

Factors affecting the cost effectiveness of renewable energy in desalination plants in Australia

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Outline

- **Policy context**
- **Water shortage solutions – desalination?**
- **Potential role of renewable energy**
- **Coupling renewable energy with desalination**
- **Cost drivers**

Policy context: growing population in Australia

- **Population projections:** rise from 22m in 2010 to 36m in 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?
- **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.**
- **How do these potentially large cities or regional centres secure public infrastructure including:**
 - energy and water supply in a sustainable manner in the medium to long term.

Policy context: growing demand for water

- **Many factors influence water usage in cities/towns:**
 - Climate change, housing type/density, design of our growing cities
 - Uptake of water efficient appliances, water restrictions, water saving rules,
 - Cost of water, economic growth, demographics
- **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%.**

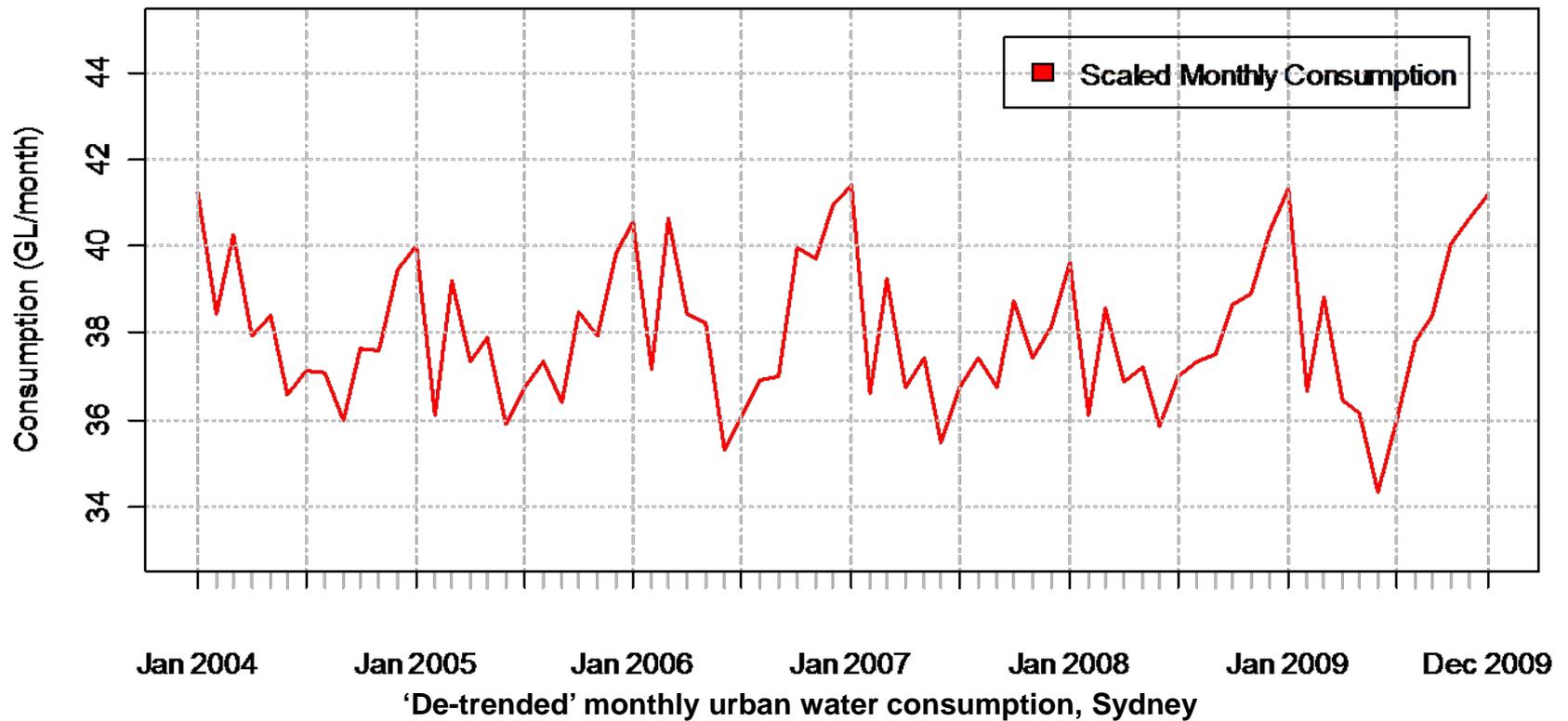
Desalination in Australia

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
- **Desalination process (fossil fuel powered): energy and emission intensive**
- **Use of renewable energy could be a sustainable option**

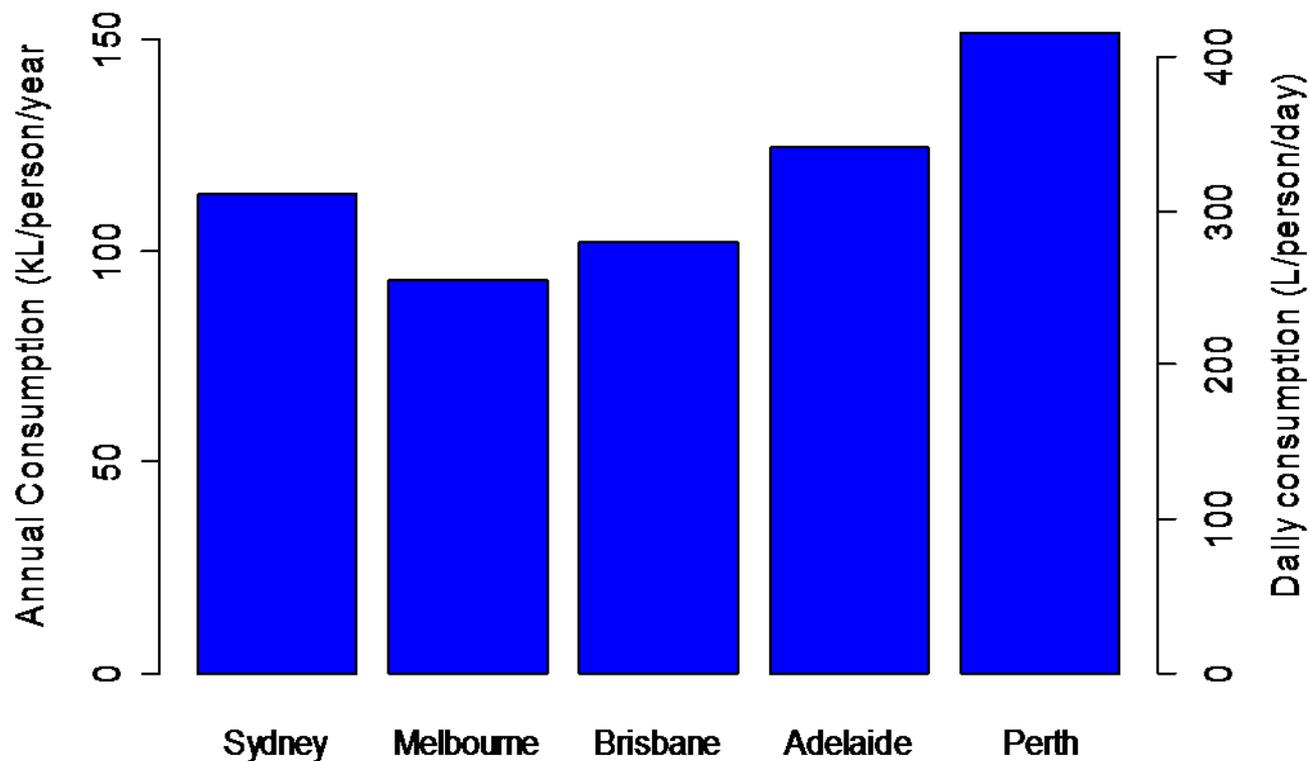
Water Consumption - Sydney

'De-trended' monthly consumption pattern



Per person water consumption

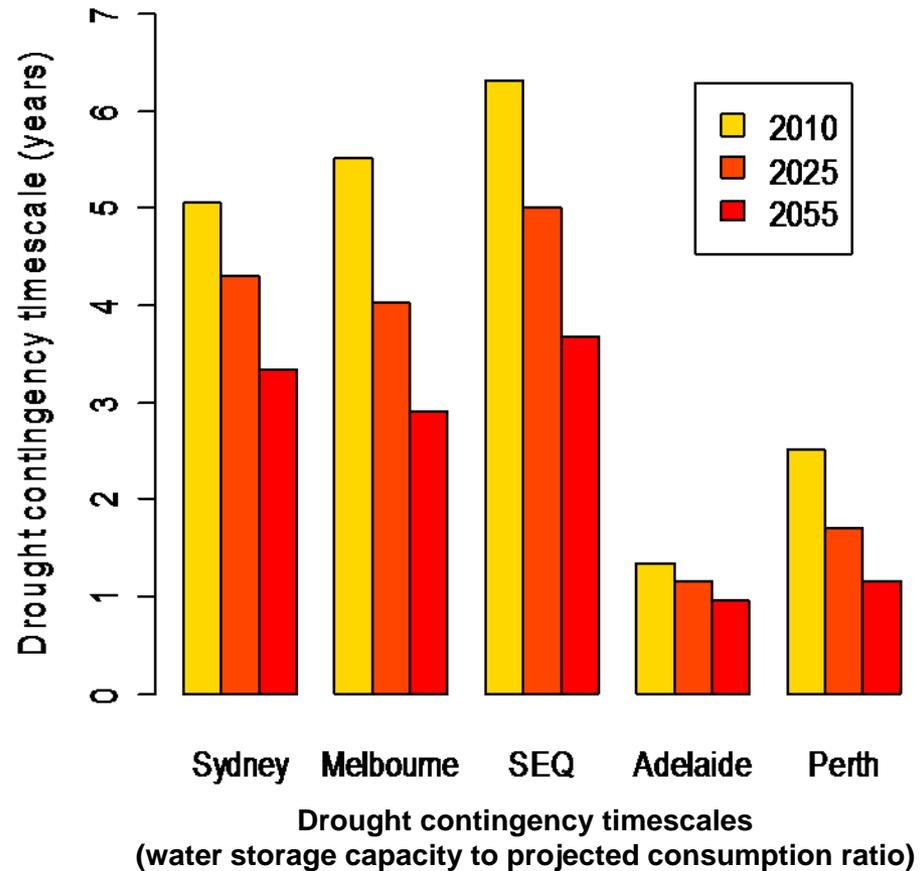
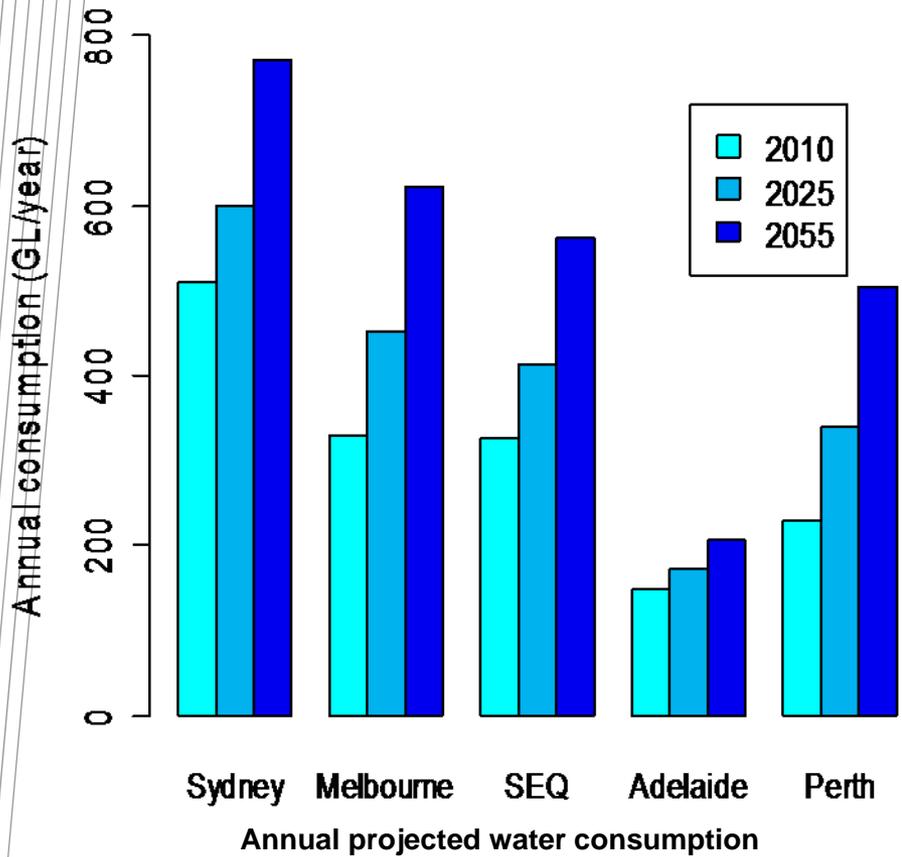
Consumption per capita figures for relevant Australian capitals



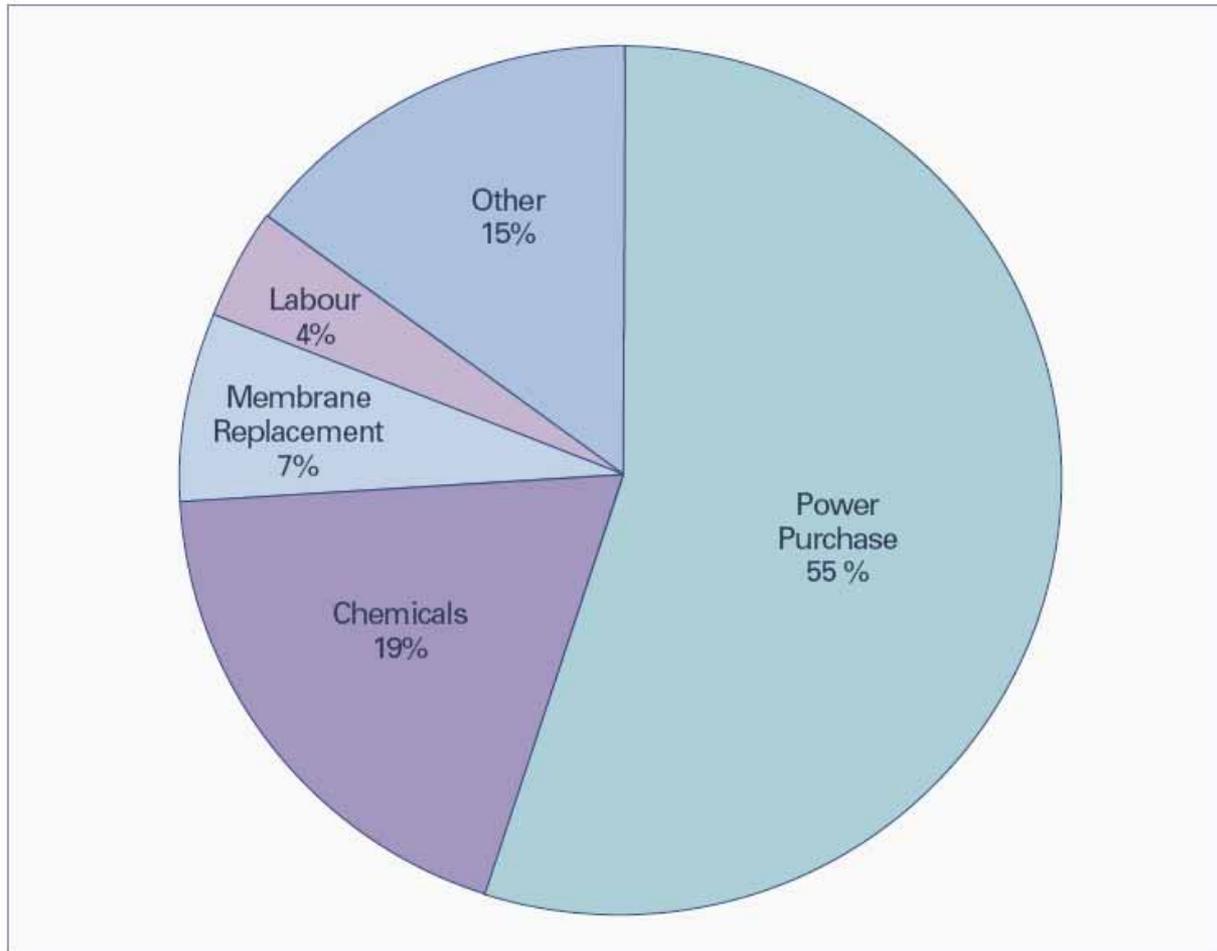
Total urban water consumption per capita, 2008/09

Water Consumption - Projections

Future water demand:

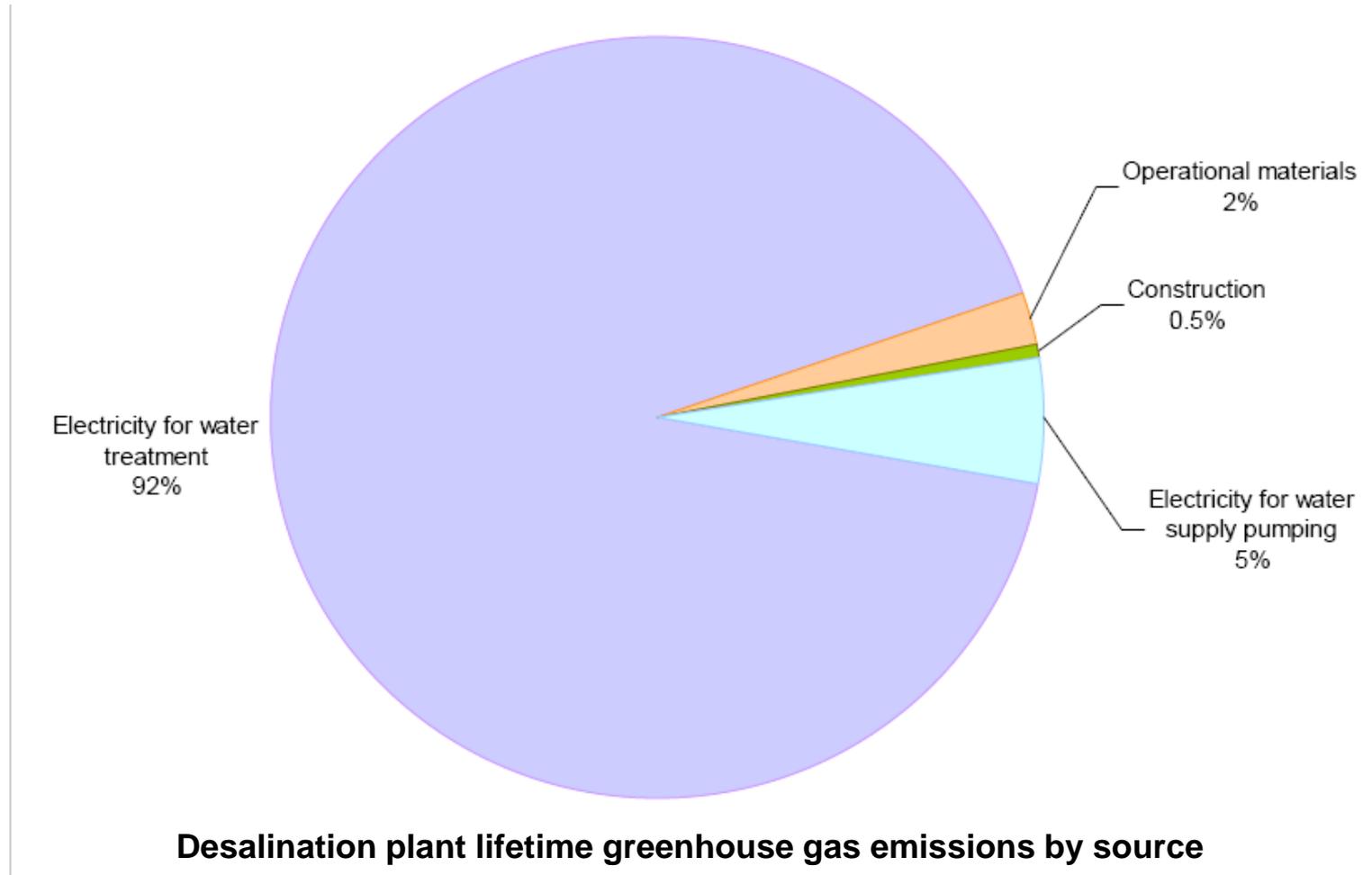


Desalination - Cost shares (%)



Operating cost breakdown for a 500ML/day desalination plant

Desalination - Emissions profile (based on conventional energy use)



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**

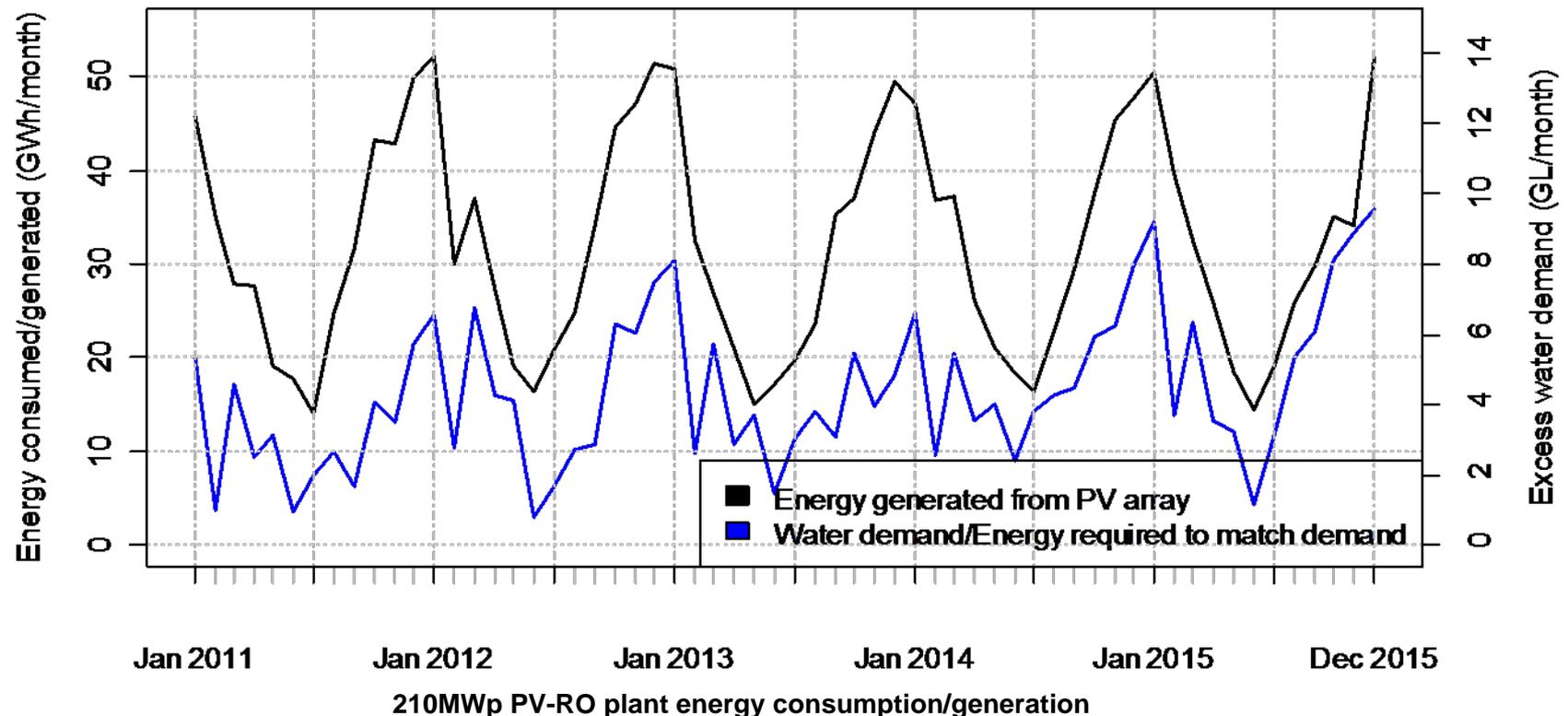
Desalination - Renewable Energy

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**
 - **Atmospheric variables of importance: Solar irradiance & 10m Wind**

Renewable Energy Powered Desalination – PV-RO

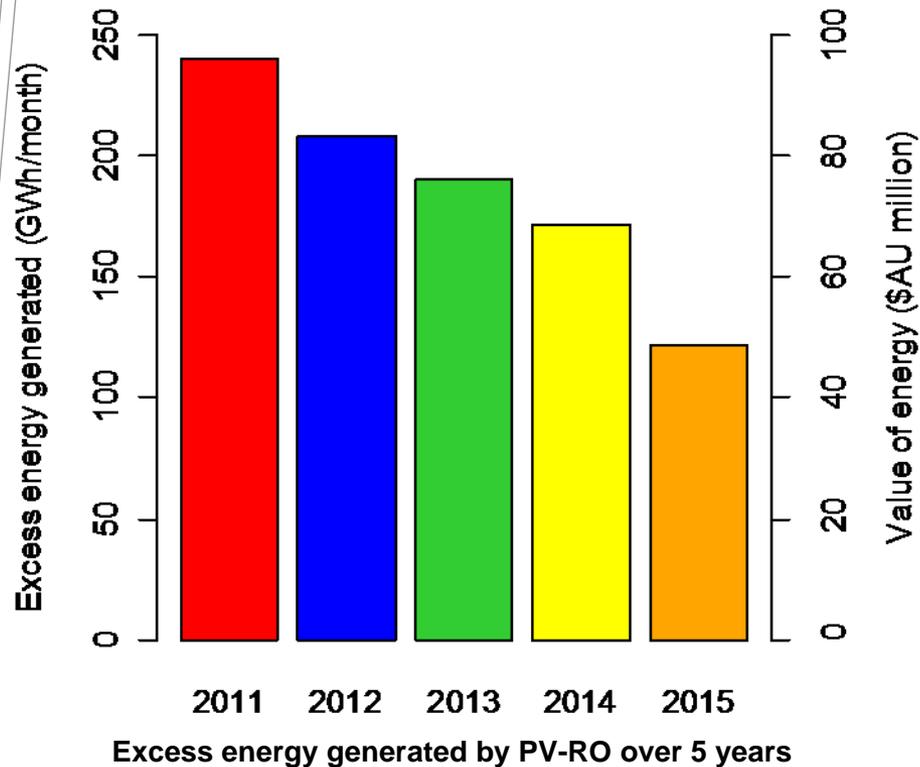
Hypothetical large-scale PV-RO Desalination plant in Sydney



- 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 210MW PV solar array would be needed.
- The array would have an effective area of 1.4km^2

Renewable Energy Powered Desalination – PV-RO

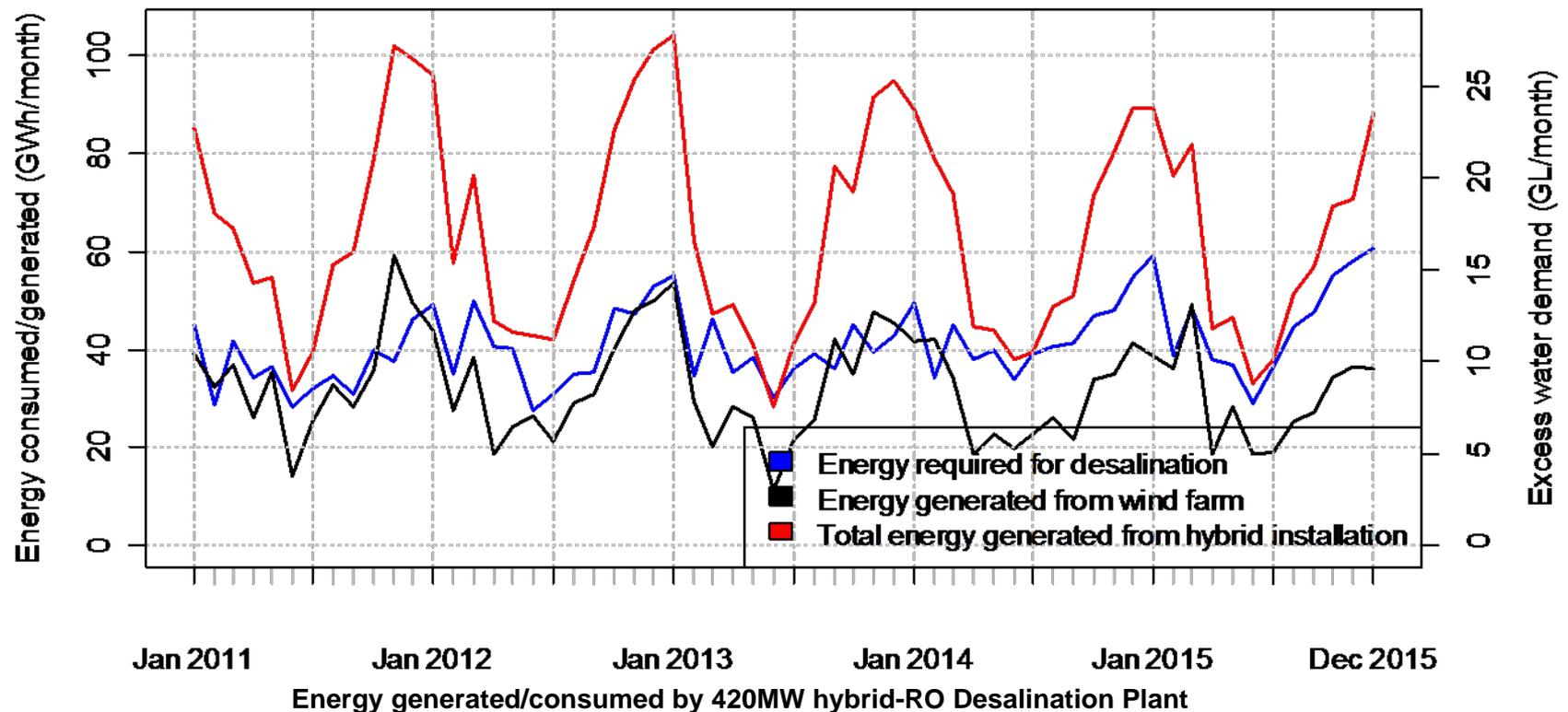
Hypothetical large-scale PV-RO Desalination plant in Sydney



- Electricity generated in excess to that required by the desalination plant to meet the water demand would be sold back to the grid.
- Assume large-scale feed-in-tariff (FiT) scheme. Based on similar schemes in Germany, Spain and Canada, estimated FiT of \$0.40c/kWh.
- Value of excess energy generated over the five year period - \$372.8m

Renewable Energy Powered Desalination – Hybrid-RO

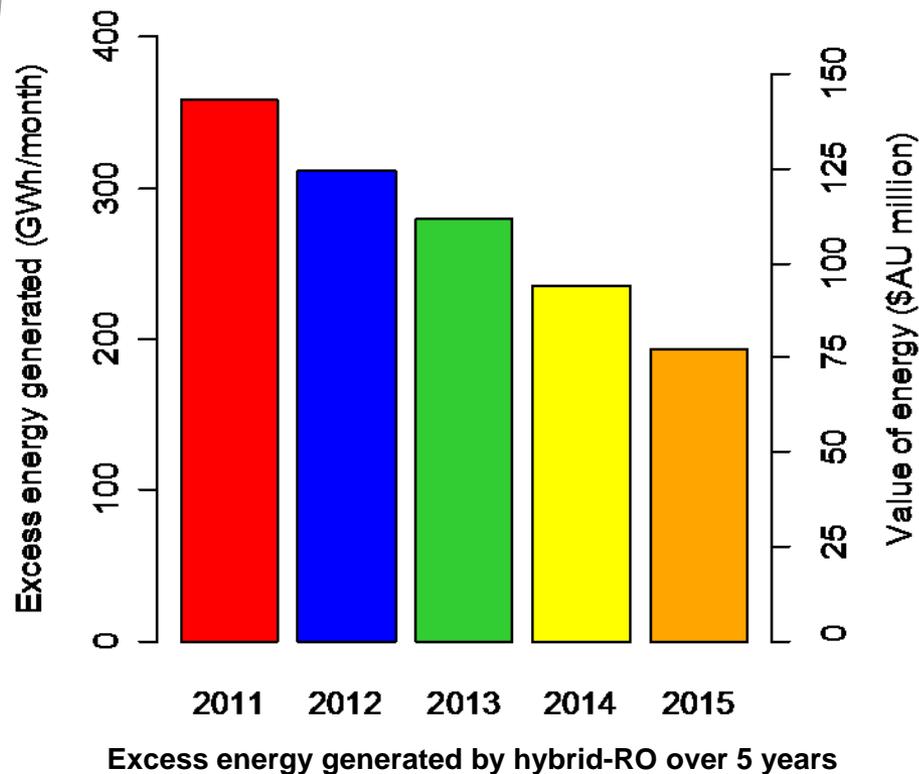
Hypothetical large-scale Hybrid-RO Desalination plant in Sydney



- To meet increased power demand for desalination, a 210MW wind farm would be constructed in addition to the 210MW solar PV array
- The combined capacity of 420MW would meet demand in all but the lowest yielding months, in which case its grid parity will provide auxiliary energy supply.

Renewable Energy Powered Desalination – Hybrid-RO

Hypothetical large-scale Hybrid-RO Desalination plant in Sydney



- Value of excess energy generated over the first five year period - \$550.9m (assuming the same large scale FiT scheme is applicable)
- Beyond the first five years, water demand will continue to increase and the plant will become more reliant on auxiliary grid power
- Plant will eventually be required to operate at capacity for most of the time, but will continue to be a net *producer* of energy

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 such as Solar Flagships**

Thank you

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