www.csiro.au

Potential role of renewable energy in water desalination in Australia

Ben Rowlinson, Don Gunasekera and Alberto Troccoli
CSIRO Marine and Atmospheric Research
ICEM 2011 Conference, 8-11 November 2011
Surface Paradise Marriot Resort, QLD

CSIRO

Policy context: growing population and water demand in Australia

- **Rise in population from 22m in 2010 to 36m in 2050:**
  - Sydney and Melbourne may grow from 4.5 and 4m people respectively at present to cities of almost 7m in 2050.
  - Brisbane may more than double in size to 4m by 2050
- **Has several public policy implications:**
  - Where will the additional number of people live? in the current major cities and regional centres or in cities that haven't yet even been envisaged or planned?
- **How do we secure public infrastructure including:**
  - Energy and water supply in a sustainable manner in the medium to long term.
- **Total urban water demand in Australia:**
  - Likely to increase by 76% (or 1147 GL) by 2050s
  - Desalination may help supply a part of the additional water required
  - In 2009, the share of desalinated water in total supply of water in Australia was 3%.

CSIRO

Desalination in Australia

By the end of 2012, all coastal capital cities (with the exception of Hobart and Darwin) will have at least one major desalination plant operational.

- **Desalination technology:**
  - **Thermal: multi-stage flash distillation (MSF); multiple effect distillation (MED); vapour compression (VC)**
  - **Membrane: reverse osmosis (RO); electrodialysis (ED); membrane distillation (MD)**
- **Desalination process (fossil fuel powered): energy and emission intensive**
- **Use of renewable energy could be a sustainable option**

Role of renewables in sustainable desalination

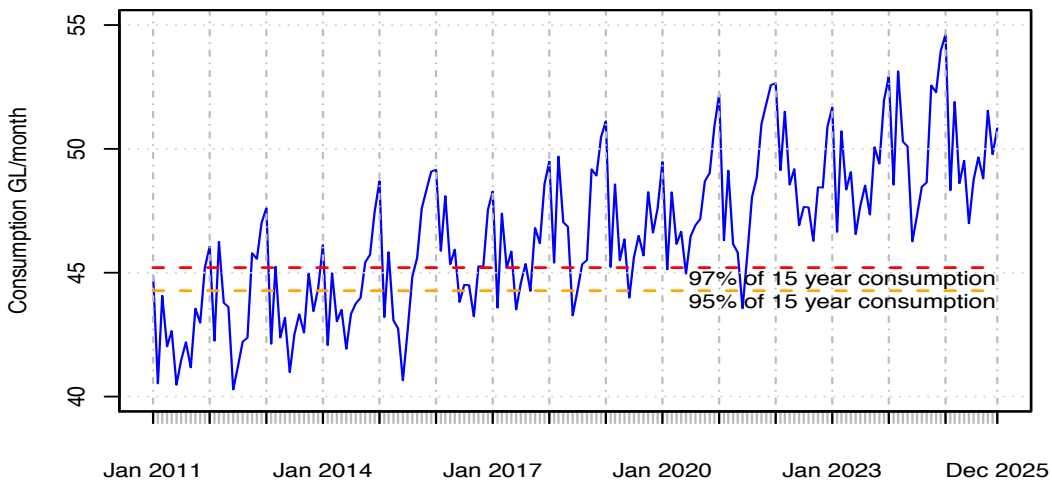
- **Utilising renewable energy (solar thermal energy, solar photovoltaic, wind power etc) for desalination helps:**
  - **to address the issues of providing adequate amounts of sustainable energy and water resources.**
- **Desalination systems powered by renewable energy are:**
  - **still far from achieving their full potential in terms of large scale commercial applications**
  - **but, technological advancements will continue to improve these systems and benefit a growing market.**

Desalination - Renewable Energy

Large scale desalination, driven directly by renewable energy sources, is still for the most part in the R&D stage.

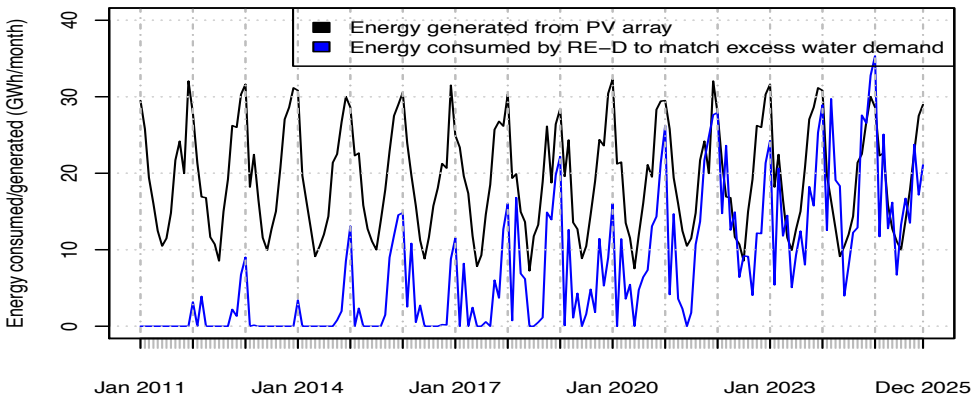
- **Some technological barriers to overcome**
- **Desalination → constant process; RES → intermittent supply**
- **Typically require large electrical storage**
- **Several successful small-scale installations**
- **Two of the most promising: PV-RO & Wind-RO**

Projected water consumption - Sydney



Renewable Energy Powered Desalination – PV-RO

Hypothetical large-scale PV-RO desalination plant in Sydney

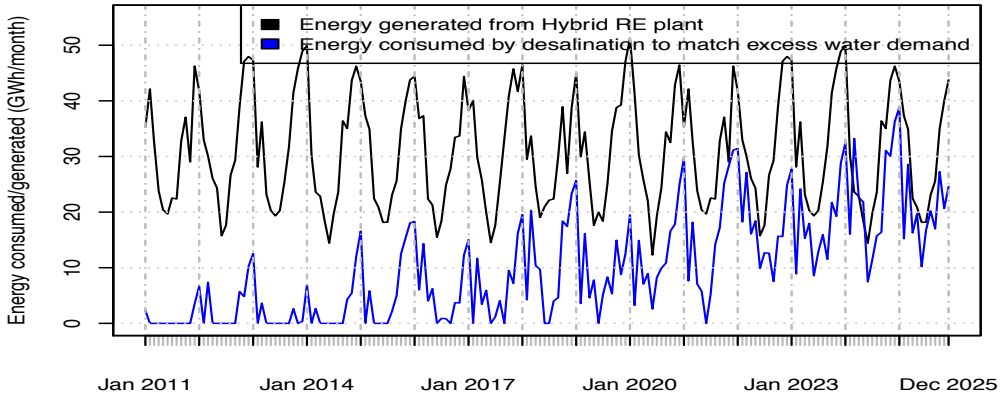


130MWp PV-RO plant energy consumption/generation

- Based on Sydney's existing plant, desalination would have a specific energy requirement of 3.75kWh/m^3
- To ensure this power demand is met, a 130MWp PV solar array would be needed.

Renewable Energy Powered Desalination – Hybrid-RO

Hypothetical large-scale Hybrid-RO desalination plant in Sydney



205MWp PV-RO plant energy consumption/generation

- Based on Sydney's existing plant, desalination would have a specific energy requirement of 3.75kWh/m^3
- To meet increased power demand, a 75MWp wind farm would be used in addition to the 130MWp PV solar array.

Additional cost advantages

- **Under carbon penalty rates of \$20/tCO_2 and \$30/tCO_2, the estimated cost savings (in NPV terms assuming a discount rate of 4.23%) over 15 years**
  - **PV solar plant will amount to \$16.86m and \$ \$ 25.29m**
  - **Hybrid plant will amount to \$ 23.38m and \$ 35.08m**

- **Estimated revenue through excess electricity sales (in NPV terms assuming a discount rate of 4.23% and wholesale electricity price of \$36.74/MWh) over 15 years**
  - **PV solar plant has the capacity to earn \$63.9m**
  - **Hybrid plant has the capacity to earn \$110.0m**

Concluding remarks

Cost effectiveness will be influenced by:

- **Greenhouse reduction target or a carbon penalty high enough in the future to justify a wide range of renewable energy generation**
- **Future investment in solar and renewable energy technologies**
- **Ongoing developments in desalination technologies**
- **Cost of supply of water from conventional sources**
- **More market oriented water pricing**
- **Reforms to electricity grid networks to accommodate renewable energy**
- **Any assistant measures for renewable energy through budget funded grants**

Thank you

- don.gunasekera@csiro.au