ENERGY MODELLING PLATFORM – AFRICA | 2023

INTEGRATED RENEWABLE ENERGY FINANCE OPTIMISATION FOR MINI-GRID POWER SUPPLY TO 15 NEIGHBOURHOOD CLIENTS IN TSUMKWE, NAMIBIA

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1. Context

- Solar irradiation of 3000 kWh/m^2 (2nd highest in the world)
- Low population density (2nd lowest in the world)
- About 50% of the Namibian population is unelectrified (30 000 households), consisting of 70-80% of the rural population
- Community main economy is cropping farming

2. Aim

- Ascertain project financial viability of Mini-grid in Tsumkwe
- Increase of power quality and reliability from the production of energy close to demand
- Eliminate dependency on the already strained main energy network
- Reduced loss from energy transport
- Environmental, health and security considerations
- Can employ a wide range of technologies
- Ideal for isolated communities with low energy demand

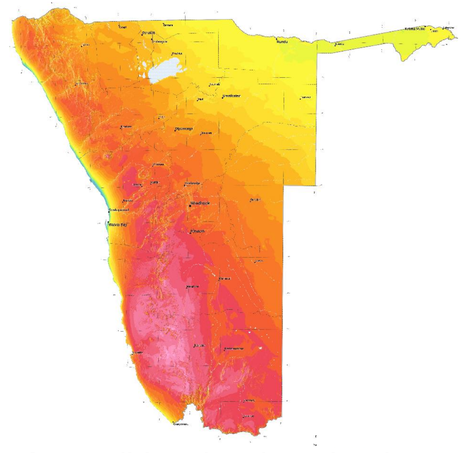

Figure 1. Map of Namibia showing the intensity of direct normal irradiation and highlighting the location of Tsumkwe (Global Solar Atlas, 2023).

3. Methods & Scenarios

FINPLAN was used to generate the key financial indicators to ascertain the feasibility of the microgrid plant.

Table 1: Project description and financing

Type of grid	Hybrid mini-grid solar-diesel-biomass-battery
Technologies	PV Unit, lithium batteries, steam turbine, biodigester, diesel generator
Location	Tsumkwe, Namibia
Construction period	2024-2026
Duration of plant	20 years
Inflation rate	2% USD/ 6% NAD (Steady rate)
Generated amount	0,1 GWh/year
Fuel cost	0,1 Million NAD/year
Discount rate	10%
Plant size	30 kW
Electricity price	NAD 2/kWh
Estimated cost	0,2 Million USD

Table 2: List of parameters and indicators used for the sensitivity analysis

Parameters changed	Parameters studied	Assumptions
Sale price 2 -10 N$/kWh	❑ Profitability (IRR & NPV) ❑ Dividends ❑ % return on equity	❑ 5 values: increments of 0,2 ❑ One parameter changed at a time
Investment 0,05 – 0,6 million USD	❑ Profitability (IRR & NPV) ❑ Dividends ❑ % return on equity	❑ 7 values: 0,05; 0,1; 0,2; 0,3; 0,4; 0,5; 0,6 ❑ One parameter changed at a time

4. Results

- The sensitivity analysis of the power sale price shows potential for profitability if salme price is doubled
- Capital investment is bottlenech for profitability as a plant of this size is not large enough to cover overheads

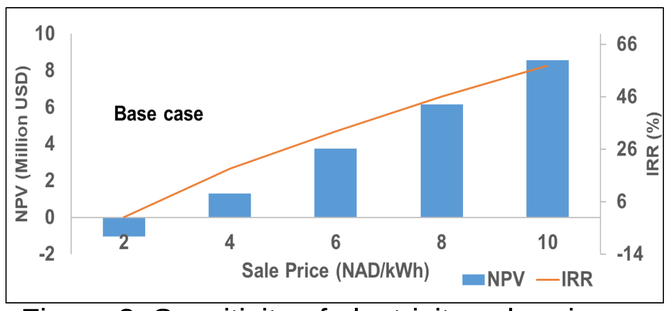

Figure 2: Sensitivity of electricity sale price on NPV and IRR.

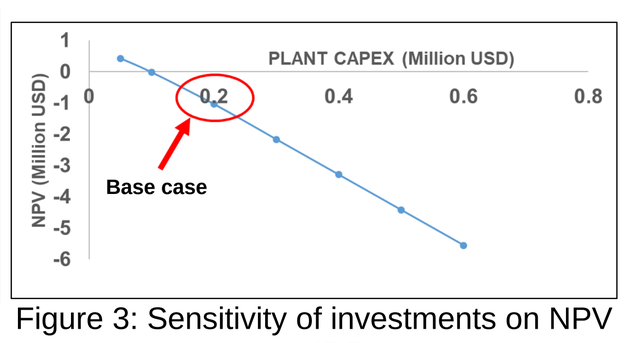

Figure 3: Sensitivity of investments on NPV and IRR.

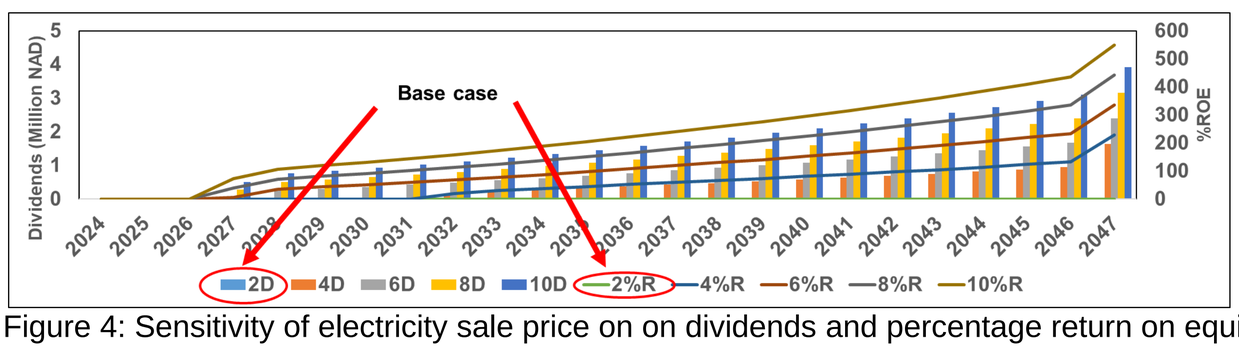

Figure 4: Sensitivity of electricity sale price on on dividends and percentage return on equity.

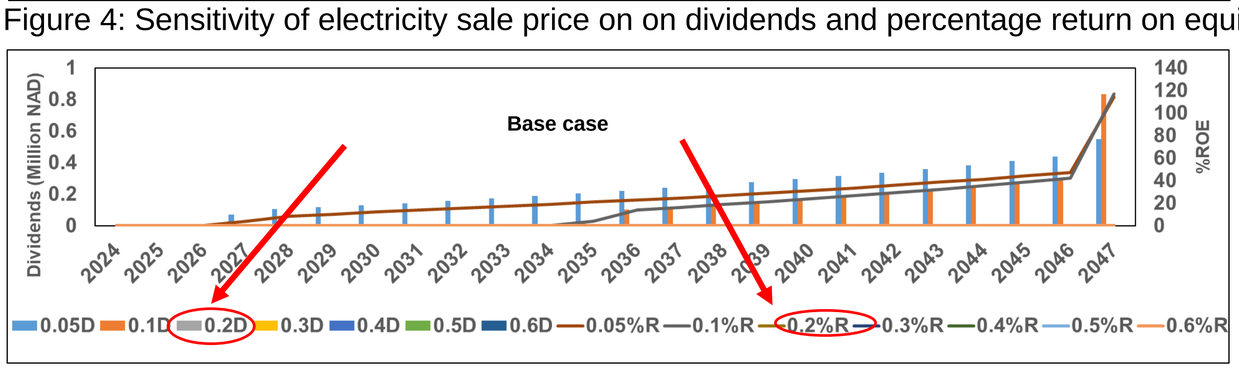

Figure 5: Sensitivity of investment on on dividends and percentage return on equity.

5. Policy insights, conclusions and future work

- *Base case model not profitable, plant is too small to cover overheads*
- *To make the plant profitable the following must be done:*
  - *Increase production (capacity index) to 150 GWh/year and above while keeping CAPEX fixed*
  - *Reduce the production cost to 0,05 million USD and below*
  - *Increase electricity sale price to 4 NAD/kWh and above*
  - *Reduce interest on loans*
- *Interdependency/nonlinearity of parameters*
- *Low interest loans provided by government*
- *Community subsidy of up to 50% for local consumption use (2 NAD/kWh)*
- *Expand the size of the hybrid plant to include the whole community (reduces overheads)*
- *Use differential electricity rates for residential, industry and service providers*
- *Consider other power conversion technologies in the hybrid system*

6. References

[1] Global Solar Atlas, 2023. Global Solar Atlas. [Online] Available at: https://globalsolaratlas.info/map?c=-19.478245,20.179138,9&s=-19.792549,19.978638&m=site

[2] Gesto Energy Consultants, 2012. Pre-feasibility study for the establishment of a pre-commercial concentrated solar power plant in Namibia, Windhoek: Polytechnic of Namibia.

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Contact: names and emails

A Cost-benefit analysis of Policy, Programs and Projects (C3PO) that is Retrievable, Reusable, Repeatable, Reconstructible, Interoperable and Auditable (u4RIA)