Insights from Smart Water Meters

Potential to mitigate impact of heatwaves on peak demands

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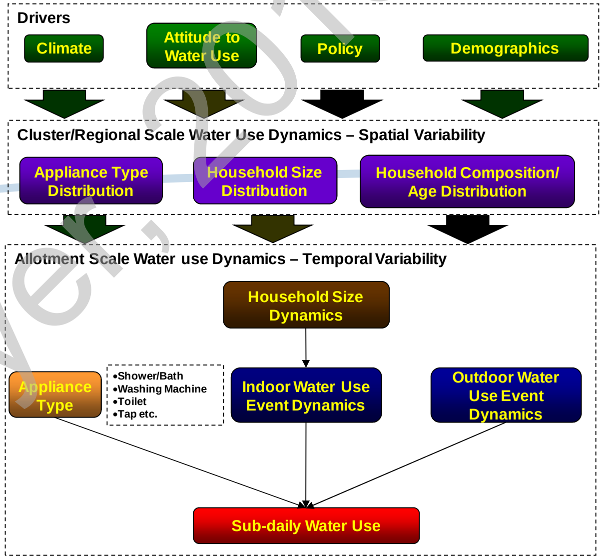
GOYDER INSTITUTE FOR WATER RESEARCH · THE UNIVERSITY of ADELAIDE · CSIRO · Government of South Australia · SA Water

Background



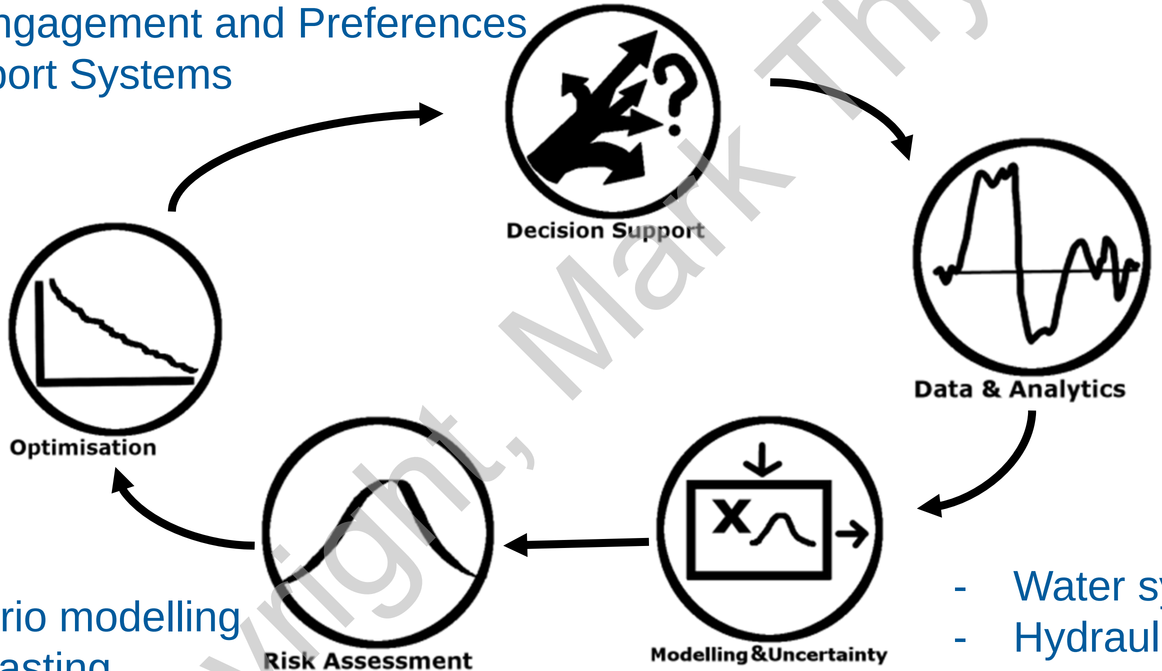
- University of Newcastle (2004-2010)
- Leader: Behavioural End-Use Model (BESS)
  - Predict end-uses range of temporal and spatial scales
  - eWater CRC
  - Used Australia-wide, as part of Urban Developer
  - Integrated Urban Water Management
- University of Adelaide (since 2010)
- Leader: Understanding and Predicting Household Water Use for Adelaide
  - Goyder Institute Project "Optimal Water Resource Mix" (2013/14)
  - Smart meters on 150 houses and household characteristics
  - 3-4 year subdaily continuous water use data
  - Insights on Drivers of Indoor and Outdoor Water Use
- Intelligent Water Decisions research group: School of Civil & Env. Eng
- Australian Smart Cities Consortium: University-wide initiative
  - www.adelaide.edu.au/smart-cities/

Intelligent Water Decisions Research Group

- Key Capabilities

www.waterdecisions.org

- Options Analysis
- Community Engagement and Preferences
- Decision Support Systems



- Smart sensors
- Pipe network monitoring
- Citizen Science
- Data analytics

- Multi-objective optimisation

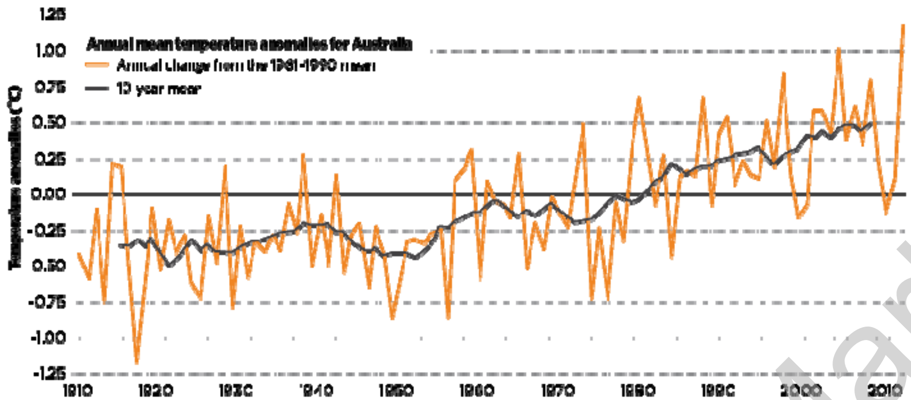
- Water systems modelling
- Hydraulic network modelling
- Statistical modelling for uncertainty/risk

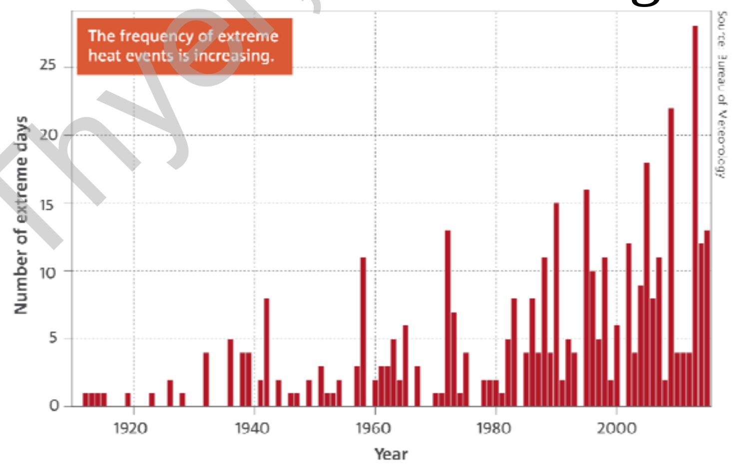
- Climate scenario modelling
- Weather forecasting
- System risks (e.g. droughts)
- Pipe condition assessment

- Water supplies optimised for cost, resilience, reliability, environmental impacts and community benefits

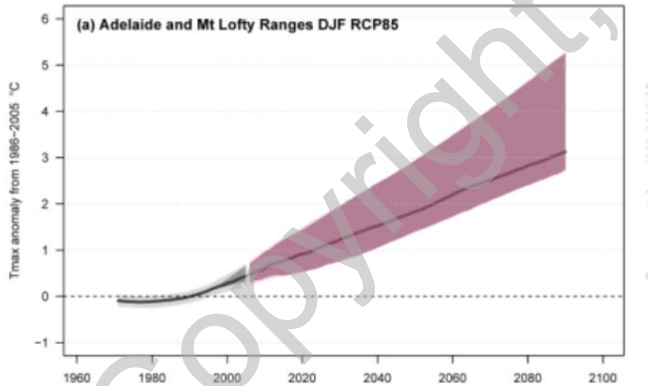
Motivation: Climate change will increase temperature and heatwaves

- Historical: Avg Temp and Extreme heat events increasing





- Future: Project to further increase in the future



Expected changes in summer max. temp for Adelaide (Charles and Fu, 2015)

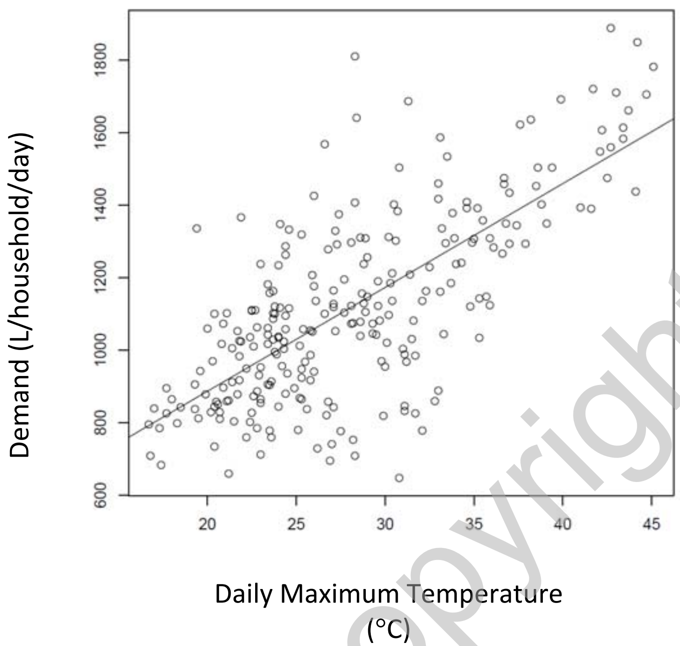
- What will be impact on peak demands?

Charles, S. P. and Fu, G. (2015) *Statistically Downscaled Climate Change Projections for South Australia*, Adelaide, South Australia: CSIRO.

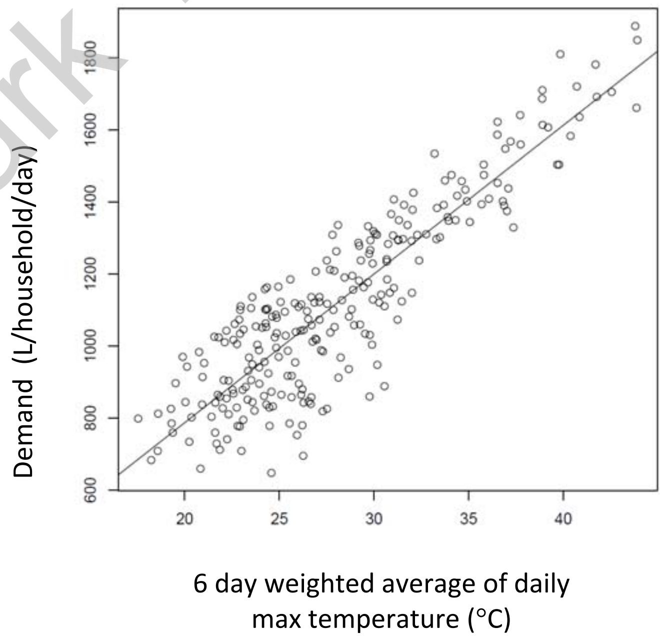
Heatwaves are a major driver of peak demand

- Demand within Adelaide Metro area
- Months of December to February on a daily time-step

Single-Day Temperature
(r^2=0.52)

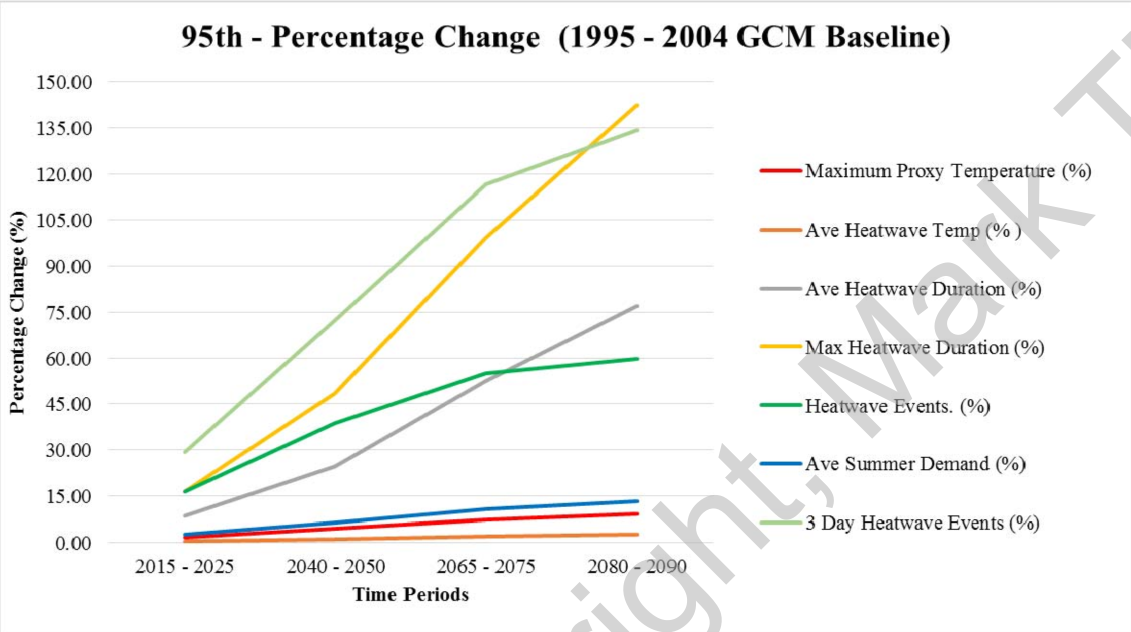


Multi-Day Temperature
(r^2=0.79)



Multi-day heatwaves explain up to 80% of the variability in peak demand

Peak demands likely to increase because climate change will increase heatwave duration



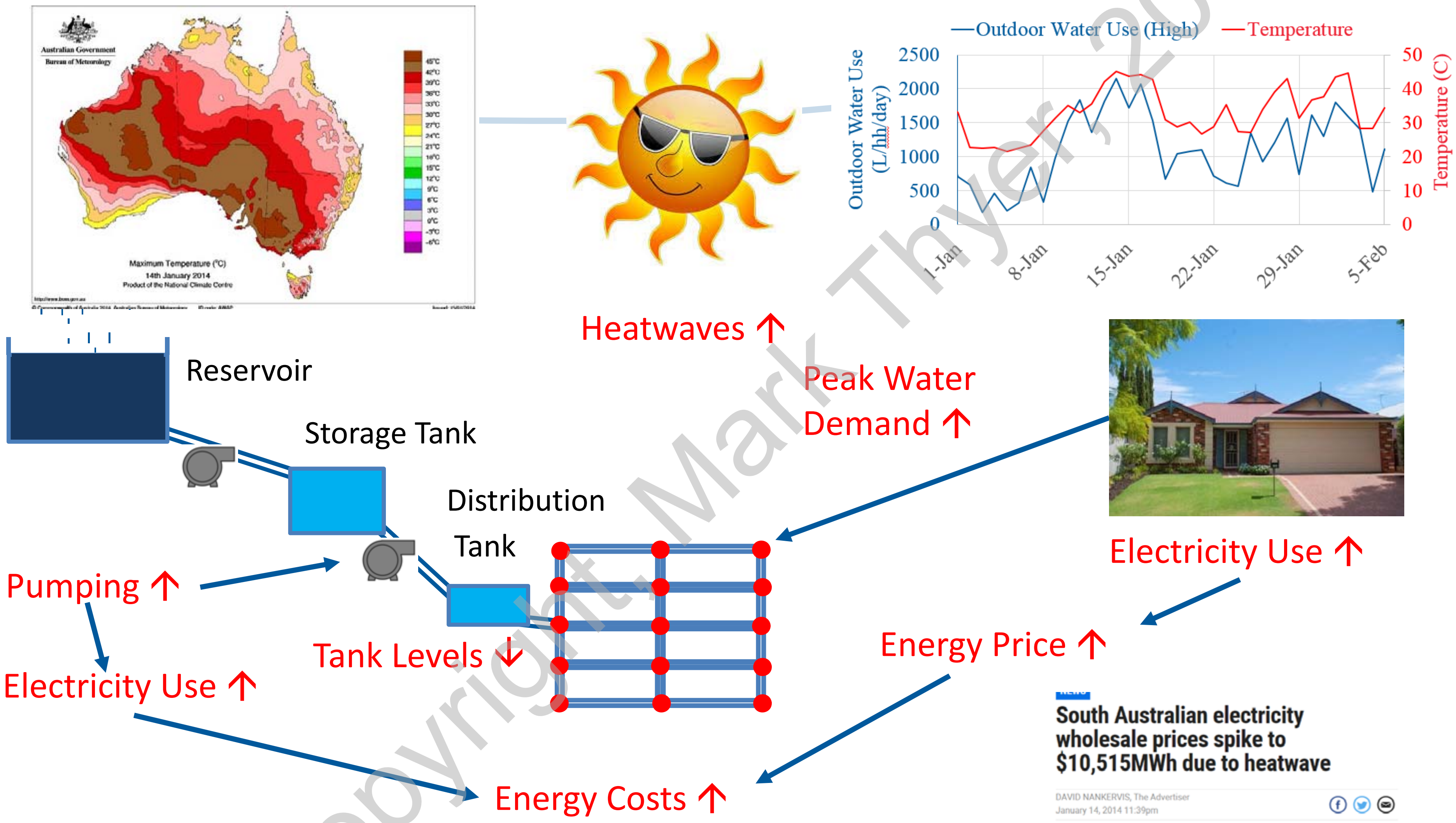
2040 Projections:

- 25% increase in average heatwave duration
- 49% increase in max heatwave duration
- 39% increase in heatwave frequency
- 10% increase in avg. summer demand

Future Climate projections from *Goyder Institute for Water Research, Climate Change Project*

Challenges: How will this impact on water distributions systems?

Compounding Impact of Heatwaves



Challenge: Potential for significant increases in energy/infrastructure costs and as heatwaves increase in freq./dur.

Opportunity: Can we reduce peak demands?

NEWS

South Australian electricity wholesale prices spike to $10,515MWh due to heatwave

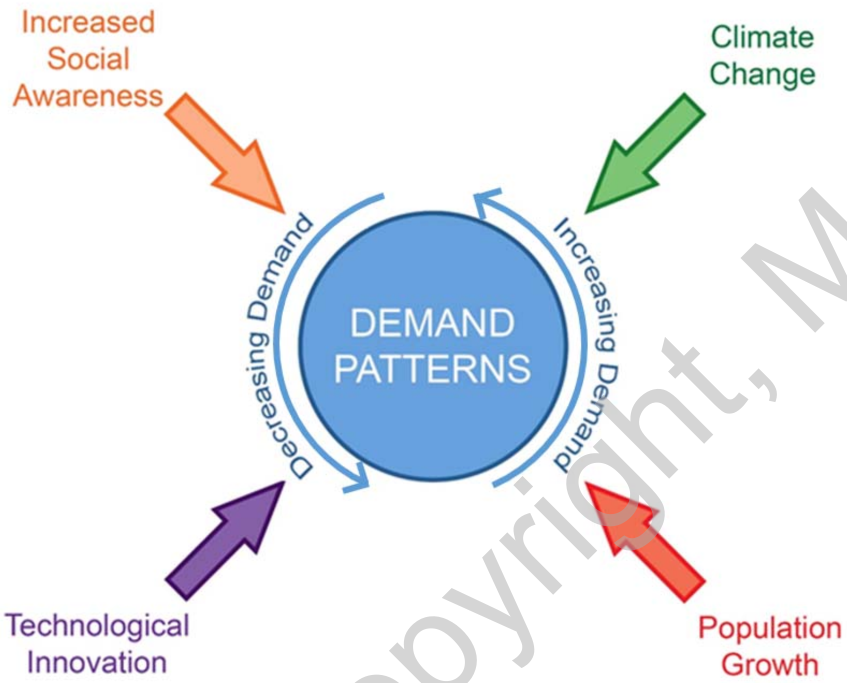
DAVID NANKERVIS, The Advertiser
January 14, 2014 11:39pm

ELECTRICITY prices hit a massive $10,515/MWh on the wholesale energy market on Tuesday, but householders are urged to continue using their airconditioners despite the prospect of higher summer power bills driven by the heatwave.

While state wholesale "spot prices" for electricity have a long term average around $70/MWh, the prices soared briefly beyond $10,000/MWh at 1pm and again around $5000/MWh at 2pm before falling back to less than $1600/MWh.

The enormous spike, which is not expected to be reflected in household electricity bills, was blamed on "high energy demand driven by high temperatures", the Australian Energy Market Operator said.

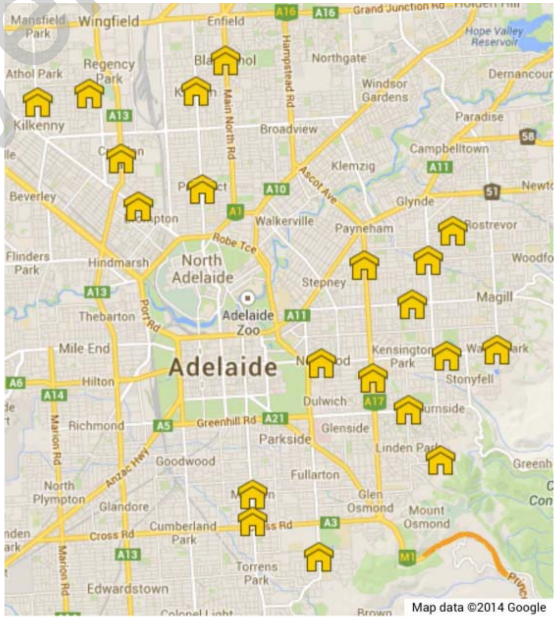
Motivation: Future demand is changing because the drivers are changing



- Water demand drives network design, operations and management
- Future water demand patterns are becoming more complex to predict
- Smart water meters provide unprecedented information
- To realise potential need to be combined with key drivers

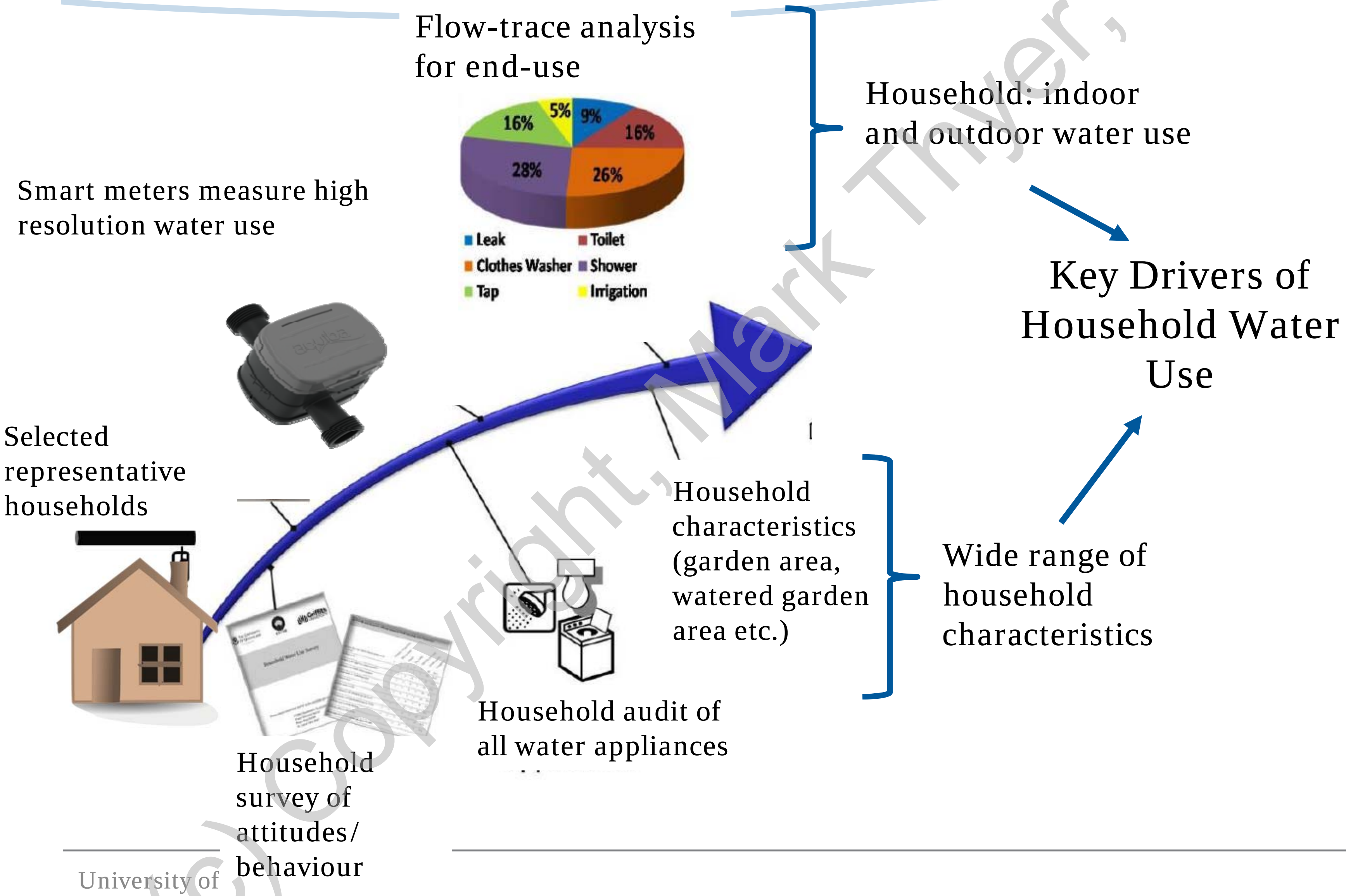
Identifying Indoor and Outdoor Drivers of Water Use in Adelaide

- Indoor Demand Drivers
  - Goyder Project (Oct 2012- April 2014)
  - Smart meters on 150 rep. households
  - End-use analysis to identify water use
  - Wide-range of household characteristics
  - See Arbon et al (2014), Thyer and Arbon (2016)
- Outdoor and Peak Demand Drivers
  - Subdaily data for 3 years for 120 houses
  - Three summers: 2013/14, 2014/15, 2015/16
  - Preliminary Results (To be peer-reviewed)



Arbon, N., M. A. Thyer, M. Darla Hatton, K. Beverley, and M. Lambert (2014), Understanding and predicting household water use for Adelaide *1839-2725*, 1-149 pp, Goyder Institute for Water Research.
http://www.goyderinstitute.org/_r103/media/system/attrib/file/94/OWRM_Household_Water_Use_Final.pdf
Thyer, M., & Arbon, N.. (2016). Insight from Smart Water Meters: Opportunities for Targeted Management Strategies. figshare. https://doi.org/10.6084/m9.figshare.4471967

Identifying key drivers by combing smart water use with household characteristics

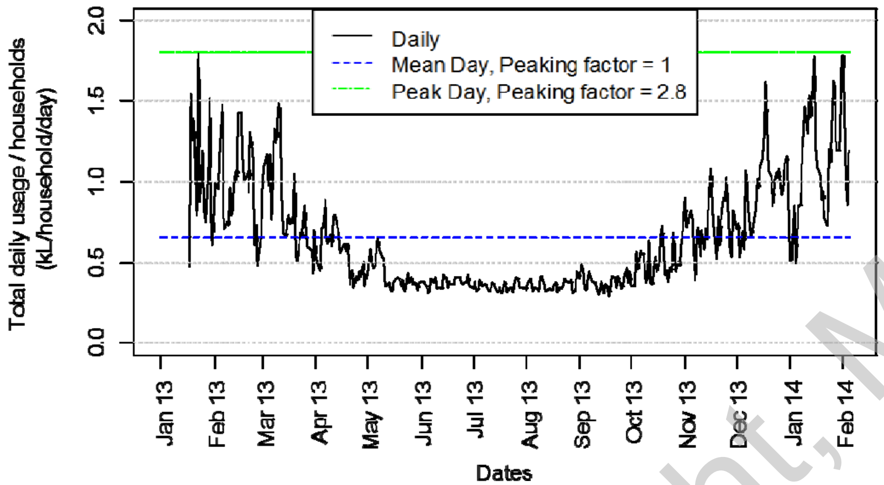


Drivers of Outdoor Water Use Insight:

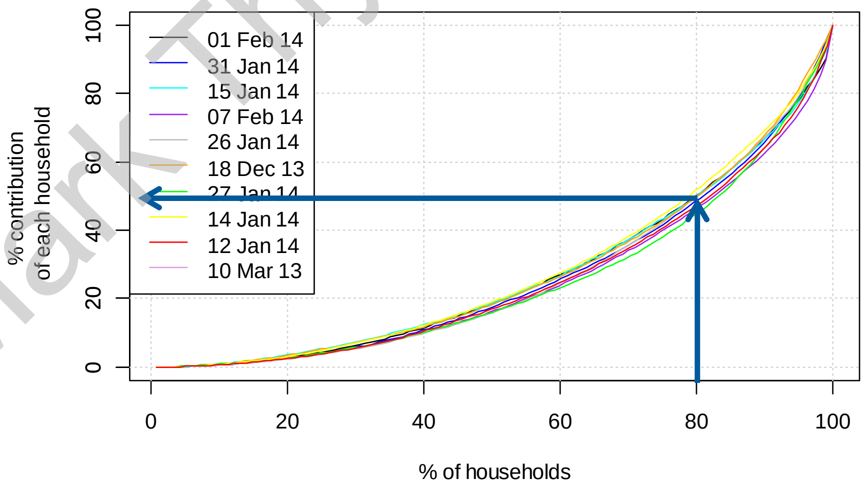
"A small proportion of households contribute a large proportion to the system outdoor and peak demands"

Small proportion of households contribute to system peak demand

- System peak demand: All study households



- Contribution of each household to system peak demand

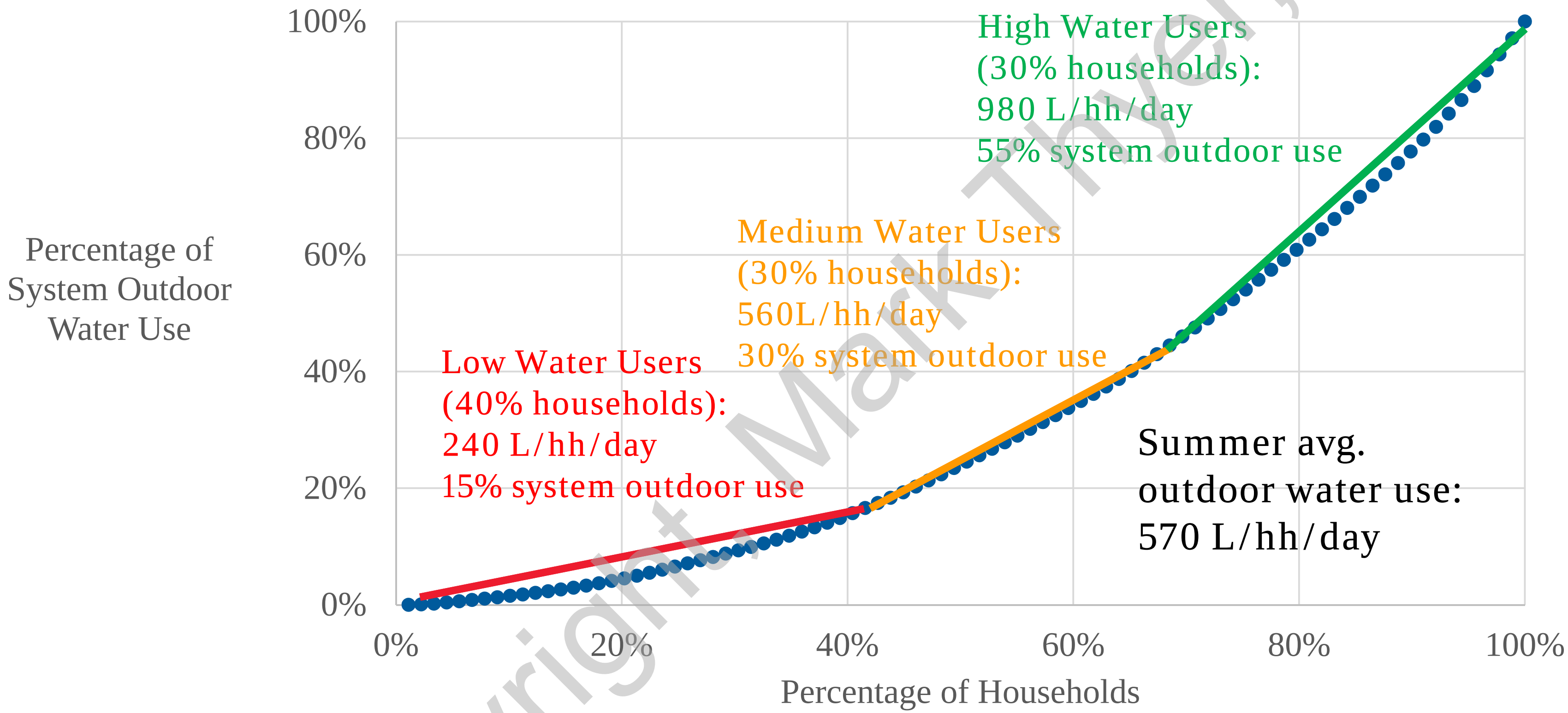


- 20% of households contribute to 40-50% of system peak demands
- Insight only possible with household level data

Opportunity:

- To reduce peak demands only need to target small proportion of “high peak usage” households

Small proportion of high outdoor water use households contribute to system outdoor water use



- 30% of households contribute to 55% of system outdoor water use
- Similar results were found in Hunter Region Study of 225 Houses (Orr et al, 2011)

Practical Opportunity

- During drought target "High outdoor water users" instead of restricting all users

Orr, D., T. Micevski, and M. Thyer (2011), Household Characteristics that Influence Household Water Use in the Hunter Region, paper presented at 34th IAHR World Congress, Engineers Australia, Brisbane, Australia

Drivers of Outdoor Water Use Insight:

"There are common characteristics for these "high peak/outdoor" water use households"

Profile of “high peak usage” households

- High Peak Usage Households

(20% of households contribute to 50% of system peak)

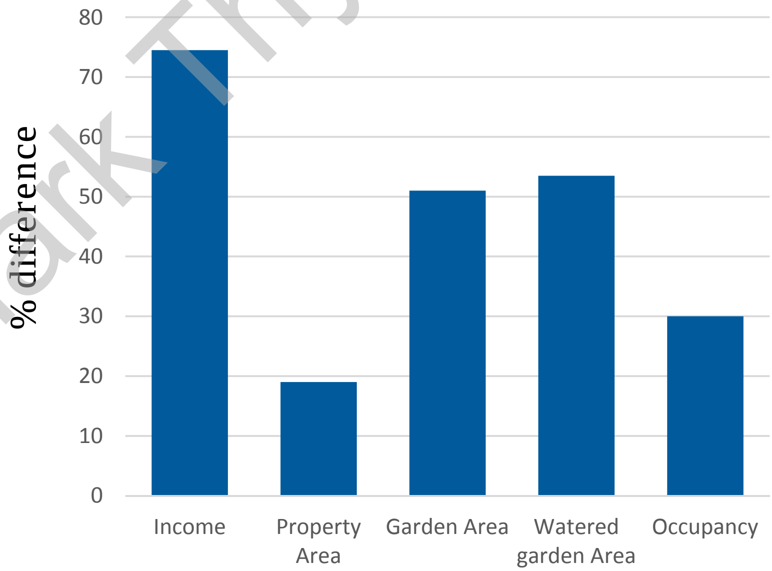
Significantly different

- 75% higher income
- 50% higher watered garden area
- 30% more occupants
- More irrigation methods (drip/sprinkler)

Not significantly different

- Property area

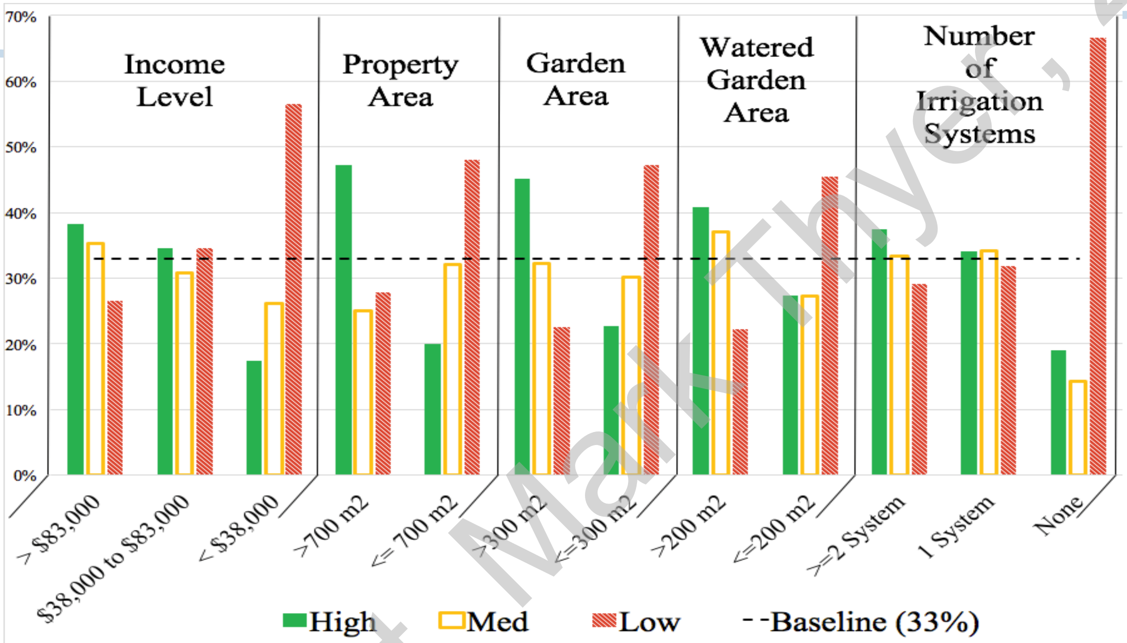
Percentage difference between high peak usage households and other households



Practical Opportunities:

- Peak demand reduction management and monitoring strategies can focus on households with these characteristics

Profile of high outdoor use households



- Average outdoor water use of ~980 L/hh/day (almost double average ~570 L/hh/day)
- Medium to High Income (>$38,000 pa)
- Large property area (>700 m^2), garden area (>300 m^2), watered garden areas (>200 m^2)
- Have at least one or more irrigation systems (drip and/or sprinkler)
- Suggests these households are "Garden carers"

Practical Opportunity:

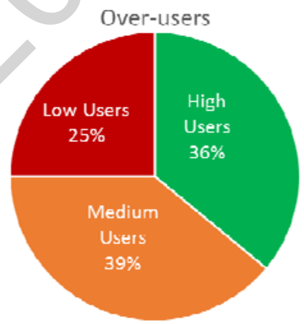
- High water users may be identified and targeted through household characteristics

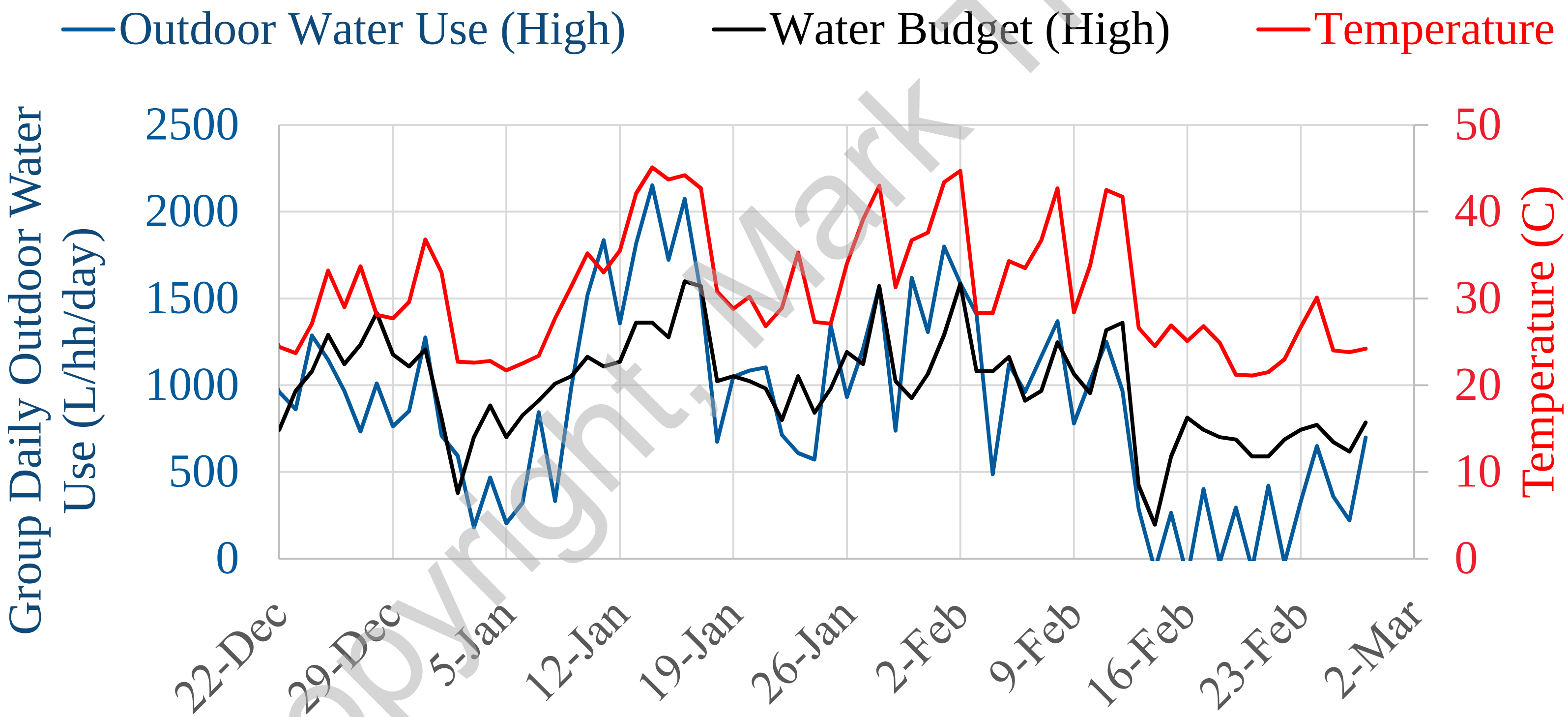
Drivers of Outdoor Water Use Insight:

“The ‘over-users’ of water tend to over-water during heat waves”

Over-users tend to over-water during heat-waves

- Over-users: Outdoor Water Use > Est. Water Budget
  - Water Budget = F(Potential Evapotranspiration, Garden Area, Landscape Type)
- Over-users: 75% medium and high water users





Practical Opportunity:

- Target “over-users” based on water budget to “smooth” peaks and reduce “unnecessary” peak demands

Opportunity:

"Develop targeted strategies to reduce impacts of heatwaves for water authorities"

Opportunity to mitigate impact of heatwaves on peak demands and reduce costs for water authorities

- Increasing heatwaves will likely increase peak demands, energy and infrastructure costs
- To reduce peak demands only need to target small proportion (20%-30%) of "high outdoor/peak use households"
- Target households with high outdoor/peak water use profile
  - "Garden Carer" Households
  - Medium-Higher income
  - Large watered garden area
  - Irrigation system
  - Contribute to 40-55% of peak demand and outdoor water use
  - Tend to over-water during heat-wave events

- Opportunity: Develop "Garden Carers" Program
  - Monitors water use/soil moisture and garden health
  - Optimise water use to maximise garden health and "smooth" peak demands

Opportunity to enhance short-term and long-term demand predictions using smart water meters and drivers

- Key insights developed by combining high resolution water use with information on key drivers
- Develop predictions of short and long-term demand using information on drivers of water use (scocio-economics, household characteristic)

Potential Uses

- Include in operations and planning decisions
- Short-term operational decisions
- Long-term Planning Decisions
- Develop a business case for peak demand reduction over city-wide scale