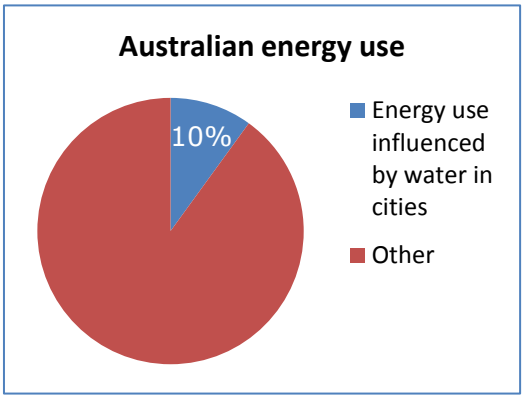
Water-energy-carbon links in households and cities: a new paradigm – Newsletter 2015

a: Background

There is presently little understanding of the inter-relationship between water, energy and carbon in households and cities. At a time when water, energy and carbon each present their own challenges as our population continues to grow, we believe that increasing our knowledge of the inter-relationship will provide major opportunities to improve the efficiency of homes and cities.

WSAA indicates that energy consumption for urban water supplies is expected to grow to around 250% of 2007 levels by 2030. Energy expenditure for urban water are also anticipated to rise around 500-700% over the coming 25 years. The use of energy that is influenced by water in Australian cities is substantial, accounting for some 13% of Australia's electricity use and 18% of Australia's natural gas use: collectively nearly 10% of Australia's total primary energy use is influenced by urban water management. Most of the effect occurs with heating of water in households and industry.



This is the second Newsletter for a multi-partner project focussed on understanding and finding solutions to the challenge of the growing energy dependence and cost of urban water systems in Australia. Outputs from this project are available via the Smart Water Fund Knowledge Hub.

b: Project activity update

Objective 1: To understand water and energy connections in individual households

We have assessed five households in detail using surveys, interviews and high resolution water and energy metering. This information has been used to construct a detailed Material Flow Analysis Model of each house as well as to understand how each household performs. See Household Summary Reports.

Objective 2 & 3: To characterise "household types' to understand district-scale water-related energy use and greenhouse gas emissions

We have compiled key data for a sub-area of Melbourne (the postcode "Reservoir") into a geo-database in order to model district-scale water and related energy use. Electricity and natural gas usage records are currently being incorporated to enable validation of modelled results.

Objective 4: Identify opportunities to reduce water-related energy

Preliminary opportunities to reduce water-related energy have been shortlisted. New shower technologies including recirculating showers have been reviewed and the potential evaluated. The final project workshop is intended to help further develop these options at the scale of individual households as well as district-scale solutions.

c: What have we uncovered so far?

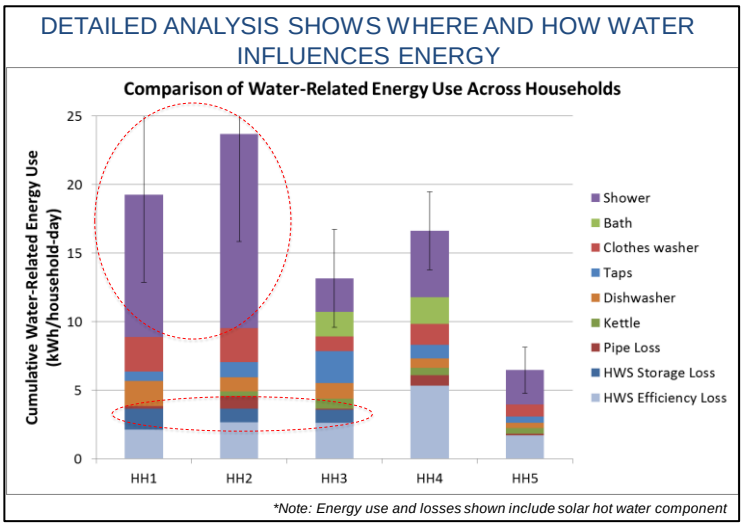
For household consumers

Our research has shown that up to half of household energy use is water-related. The biggest influences are in showers, efficiency losses, and clothes-washers. Small changes to water management can have a surprisingly large impact on energy use for the household consumer. For example, in certain households a 10% reduction in the frequency, duration, or flow-rate of water for showers reduced household energy use by approximately 0.5 and 1.0 kWh/hh.d kWh/hh.d. This is approximately equal to one percent of the total household energy use as Melbourne households typically use some 13 kWh and 45kWh per day for electricity and gas respectively A 10% increase in the temperature of cold water may have a similar effect. Over an entire year, in 2013, the household could potentially save $100 if they have electric hot water heaters.

"10% shorter showers could save households $100 per year if using electric hot water heaters"

Early findings indicate that water-related energy usage ranges from 5–20 kWh/hh.d (kilowatt hour per household per day). For perspective, 10 kWh is equivalent to 37 efficient (11-watt) light bulbs operating for an entire day. The range of usage between individual households can vary dramatically and may be indicative of different technology in the household or associated behaviour patterns.

DETAILED ANALYSIS SHOWS WHERE AND HOW WATER INFLUENCES ENERGY



*Note: Energy use and losses shown include solar hot water component

"15-50% of total household energy use is water related"

Full household reports and analysis reports are available on the project webpage.

For Energy Utilities

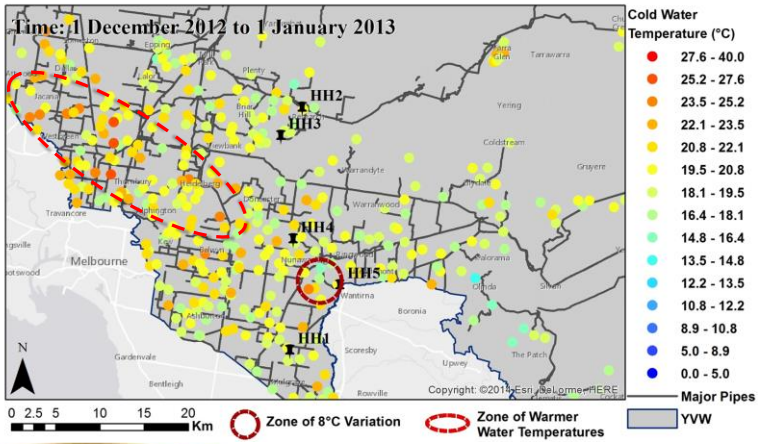
Involvement from the energy sector is relatively recent. Preliminary discussions suggest that a range of potential benefits from the project could include (i) improved forecasting of energy demand (ii) strategies for combined asset efficiency. International experience suggests that a strengthened relationship across the water-energy sectors, for example in combined retail services provision, could enable consumers with integrated water and energy utilities.

For Water Utilities

Water asset design and management practices could achieve different energy outcomes for cities. For example, variation in the temperature of water delivered in Melbourne now is influencing household energy costs differently in different regions. The household model indicated water temperature from the mains is a key factor affecting water-related energy use and cost in households. A review of water temperature in Melbourne's Water's supply network indicates significant variations in water temperature within relatively short distances, by as much as 8ºC. In the five households studied this difference in temperature translates into 2.5-5 kWh/hh.d energy use for heating impact for this group of houses or 4-15% of the total energy use of the households studied (refer to map below).

Temperature of water in the supply network has significant impact on household energy

The water utility of the future may be providing not only water at certain water quality but at specified temperatures to meet their customer needs. For example, commercial customers may want either cooler or warmer water based on their processes, if they understand the impact this has on their energy bill. Some utilities are already investigating how to provide such services for the benefits of their industrial and/or residential customers. For more details see report on Water Temperature in Melbourne and Implications for Household Energy Use.



For Appliance Manufacturers

With the appreciation above on water temperature and its impact on household energy use, appliance manufacturers should explore 'ecofriendly' cycles on washing machines and dishwashers and/or setting hot water system thermostats at cooler temperatures. Similarly, ensuring appliances can connect to both hot and cold water sources can help reduce costs for consumers – e.g. ensuring clothes-washers and dishwashers can connect to hot water from renewable sources (such as solar or heat pump) using a hot water inlet to the appliance (rather than having only a cold water inlet) then this can help maximise use of renewable energy, reduce demand for electricity, and often reduce greenhouse gas emissions and operating costs. To do this, appliances need a hot-water inlet (as well as the normal cold water inlet). This is also relevant for appliance manufacturers. The detailed maps and characterisation of cold water temperature could also be used to size solar hot water systems more accurately.

"Ensuring appliances can connect to hot water from renewable sources can help reduce appliance operating costs."

The project is exploring emerging technologies and appliance trends, which reduce both water and energy use. These include recirculating showers which rapidly treat and recirculate warm water. A report on this will be available by December 2015.

d: Information Gaps

The district-scale model and geodatabase are now ready for exploring scenarios as a means to understand and compare impacts. We are seeking guidance currently across all sectors on investigation priorities between now and **December 2015** when this project finishes. The scenarios in consideration:

Scenarios	Why?
High efficiency & emerging appliances vs current	During the millennium drought, where households were incentivised to convert to water-efficient fixtures. The model can quantify the water reduction and associated energy impacts. With emerging trends on appliances, what is the potential impact on energy, water use, greenhouse gas emissions and costs? Have some water efficiency measures led to increases in greenhouse gas emissions, for example by diverting water heating in clothes-washers to electricity within the machine, rather than drawing on hot water from gas, solar or heat-pump systems? This can occur if the clothes washer has only a cold water inlet, and cannot accept hot water into the machine.
Manipulation of delivered water temperatures	Small changes in delivered water temperature could lead to substantial impacts on household (and/or industry) energy use. A key to success of such options would be locating area where cooler, as well as warmer water were required.
Solar Hot Water Service vs Rain water Tanks	Victorian building policy currently requires new developments to either install Solar hot water heaters or rainwater tanks. Rainwater tanks are the lowest cost option for developers and households. But is it the best in the long term and in relation to energy and water use? Does this policy "problem-shift" between water and energy, and are alternatives available that enable efficiency for water and energy simultaneously?
Integrated water cycle planning and energy implications	Integrated water cycle planning is now required in many areas and local stormwater harvesting and re-use is a strong component of this. Is this also a minimum energy use scenario for the water utilities in relation to pumping and distribution of water? More widely, how can integrated water cycle, and energy planning combine to enable water and energy efficiency at local government and precinct scales?
District Heating and Cooling vs individual systems	All water consumers in Australia typically install and maintain individual hot water services. Across many European countries, waste heat from energy generation is being captured to provide centralised hot water services. Could this be a cost-effective solution in Melbourne too, for example in higher-density developments?

Stakeholder Workshop

A stakeholder workshop was conducted on 12th May 2015 to communicate progress, support identification of system leverage points and input to scenario design including building towards city/district-scale scenarios to achieve least-cost management of water-related energy consumption in cities

In summary the workshop identified over sixty suggested actions to progress improved management of water-related energy across (a) a range of scales including: Technologies, buildings, consumer demand management, districts, water and energy utilities, State and Federal government, and (b) a range of "system intervention points" including (i) constants/parameters, (ii) information flows (iii) system rules and (iv) system goal and paradigm mindset.
Six areas of higher impact-to-effort ratio were identified including:

- Integrated water and energy metering
- Improved connection of water and energy efficiency labelling and assessment;
- Setting State-wide water and greenhouse gas emissions targets.
- Targeting water and energy programs to benefits (by customer type)
- Further consideration of Water and Energy utility operation mission statements and goals.

For full workshop outcomes, see http://clearwater.asn.au/resource-library/smart-water-fund-projects/water-energy-carbon-links-in-households-and-cities-a-new-paradigm.php For more information on the project please contact Steven Kenway (s.kenway@uq.edu.au. 0419 9794 68).