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Design Needs of A Solar PV System For Winton – Queensland, Australia

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Abstract

To build a solar PV power plant in Winton the feasibility of installing a centralized of the system is required to investigated in order to replacing gensets with a solar PV/battery installation that will meet the town's needs. The PV modules will last 20 years, the other major electronic components 10 years and the batteries will be replaced every 7 years. The estimate of the costs of gensets installed at the site is very high. Maintenance is also high on these units in remote area. Estimate of the maintenance costs should to considered clearly. The inflation rate as 4.5% and use a discount rate of 9.5%. The project is financed with 60% debt and the interest rate on debt is 7.5%. Therefore, firmly that installed the solar PV system is cheaper rather than purchase new diesel powered gensets to meet the town's needs for the next 20 years. Which is the end of project life had earned remains unused fund is A$ 50 000.

Keywords: RET Screen, PV system, financial viability

1. Introduction

Winton Shire is a large locale of some 54 000kM^2 located in western Queensland (Qld), Australia. The expected population by 2011 will be between 1520 to 1560 people (Department of Infrastructure & planning, Qld Gov, 2010)

Figure 1. Winton map

Source: Google image, 2010

Winton is located in Central Western Qld on the Landsborough Highway, 178kM northwest of Longreach and 470kM south-east of Mount Isa. Winton is approximately 1500kM from Brisbane and is home to diverse landscapes: rolling Mitchell Grass Downs suddenly interrupted by mesa formations, starkly beautiful red earth and spinifex country, and channel country, undulating plains as far as the eye can see with a myriad of dry channels, waiting for the wet season (Winton Visitor Information Centre, 2010).

Table 1. Winton Shire Council operation plan 2010/11

Strategic functions	Outcomes	Strategies for implementation	Performance indicators and levels of service outcomes
Power/Electricity	To lobby government and implement programmes to ensure the provision of reliable electrical power in the Winton	Mayoral and councillor initiatives with political and department to maintain reliable electricity supply	Number of outages, energy audits

Winton Council in cooperation with Qld government decided to seek information regarding the feasibility of installing an off-grid solar PV power plant for Winton to allow the replacement of diesel-powered generators which are currently used to meet the electricity demand of 450MWh and the peak load of 65kW in the summer.

2. Design Criteria

Some specific design criteria:

- Cost of the solar PV modules (cost of the additional equipment, transporting to/from Winton - Brisbane
- Cost of the operational & maintenance (O&M) long and short terms (Modules PV will last 20 years, and major electronics components and the batteries will be replaced every 10 years and 7 years respectively.
- Estimated costs gensets installed predicted will be replaced every 6 years, annual cost for O&M and diesel consumption over the 20 years ahead.
- Calculated all possibility of inflation rate, fuel cost escalation rate, discount rate and debt involve interest rate on debt.

In order to manifest these calculations accurately, a design solution that will be used is **RETScreen** simulations and references that are most appropriate to fill the federal requirements.

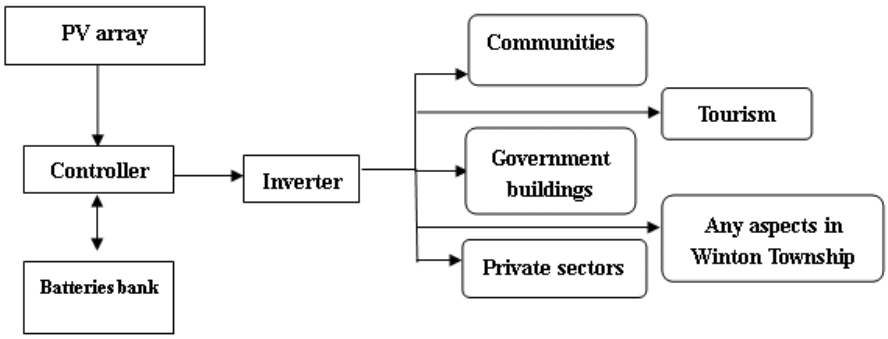

Figure 2. Off-grid DC systems model
Source: adopted of Hussam 2004, (modified by Amheka)

3. Solution and Discussion

3.1 Solution

The increasing use of diesel, exacerbated by uncontrolled environmental pollution, has given a view to Winton council in taking action to reduce the use of diesel consumption toward using environment-friendly energy. What are the possible technologies for producing off-grid electricity in Winton Township? The options include fossil fuel-based technologies (diesel generators) or renewable sources (Photovoltaic=PV). As a solution, it will need to describe the design and implementation of a PV electric power system in rural East Qld (Winton). The system provides 450MW annually of DC power and the peak load is 65kW for living and activities in Winton.

A number of costs associated with infrastructures, development, engineering, power system, annual operational & maintenance (O&P) including labour and unexpected costs such as damage equipment to build a PV system within this rural area may incur.

3.2 Discussion

Power is derived from 1605 units of PV modules and 165W of BP Solar panels and delivered via a charge controller to a set of deepcycle batteries, which ultimately deliver power to community and other sectors around Winton.

The panels will be placed on the land area in the middle of the village where batteries, charge controller and inverter inside one corner of that area exist. A specific location for equipment to support the PV system will be determined upon arrival on site

3.2.1 Power project

Some information was provided regarding Winton power system such as where this project would be implemented. The costs of used technology are two diesel generators: *John Derre* model 3029T with a capacity of 35kW and priced at A$ 11 250 each. The cost of fuel is A$ 1298 per liter which has a capacity of about 13 000kJ/kWh, and the annual O&M cost is estimated to be A$ 20 108.4 per year (see appendix 4: average diesel prices) for lubrication, plant staff. The load characteristic electricity DC daily is 1 232 877kW that will be supplied to this village. (RETscreen calculation, 2010).

3.2.2 Winton power system

There is an inverter type known as *Latronics sinewave* 1800W 48V, which will be used with the price of A$ 4200. The **685 units** of batteries bank to meet an electricity supply for four days is provided. The battery specifications are as follow: Deepcycle battery *sonnenschein* solar series 48V 300Ah with a price of @A$ 2200. Therefore, the total price for deepcycle batteries is A$ 1 507 000. (energymatters, 2010).

To earn annual solar radiation adequately using the fixed solar tracking mode with slope 33^0 and azimuth 180^0 were generated 449.54MW annually electricity with delivered to load is 99.9% by capacity factor 19.4%.

An appropriate module for this system which has been used is solar poly-si BP3165 with power capacity 407.4% as much as **1605 units** cost A$ 2 399 475 (@A$ 1494). (energymatters, 2010)

3.2.3 Cost analyses

Some information and high consideration have been decided involving a number of resources such as experts from local universities with their emphasis respectively on the economic development, power system engineering, environmental engineering, life cycle management and some industrial practitioners and also some from functional and service government bureaucrat.

There are generated results including total initial costs such as feasibility study, development, engineering, power system, balance of system and miscellaneous cost of A$ 1 471 923 (RETScreen calculation, 2010).

Cost of electrical design A$ 10 000 due to replaced every 10 years; therefore, this price was increased to A$ 100 000 (including charge controller and other electric equipment). The annual costs to O&M and fuel two gensets 35kW are predicted to be A$ 41 800 and A$ 214 respectively, with annual saving for this project about A$ 214 851; a periodic cost covered batteries that will be replaced every 7 years is A$ 2200, whereas for two gensets 35kW will be replaced every 6 years credited is @A$ 11 250. In terms of the end of project life had earned remains unused fund is A$ 50

000 (RETScreen calculation, 2010).

3.2.4 Financial analyses

In this stage, the calculations were done with a greater range of economical system to identify matters such as the initial cost of fuel by assuming it will escalate by 5% per year over the next 20 years since the start of the project. The inflation rate is as high as 4.5%, a discount rate of 9.5%. This project will be financed with the following breakdowns: 60% from debt A$ 883 154 and the interest rate on debt 7.5% with an annual installment of A$ 10 050 up to 15 years. The government has also awarded a grant of A$ 300 000 (RETScreen calculation, 2010).

To make an integrated approach in terms of financial analyses related with cumulative cash flow (see figure 3).

Pre-tax IRR- equity	39.3%
Pre-tax – assets	13.0%
	39.3%
After –tax IRR – equity	13.0%
After-tax – assets	6.7 years
	3.0 years
Simple payback	A$1 319 886
Equity payback	A$149 776/year
Net Present Value	3.24
(NVP)	1.85
Annual life cycle savings	A$366/CO2
Benefit-Cost (B-C) ratio	
Debt service coverage	
GHG reduction cost	

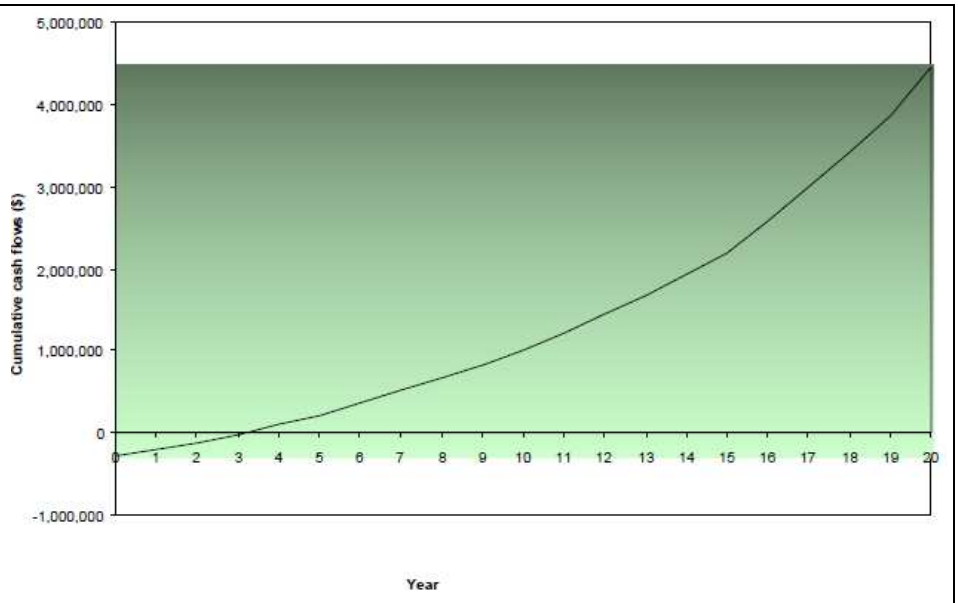

Figure 3. Financial viability
Source: RETScreen calculation, 2010

4. Conclusion

The PV solar system for a remote rural community has been the most appropriate choice which can reduce harmful

effects to the environment. It was a good thought of Winton council and QLD government in taking into accounts a possibility to build a solar PV in village Winton through *'solar conversion'* consultant's work.

The RETScreen has been used to solve the problems of this project under a working relationship with the experts from various backgrounds to achieve the goals. An important consideration to catch the electricity delivered to load the PV solar system is that engineers should think about the PV type and the power capacity that will be used and followed by a control method and miscellaneous percentage of the PV module.

How many batteries will be used and how long it would be work over the next 20 years and how these costs can be predicted and compared if diesel gensets are utilised (increasing fuel cost, O&M cost which is very high than other environment friendly energy) in terms of cost availability. It also will be a reference to the government and other consultants to prepare a budget of this project.

The time has arrived to put some effort towards this goal. Once the benefits start to appear, the programme will generate its own momentum, and there is no doubt that it will change the future of Winton, which can be an inspirational example to other rural/villages in all over the world.

5. Acknowledments

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