Opportunities for energy generation from renewable energy sources within the water industry

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Abstract

The Water Corporation strives to become a leader in sustainability. Faced with growing electricity needs, the Water Corporation is considering where renewable energy could be used to reduce its carbon footprint. Since Photovoltaic (PV) technology is yet to reach grid parity, the most sustainable option is not always the most cost effective option. In recognition of these tradeoffs, this paper seeks to incorporate future electricity price appreciations and the intangible benefits associated with renewable energy into a single financial model. By encapsulating external cost savings and intangible benefits, the true value of renewable energy can be realised. Upon developing the community model, this paper uses the East Rockingham Waste Water Treatment Plant (ERWWTP) as a case study to investigate the feasibility of various PV systems. It has been found that Community Models yield consistently higher capital returns, ranging from 8-39%, (in excess of a purely economic analysis).

1. Introduction

The Water Corporation has a business goal of becoming a leader in sustainability. To achieve this goal, the Water Corporation is investigating ways of meeting future electricity needs in an environmentally socially sustainable manner. The environmental benefits of renewable energy over traditional generation practices are paramount and the growing concern surrounding greenhouse gas emissions has lead to increasing social demand for renewable energy within the community (Wüstenhagen, Wolsink et al. 2007). Recognising this, the Water Corporation is shifting towards renewable energy and is working to standardise the use of renewable energy through its core businesses.

With electricity prices forecast to increase over the coming years, the cost difference between renewable energy and grid electricity is diminishing (Frontier Economics 2008). As this project reveals, some renewable energy projects are already viable under existing Australian legislation. Furthermore the benefits of localised generation and a progressive shift towards grid dispersion extend beyond the Water Corporation and into the broader community. The most easily measureable benefits of these reforms are quantified in the form of cost savings realised by electricity retailers and network operator (Passey 2007). These measurable cost savings take the form of reduced transmission losses and the realisation of additional capacity within the grid (Passey 2007). This is shown in Table 1 below.

Benefit	Approximate Average Value cents/kWh		Who Benefits
	North	West	
Generation capacity	3.5	5.1	Retailer
Deferring network aug.	0.8	0.8	Retailer/Network operator
Reducing line losses	1.41	1.61	Retailer/Network operator
Total	**5.71**	**7.51**	

Table 1 Third Party Savings (Passey 2007)

For the Water Corporation to fully consider sustainability as a corporate citizen, it is important to account for all the benefits derived from renewable energy in a conclusive financial analysis. By accounting for and including the external benefits realised by the wider community, the feasibility of a renewable energy project is improved and the true value of the project can be realised. The 'Community Model' derived in this project attempts to capture the benefits of the projects, and notably also includes the external benefits felt beyond the Water Corporation's immediate sphere of influence.

The 'Community Model' shows the value renewable energy project creates within society exceeds that yielded directly for the Water Corporation. Recent studies have shown that organisations which adopt sustainability as a fundamental value and a core motivator yield greater long term returns on investment (Cerin and Dobers 2001). Over time, while propagating a culture of sustainable business practice, an organisation can realise the benefits of higher employee productivity, enhanced corporate image, higher moral and staff retention rates and shorter regulatory approval periods (Consulting 2009).

The difficulty in modelling the advantages of sustainability is that most of the benefits are intangible and often lack an equivalent historical scenario to use as a comparison between the mutually exclusive choices available to an organisation. For the purpose of this project two models have been developed; the 'Pure Financial Model' (PFM) and the 'Community Model'. The PFM analyses the profitability of renewable energy, including the cost savings realised by generating and consuming electricity and the revenue that results from creating and selling Renewable Energy Credits (RECs) on the REC market. The Community Model considers all the third party benefits of renewable energy and attempts to capture all the intangible benefits that becoming a sustainable focused corporate citizen entails. This project, upon derivation of the two models, will show how becoming a sustainable focused company and incorporating renewable energy practices into everyday business creates a more profitable organisation.

To demonstrate the feasibility of renewable energy and how acting as a sustainable organisation yields higher returns, the ERWWTP was employed as a case study. The ERWWTP is a Water Corporation project slated for delivery in 2015 and represents a possible project where renewable energy generation could be effectively incorporated into the design from the ground up.

2. Process

In developing the two financial models, the PFM and 'Community Model', the Net Present Value (NPV) analysis technique is incorporated to reflect the overall value a renewable energy project can create throughout its lifetime. Both models are based upon the Water Corporation's internal financial model, which is a tailored NPV calculation tool. The models are based upon several assumptions derived from market research and future expectations. The assumptions governing the models are listed below:

- Inflation rate of 2.5% (median value within the Reserve Bank of Australia's 2-3% target range)(Gordon de and Ericsson 1998)
- Discount rate specific to the Water Corporation
- Operating Cost Index, 4% until 2012 and then 3% from 2013
- Electricity price increase of 10% in 2010, 20% in 2011 and 2012 and then 3% from 2013 thereafter
- Minimum REC price of $40
- Maintenance Costs 1% of initial cost (IEA 2010)

The Community Model is a holistic model that builds upon the PFM findings to incorporate the third party benefits and internal intangible benefits realised by the Water Corporation over time. The future cost savings associated with becoming a sustainable company are estimated via proxies, assuming moderate reductions are achieved. The less tangible benefits realised by the Water Corporation, such as shorter environmental approval and social impact assessment times, could lead to direct future cost savings. These cost saving effects are considered small with only 2% reduction in approval costs being achieved; however, a multiplier can then be easily applied to show the sensitivity of the intangible cost savings to the overall feasibility of a renewable energy project.

Upon development of the two financial models, they have both been applied to ERWWTP. In applying the two models, the overall system size, REC prices and intangible savings are all varied in order to determine how sensitive a project's feasibility is to each input. Ultimately, upon varying each input, the minimum electricity price required to yield a positive NPV is determined. In order to compare each of the viable project options against each other the Internal Rate of Return on the initial investment is calculated, such that the highest return yielding option can be determined.

3. Results and Discussion

The ERWWTP will ultimately service around 700,000 people in the Rockingham and surrounding area. Similar to the Woodman Point Waste Water Treatment Plant, the ERWWTP can use biogas gas, given off as a by-product from the anaerobic digestion process to generate electricity on-site. Prior to combustion, the biogas is scrubbed removing any impurities and producing a gas comprising of between 60-70% methane, with a calorific value of between 50-60% that of natural gas (Mata-Alvarez, Macé et al. 2000). Figure 1below shows how the ERWWTP's electricity requirements can be offset from using biogas to generate electricity upon commencing stage two of the project in 2027.

In stage one of the ERWWTP there is insufficient effluent inflow to support the installation of any biogas generating capacity. As a result this paper will focus solely on the feasibility of PV cells as a generation source for stage one of the project.

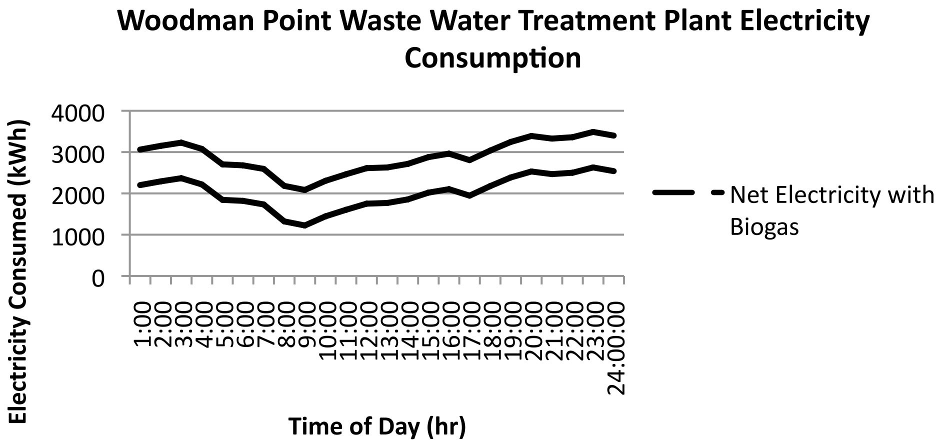

Figure 1 ERWWTP with Biogas Generation

After modelling the electricity demand for stage one of the ERWWTP, there was found to be no favourable orientation for the PV array. Figure 2 below shows how a 565 kW PV array both west and north facing offsets grid electricity demand. The west facing array generates electricity at a three hour lag relative to the north facing array, as shown by the right most curve below. However, as a west facing array creates greater grid savings for electricity retailers and network operators. The effects of a 50/50 combined north and west facing 565 kW PV array is also shown in Figure 2 below.

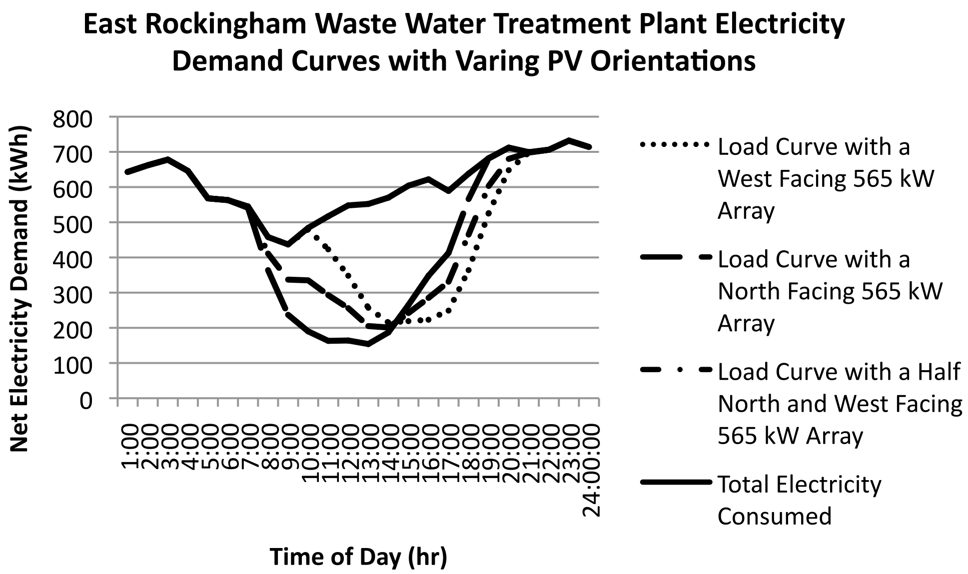

Figure 2 ERWWTP Electricity Demand Curves with Varing PV Orientations

Figure 3 below shows how the load curve for the ERWWTP would be offset with the installation of 170 kW, 282.5 kW and 565 MW west facing PV arrays.

On conclusion of the initial feasibility studies of the three PV systems, the 2 larger systems were found to produce a positive NPV. Table 2 below shows how the NPV increases with array size, due to economies of scale; while also showing how the magnitude of the NPV is increased with a single installation as opposed to a disjoint 50% installation in 2015 and 2017. It should be noted that this model is based upon existing prices and technology and does not factor in anticipated cost reductions in PV modules expected over the coming years. The future improvement in PV efficiencies and module cost reduction creates an upside potential

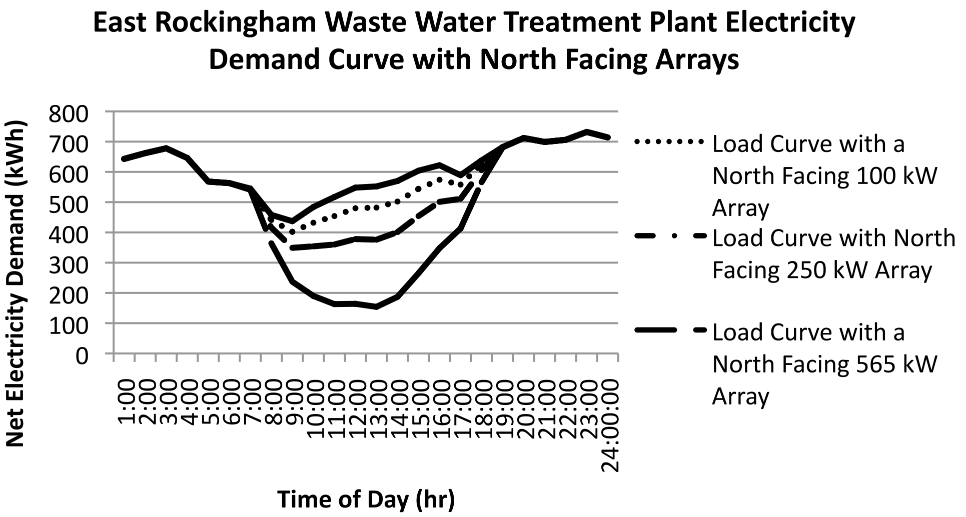

Figure 3 ERWWTP Electricity Demand Curves with North Facing Arrays

to this model, as cost/kWh decreases over time. In addition to the NPV the Return on Invested Capital (RoIC) before tax has been calculated and was found to range from -20 to 26%, increasing with array size.

	NPV ($'000)		Return on Invested Capital Before Tax (%)	
PV array size (kW)	**Split Installation 50% in 2015 & 2017**	**2015 Installation**	**Split Installation 50% in 2015 & 2017**	**2015 Installation**
140	-182	-156	-20	-17
282.5	-31	36	-2	2
565.6	603	643	24	26

Table 2 NPV and IRoR for the 3 PV Array Options

Due to the uncertainty surrounding the value of future RECs, a sensitivity analysis was conducted to show that an increasing REC price resulted in a higher NPV and RoIC. Table 3 below shows that for every $5 increase in the REC price, the RoIC increases by 2-3% and the NPV by approximately 9%, for a 565 kW system.

PV Array Size: 565 kW REC Price	NPV 2015 Installation	Return on Invested Capital (Before Tax)
40	643	26
45	695	28
50	757	30
55	819	33

Table 3 NPV's Sensitivty to the REC Price

Initial applications of the Community Model were found to yield both higher NPV and RoIC returns compared to the PFM. Table 4 below shows the effects of reducing transmission losses, generating network capacity and overcoming network augmentation, has on the NPV and RoIC for the 3 PV array sizes considered. From Table 4 below it becomes apparent that by acting as a sustainable organisation and internalising external third party cost savings, the overall feasibility of PV improves dramatically. Furthermore this model does not include the intangible benefits of improved company reputation, increasing trust within the community and higher moral and productivity within the organisation. The inclusion of intangible benefits via proxies is extremely difficult to quantify and from the conclusive evidence presented above, the feasibility of renewable energy would only be improved.

	NPV ($'000)		Return on Invested Capital Before Tax (%)	
PV array size (kW)	Split Installation 50% in 2015 & 2017	2015 Installation	Split Installation 50% in 2015 & 2017	2015 Installation
140	29	-2	3	0
282.5	394	499	26	33
565.6	1444	1546	58	62

Table 4 Community Model

4. Conclusions and Future Work

The application of the PFM analysis demonstrates that with realistic expectations about future electricity prices, the ERWWTP can offset part of its electricity usage from biogas and PV in an economically feasible manner. Furthermore by internalising external cost savings and attempting to capture the true value renewable energy creates for the community, the NPV increases significantly. In applying the PFM, the 565.6 kW PV array was found to have a positive NPV of $643,000 and with the addition of the third party savings encapsulated in the Community Model the NPV values increased to $1,546,000. The PFM and Community models in their current form offer significant upside with the inclusion of future cost reductions through technological developments and improved manufacturing capabilities.

6. References

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