IS THE INSTALLATION OF MINI HYDROPOWER TURBINES IN WATER TRANSMISSION SYSTEMS COST EFFECTIVE?

THE UNIVERSITY of ADELAIDE

SA Water

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Motivation for Research

Whilst Australia is the 15th largest carbon dioxide emitter per capita, it has the largest contribution of carbon dioxide emissions from the energy production industry at 85%. Given the irreversible effects from climate change and this appalling statistic, we have a responsibility to play our part in transitioning to clean renewable energy sources. Due to the relatively cheap construction cost of mini hydropower when compared to pumped hydropower and solar and wind farms, as well as its capacity to be widely implemented in current water distribution pipelines, it may well prove an integral part in this transition. It is important then to understand whether the benefits from energy generation for mini hydropower outweighs the cost of its implementation, and hence whether it could potentially play a vital role in Australia's movement to a greener future.

Objectives

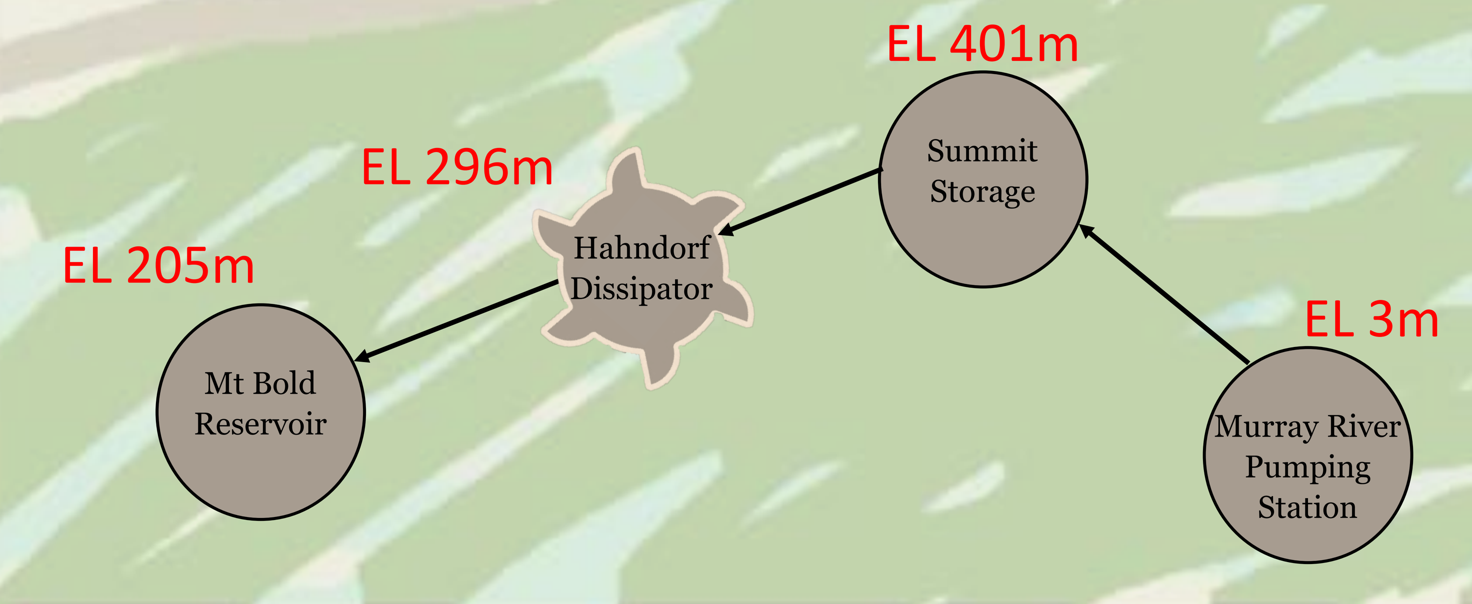
1. To investigate AEMO energy generation prices and how they can be utilised to make mini hydropower cost effective.

2. To study how altering the discount rate will affect the feasibility of mini hydropower with a net present value (NPV) analysis.

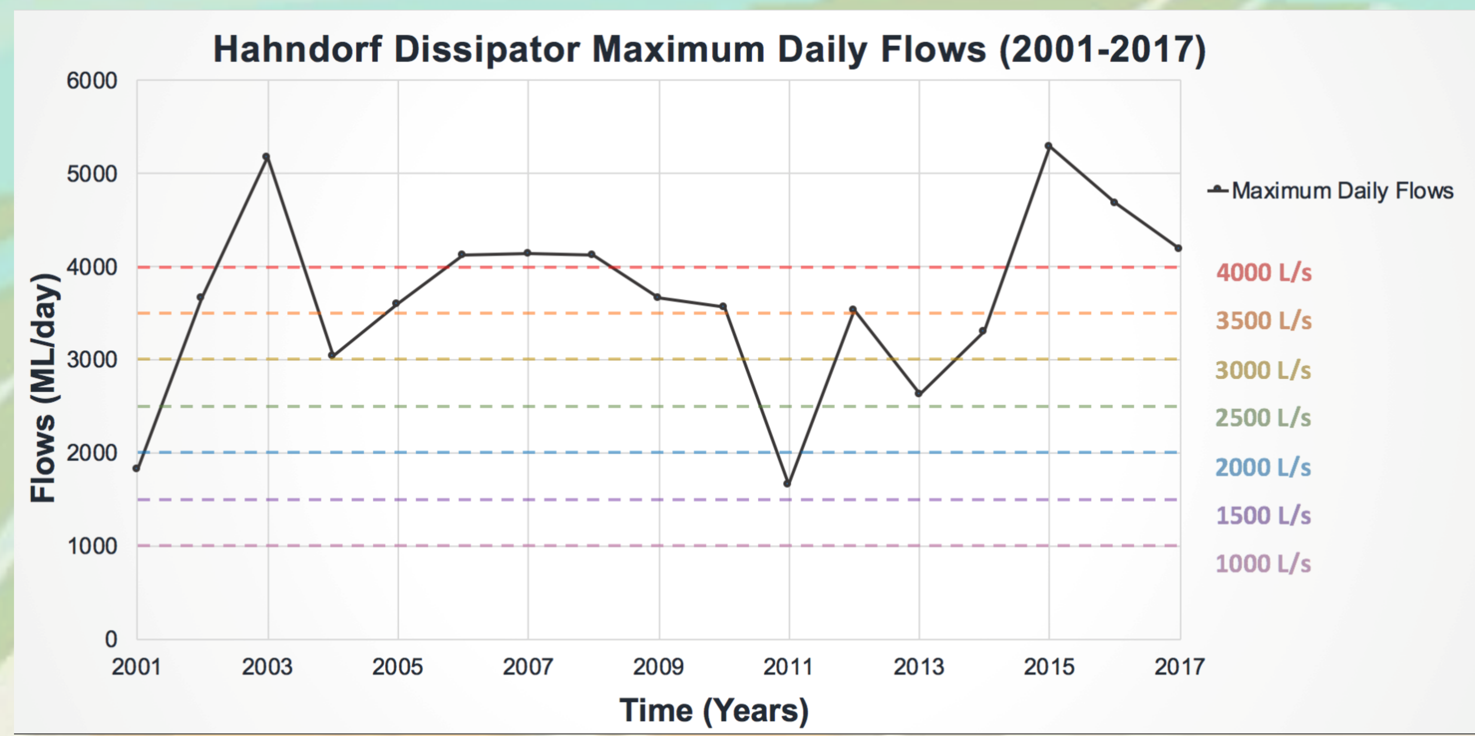
3. To test the sensitivity of the perfectly-forecasted scenarios against a series of multiple plausible future scenarios to determine how the feasibility of mini hydropower changes.

Case Study

- Water is transported from Murray Bridge through to Happy Valley via the Murray Bridge to Onkaparinga Pipeline (MBO).
- The system provides water to meet the demands of Southern Adelaide.
- The Hahndorf Dissipator is SA Water owned and is located at the end of this pipeline in the Adelaide Hills with the purpose of dissipating kinetic energy from flowing water.
- A mini hydropower turbine is proposed to harness this wasted energy.



Methodology



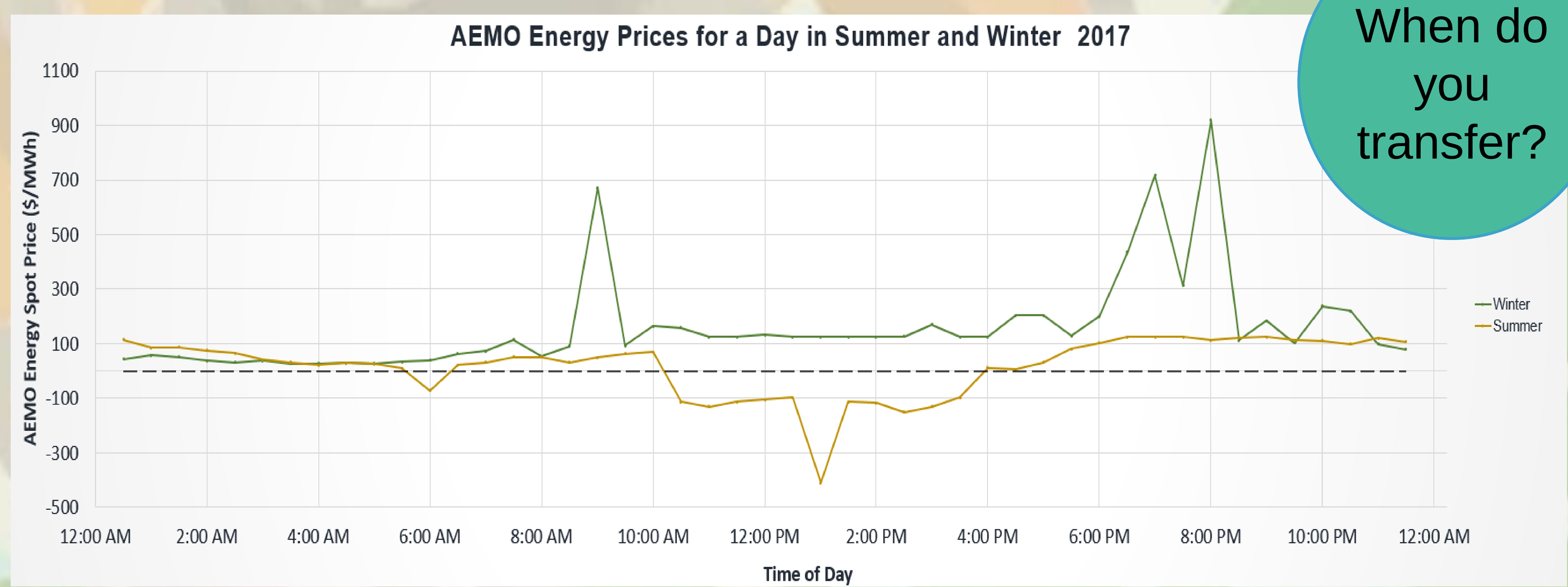
Feasibility Scenarios

Scenario 1 – Finding the turbine energy generation profits from transferring in highest known energy price times.

Scenario 2 – Finding the turbine energy generation profits using historically predefined optimal times.

Scenario 3 – Optimisation of the system to find energy generation benefits by passing maximum flow through the turbine whilst balancing reservoir levels.

When do you transfer?



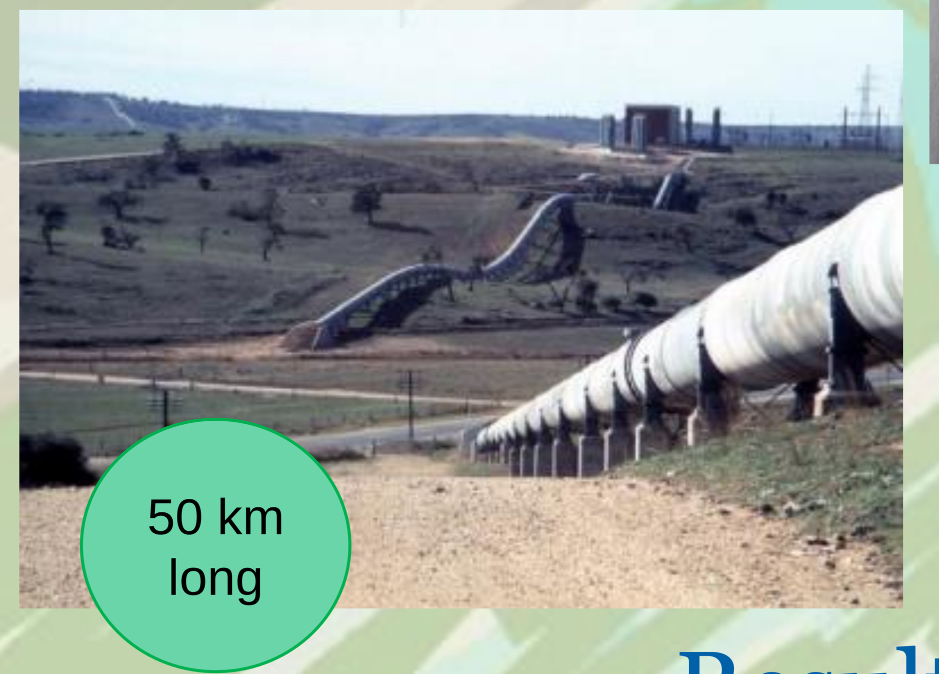
Multiple Plausible Future Scenarios

- Project future water demands for SRES climate scenarios B2 and A2.
- Predict future changes in energy generation prices under three different renewable energy supply projections (low, medium, high).
- Scenarios constructed for entire project design life (25 years).

System Design

Selected Turbine

MBO Pipeline



Results

Below is the NPVs for each of the three feasibility scenarios as well as the medium case for both SRES climate scenarios. The feasibility of each scenario against a range of discount rates can be observed. SA Water recommends applying a discount rate of 4.63%, however, a positive NPV at higher rates leaves little risk in project viability.

Feasibility Scenarios	Discount Rates 1.4%	Discount Rates 4.63%	Discount Rates 6%	Payback Period (Years)	Optimal Turbine Size (L/s)
Scenario 1	$3,862,454	$409,113	-$597,780	11.5	2500
Scenario 2	$2,858,548	-$185,511	-$1,073,069	12.4	2500
Scenario 3	$10,934,531	$5,721,193	$4,201,138	7.1	1000
SRES B2	$23,384,715	$13,197,567	$10,310,319	4.5	2500
SRES A2	$24,712,252	$14,005,484	$10,976,580	4.4	2500

Conclusions

- Feasibility scenarios show with a more social discount rate (1.4%), mini hydropower is feasible today without considering future climate change effects.
- Multiple plausible future scenarios investigated improved feasibility with mini hydropower over the next 25 years with any of the discount rates, incorporating climate change and growing population dynamics. Expected payback period of project is less than 5 years.
- Investigations into the future with the worst case scenario (B2 Low), show that a mini hydropower turbine under a social discount rate will generate 23.1 million dollars in profits over 25 years.

Supervisors: Professor Angus Simpson and Jinzhe Gong