the opportunity has been summarised on a per shower basis. Table 5 shows the energy savings per shower per year from the various sizes of heat exchangers available.

Table 5: Heat recovery from shower water opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	Unit Price	Install Cost	Annual OPEX
28%-44% per shower	28%-44%per shower	$660-$740 per unit	Site dependent	28%-44%per shower

As mentioned previously, having multiple showers connected to the same heat exchanger would improve energy savings while minimising CAPEX costs.

6. Point of use water heating

Point of use (POU) water heating is an alternative solution to centralised hot water storage. It is beneficial for instances where multiple bathrooms and other fixtures are spread out resulting in significant hot water transport losses. They also only heat the water at the time it is used and thus, are not prone to supplying more hot water than is required compared to what might occur in an oversized hot water storage tank.

Furthermore, it can simplify plumbing requirements as only a cold-water line is necessary. This may be advantageous especially in retrofits where piping may not be easily accessible.

6.1 Three-phase vs single phase

Point of use water heating in generally split into two categories: three-phase and single-phase. Three-phase units are more powerful and can often generate enough hot water for a whole bathroom, whereas single-phase units are usually installed to service an individual end use (most commonly a sink or basin).

Both types are around 99% efficient which is 12% greater than a conventional electric storage heater [17]. Point of use heaters are often more expensive per kW ($1,000 for a single-phase unit and $2,000 for a three-phase unit) but lower energy and operating costs make up for this [18].

6.2 Comparison to centralised hot water heating

Beyond what has already been mentioned, POU heating has several other benefits over a centralised hot water storage system, such as:

- POU systems have a longer life expectancy (20 years vs 10-15 years) [19].
- POU systems have lower operating costs [19].
- Eliminates the possibility of a leaking or burst water tank.
- Less piping required due to only needing a cold-water line
- More controllable localised hot water temperature control.

However, there are some constraints to using POU water heating as well:

- Having to install multiple individual units may be significantly more expensive and time-consuming than installing one large hot water storage tank.
- Layout design and selection of appropriate units per application may become time-consuming.
- Significantly higher electrical demand if all POU showers are used at the same time. Storage units provide opportunity to install a small size heater that works for longer period such that the stored water can be used without increasing the electrical demand.
- Likely to attract significantly higher network charges as hot water consumption by residents usually occurs at a similar time – increasing site peak demand.

6.3 Opportunity Summary

Assuming POU heaters would be used instead of conventional electric hot water tanks, then a 12% energy and carbon reduction can be expected. Depending on the application will determine whether a three-phase heater or one or more single-phase heaters are required, and this dictates the CAPEX as shown in Table 6.

Table 6: Point of use water heating opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	Unit Price	Install Cost	Annual OPEX
12% energy reduction for hot water end use	12% emission reduction for hot water end use	$1,000-$2,000 per unit	Site dependant	May attract increased network charges which could cancel out energy cost savings

7. Low-emissivity coatings & solar films

Managing heat transfer through windows is very impactful to maintaining comfortable space temperature and reducing the strain on HVAC systems. Low-emissivity coatings are a possible inexpensive way to approach this as they aim to minimise heat losses from indoors when it is colder outside but also reduce the excessive heat gain during summer. Solar films more specifically target reducing heat gain from the sun as well as lessening glare and providing UV protection.

Figure 2: Low-E coating operational demonstration [31]

7.1 Low-emissivity coatings

Low-emissivity (Low-E) coatings single glazing has been considered as being a cost-effective alternative to double-glazing. However, as it cannot be sealed off from atmosphere on a single pane, it very quickly diminishes in performance, usually only lasting one year [20]. Single-glazed Low E glass does not provide the thermal performance or comfort and condensation control provided by double-glazing and is not recommended in cold climates or high humidity areas. As such, the preferred approach is to combine Low-E with double-glazing with the ability to seal the coated side of the glass within the unit [21].

Single-glazed Low-E coatings can still provide a substantial reduction in reducing heat loss through glazing by 38% (4% total energy savings [22] [23]). But standard double glazing (12mm space, air-filled), has a thermal performance improvement of 54% [24]. Adding the two technologies in conjunction, results in even further improvement.

There may be a niche opportunity for single-glazed Low-E coatings where a thermal performance improvement is required at low cost and potentially as a temporary stopgap for a superior solution.

7.2 Solar films

Solar films aim to reduce heat from the sun from entering through windows. As such, they can decrease the cooling load of the building saving energy on the HVAC system. In some instances, installation of solar films can result in:

- 79% heat rejection
- 30% savings of the heat loss through glazing (about 3% total energy savings [22] [23])
- 99% UV protection
- 95% glare reduction [25]

A case study shows that the installation of solar film on a visitor centre's windows in Victoria, Australia reduced electricity consumption by 6,300 kWhpa ($2,900 pa) which resulted in a payback of 1.5 years [26]. These results may not quite be achievable in New Zealand's climate but can show that solar films may be an inexpensive way of reducing heat gain from the sun.

7.3 Opportunity Summary

While Low-E coatings on single-glazing may only be appropriate in niche cases, having them in conjunction with double-glazing results in considerable energy savings. However, in most instances, traditional double glazing is sufficient for New Zealand climates.

Solar films may be more suitable as not only do they significantly reduce solar heat gain but also improve comfort levels through minimising glare and heat spots. CAPEX for a solar film installation is generally <0.3% of the building value and usually has a payback of less than 10 years [11].

Table 7: Low-E coating on single-glazing opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX
4% of total energy use	4%	<0.3% of the building's value	4% reduction but may require annual replacement

Table 8: Solar films opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX
3% of total energy use	3%	<0.3% of the building's value	3% reduction

8. Induction cooking

Induction cooking involves the induction of electric currents directly into the cookware on the stove. The electric currents heat the cookware almost instantly and with very little energy loss to the surroundings which reduces load on HVAC. Induction cooking is approximately 50% more energy efficient than a comparable gas system [27].

Electrical cooking equipment is typically cheaper and easier to install, since it often involves just putting a plug into a socket, though some equipment may exceed standard socket current ratings. This is better than having to install a gas line [28]. Additionally, by going electric, there can be positive health impacts by reducing exposure to gas leaks and combustion fumes.

However, a complete overhaul may be expensive, or the added electrical load may result in increased network charges. In which case, replacing low efficiency gas equipment with high efficiency alternatives can be a simpler solution and still deliver significant energy and carbon savings. A case study of a single piece of gas equipment replacement run by FSTC saw an annual carbon reduction of 6 tonnes per year at a hotel and 11 tonnes per year at a grocery store [29].

8.1 Opportunity Summary

Table 9: Induction cooking opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	CAPEX	Annual OPEX
50% reduction from gas equivalent	69% reduction from gas equivalent	Generally cheaper than gas equivalent	Increase in network charges may outweigh energy cost savings

9. Electric commercial dryers

Electric dryers have been developed to a point where they can replace equivalent gas dryers without any hinderance to the operator. An electric unit will cost only slightly more, for example a 37kg gas dryer may cost $7,000, while a 37kg electric dryer costs $7,500 [6].

There is also negligible difference in drying time, which was concern with older electric dryers. But their main drawback is still significant current requirements. A 37kg unit will need around 60A to operate which may require upgrading existing switchboards to increase capacity [6]. If laundry is a significant portion of the site's energy consumption, it may also increase network charges when switching to electric. For new sites, it is generally easier to install greater electrical capacity than it is to install new gas lines.

9.1 Opportunity Summary

Table 10: Electric commercial dryers opportunity summary

Annual Energy Reduction	Annual Emissions Reduction	Unit Price	Install Cost	Annual OPEX
Equal to gas dryer equivalent	38% reduction (electricity vs natural gas)	$7,500 (for 37kg unit)	Site dependent	Network charges may increase

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