Optimising DC/AC Ratio for Higher Output in PV Solar

BTY BUILDING INTELLIGENCE

1. INTRODUCTION

PV solar facilities are typically designed using an industry-standard DC/AC ratio of 1.2. A number of articles have started to re-examine this issue, and some facilities have been constructed with higher ratios. This study examines the hypothesis that due to steadily decreasing module costs the optimum DC/AC ratio may be higher than 1.2. This has implications for Developers trying to maximize financial returns through:

- Taking better advantage of time-of-use power pricing in late afternoon
- Retrofitting older AC-constrained facilities
- Combining high DC/AC ratio designs with energy storage

2. METHODS

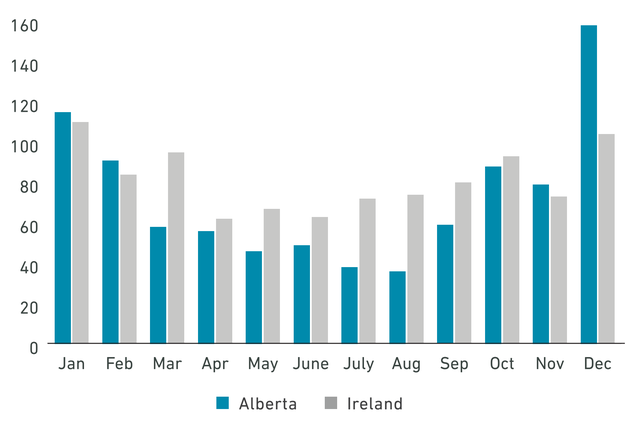
Capital and operating cost estimates were developed for representative fixed-tilt ground-mount designs. AC output was kept constant, and DC/AC ratio was varied from 1.0 – 3.0. Energy output was modeled using "Helioscope" commercial energy modeling software. CO2 offsets were included in the analysis. Two locations were studied: Alberta, Canada (good solar resource), and Wexford, Ireland (poor solar resource) to determine if solar resource quality had any impact. NPV and LCOE were calculated for each site at each ratio.

3. RESULTS

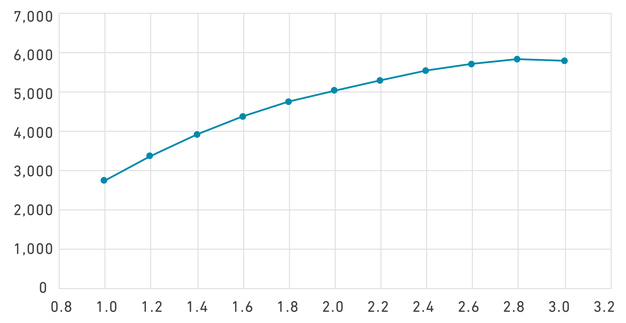
Key findings for the Ireland site are shown in the graphs below. The Alberta site showed similar results but with the optimum DC/AC ratio of 1.8. Other findings included:

- Based on NPV analysis, optimum DC/AC ratio was 1.8 for the Alberta site and 2.8 for the Ireland site
- Optimum ratio increased as power price increased (not shown)
- Optimum ratio was higher for the site with the lower quality solar resource (i.e., Ireland)
- The negative impact of inverter "clipping" did not offset the positive financial of greater DC capacity

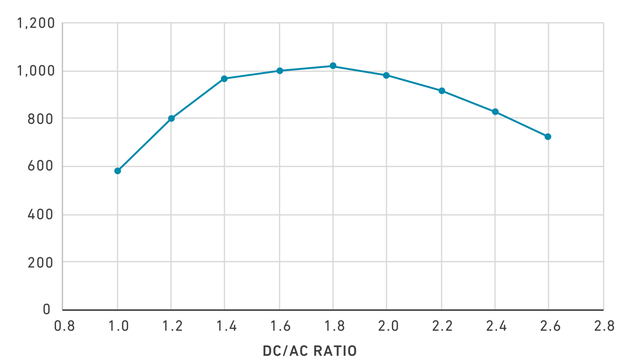
% INCREASE IN POWER, 2.6 VS 1.2 DC/AC RATIO



NPV, EURO (000'S), 25-YEAR AT €0.26/KWH
(IRELAND SITE)



NPV, $ (000'S), 25-YEAR AT $0.08/KWH
(ALBERTA SITE)



4. CONCLUSION

For AC-constrained sites, Developers should investigate using a higher DC/AC ratio for PV solar designs.

While each site is different, this study indicates that a thorough investigation of the financial benefits of using higher DC/AC ratio should be considered, including inverter capability.

We believe this has particular significance for sites coupled to energy storage, and locations where higher power prices prevail in late afternoon.

The results also indicate that "overbuilding DC" may be even more beneficial at locations where output is often limited by heavy cloud cover, such as Ireland, the UK, and Northern Europe.

5. NEXT STEPS

- The study did not address the technical aspects of inverter performance at higher DC/AC ratios, beyond what the energy modeling indicated. Many inverter models may have limitations at higher ratios, and issues specific to each site and selected equipment must be considered
- All costs were based on in-house estimates; working with an EPC contractor and equipment suppliers could provide more confidence that the selected final design was optimal
- More granularity could be useful to examine the impact of incremental output on an hourly basis vs. intra-day power pricing
- Study should be repeated for sites coupled to energy storage to examine optimal ratio for this configuration
- The impact of carbon pricing should be further evaluated, including scenarios where future carbon pricing is significantly higher than today and the financial impact of incremental output may be even more significant

ABOUT BTY

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