INSTITUTE FOR SUSTAINABLE FUTURES

The water-energy-climate nexus:

Systems thinking and virtuous circles

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Acknowledgement

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What do we mean by the nexus?

• Different perspectives – water industry, energy industry, urban, rural – NRM

• Institute for Sustainable Futures
  – Urban focus
  – Energy implications of water infrastructure
  – Consequent impacts on climate
  – Concern over the rise in energy intensive water infrastructure
Water supply systems are changing

- Significant new infrastructure in Australia
  - driven by drought
- Large-scale system augmentation
  - Desalination, water recycling, inter-basin transfers, proposed new dams
- Small-scale distributed systems
  - household rainwater & greywater systems, package recycling plants (building / estate scale), stormwater harvesting

Systems have been developed with a single focus on water
ISF Water-Energy Nexus research

ISF and CSIRO collaboration 2008-09

• Stage 1 - Water-energy nexus literature review
  – Almost no water-energy data on distributed or household scale systems
  – Considerable water-energy data on large scale systems and how they are changing
Impact of drought & large scale augmentation

(Adapted from Kenway et al. 2008)

Inter-basin transfer – Murray River

Inter-basin transfer - Shoalhaven

Desalination plant

Energy Intensity (kWh/kL)

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Energy Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000/01</td>
<td>Sydney</td>
<td>0.2</td>
</tr>
<tr>
<td>2006/07</td>
<td>Sydney</td>
<td>1.0</td>
</tr>
<tr>
<td>2001/02</td>
<td>Perth</td>
<td>0.6</td>
</tr>
<tr>
<td>2006/07</td>
<td>Perth</td>
<td>1.2</td>
</tr>
<tr>
<td>2005/06</td>
<td>Adelaide</td>
<td>0.8</td>
</tr>
<tr>
<td>2006/07</td>
<td>Adelaide</td>
<td>1.8</td>
</tr>
</tbody>
</table>
ISF Water-Energy Nexus research

• Energy intensity for large scale systems is increasing
  – What about small scale and distributed systems?

• Stage 2 - Study on energy implications of household rainwater systems
  – Proliferation of rainwater systems
  – One previous study (Beal et al. 2008) had shown energy intensities between 2.6 - 5.0 kWh/kL
Energy intensity of household rainwater systems

- ISF pilot study (2008-09)
  - Typical system average 1.5 kWh/kL
  - More unusual configurations between 3.0 and 4.9 kWh/kL
  - Energy intensity varies greatly according to system design and configuration

- Sydney Water study (2009)
  - 1.7 kWh/kL (large sample)
What does this mean?

• In most cities rainwater systems use more energy than the mains supply
  – Contributes to rising energy intensity & total energy use
  – Systems need to (and can) be optimised

• How much energy is being used by other distributed systems?
  – Stormwater harvesting?
  – Wastewater recycling in buildings and estates?

Need to monitor and evaluate new systems in order to optimise energy use
Ignoring energy use in water systems can lead to a vicious circle.
Energy intensities must be reduced

• New water systems need to be designed to *reduce energy intensity*

• Need greater focus on *reducing water demand* & optimising water end uses
  – before building supply side infrastructure

• **Efficiency in hot water** end uses has significant potential for water and energy savings (EI approx. 40-50 kWh/kL)

Water efficiency has an important role to play
Water efficiency – Creating a more virtuous circle

- Reduced water use
  - More water available
  - Limit need for new supply sources
  - Limit increase in energy used for water provision
  - Limit GHG emissions
  - More fossil fuel use
  - More CO₂ emissions
  - Increase city’s energy demand
  - Energy intensive water infrastructure
  - Contribute to climate change
  - Drought

- Drought
  - Water efficiency

- Water efficiency
  - Reduced water use
Integrated resource planning
(integrated supply demand planning)

- Service not commodity
- Understand end uses
- Assess supply & demand options
- Total costs – utility and customer, externalities
- Results provide a sequence for investment
- Start with lowest cost options
Supply curves of conserved water - Canberra

Source: Turner & White 2003
GHG intensity
South East Queensland, Australia

Source: Turner et al. 2007
Difference in Greenhouse Emissions between Portfolios (thousand tonnes CO2 eq./a)

Traveston Stage 1
Stage 2
Stage 3
Domestic Retrofit
Net difference between portfolios of options

Source: Turner et al. 2007
Conclusions

• Energy impacts of new water infrastructure need to be considered more closely
  – Supply systems need to be optimised
• Efficiency can provide GHG reductions and significant water savings
• Need much greater focus on demand side options before committing to energy intensive supply options


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