bluefield

Revamping and repowering renewable assets

For professional investors only

Executive summary

The paper below looks at revamping and repowering solar and wind plants, offering insight into the criteria utilised by Bluefield and the broader market to pinpoint optimal intervention timing. The rationale behind these benchmarks stems from comprehensive market research and Bluefield's hands-on expertise. Furthermore, the passage underscores the benefits from the successful execution of revamping and repowering initiatives.

Revamping is the replacement of faulty or old components in distressed photovoltaic (PV) or wind farms that no longer correspond to their original specifications and are beyond the scope of product warranties. Concurrently, repowering strives to increase the system's power capacity while remaining within the space limits of the existing plant. The following section outlines the essential metrics that trigger these interventions: low performance ratios, damaged components, leakage, decreased plant availability, and a drop in P50 capacity. P50 capacity represents the anticipated energy output that a renewable energy project is estimated to generate with a 50% probability under normal conditions.

By addressing these indicators, investors can leverage revamping to rejuvenate underperforming systems and repowering to augment capacity while minimizing costs. This is highlighted by real-world case studies that showcase the substantial gains achieved through these strategies, demonstrating their effectiveness in bolstering energy output, extending asset life, and enhancing investor returns.

Lastly, some of the key results of revamping/repowering are presented via case studies.

What is revamping and how is it different to repowering?

Revamping and repowering of solar and wind plants are project interventions that aim at restoring or increasing the performance and/or capacity of an existing plant.

Revamping

The replacement of faulty or old components in distressed photovoltaic (PV) or wind farms that no longer correspond to their original specifications and are beyond the scope of product warranties is referred to as revamping. These replacement components provide improved performance while maintaining the system's set power output. Revamping involves maintaining and restructuring existing photovoltaic systems to restore or enhance their initial efficiency.

An example of revamping for PV includes retrofitting solutions that improve energy performance, such as specialised coatings for pre-2013 uncoated solar modules, the replacement of inverters with more innovative and performing DC-AC conversion devices, use of more efficient bi-facial modules or the integration of modern software systems into the existing monitoring system.

Sometimes revamping can be carried out to update the production plant to the latest approved regulations in terms of health and safety or disconnection due to national power grid failures.

Repowering

Repowering, on the other hand, aims at increasing the system's power capacity while remaining within the space limits of the existing plant. Repowering can include replacement of old equipment (e.g. replacement of old turbines and gearboxes) with more efficient ones as well as a remodelling/redesign of the layout of the plant (like rewiring and/or reconfiguration of module rows in a PV plant or replacement of central inverters with string inverters).

Thanks to improvements in efficiency and technology, repowering can also include energy storage opportunities, or modifications to fixed-tilt angles of modules and the replacement of static structures with dynamic single axis trackers that are particularly suitable for bi-facial modules.

Similarities

Both procedures may include the partial or total replacement of electrical components, alterations to supporting structures, or changes to the plant's electrical configuration. The cost of this work has been made possible by the significant drop in the cost of equipment over the last decade. Regardless of the scope of the changes, the primary goal of revamping and repowering is to improve the performance of existing assets. This means either returning to or exceeding the performance ratio in the original investment case with the aim of outperforming the initial internal rate of return.

Benefits to investors

- Revamping improves the performance of solar PV and wind systems by updating components, resulting in higher energy output and improved efficiency for investors
- The plant's operating life is extended beyond its original lifespan, maximising income generation and return on investment
- Revamping helps investors achieve predicted returns by returning the plant's performance ratio to the original financial model
- Repowering allows the increase of capacity of an existing old plant by using same site/space and using part of the existing infrastructure (civil/grid connection) and hence extending useful life of the site without incurring costs that a completely new greenfield development would have
- Improved performance and extended asset life can raise the project's internal rate of return, giving investors with higher-than-expected returns
- Revamping and repowering increase asset value by making it more marketable, which benefits possible resale or refinancing possibilities for investors
- Addressing changes in rules and industry standards assures project compliance and reduces risks for investors
- Renovating reduces the risk of equipment failure and inefficiency, protecting investor capital

Identifying metrics for revamping/repowering

- Most ground-based plants with an average age of 5 years should have a PR (performance ratio) of 75% and above. If the PR falls below such similar thresholds, revamping is a viable option
- Damaged modules, inverters and cables would also require revamping
- Evidence of current leakage
- Low plant availability
- Fall in P50 capacity which refers to a decrease in the expected or predicted capacity of a renewable energy project, particularly in photovoltaic (PV) solar and wind energy systems
- The market average is to repower 30% of turbines after 20 years, this can be used a benchmark to repower turbines
- This above section underscores pivotal factors and metrics employed by Bluefield and the market as standards for gauging the optimal timing for revamping or repowering endeavours, drawing from both comprehensive market research and Bluefield's extensive operational expertise.

Post revamping/repowering results – our experience

- DC capacity (KWp) increases by ca 30-45%
- PR increases by 13-25% (revamping of technical distressed assets)
- P50 capacity increases by 30-45% (as above)

This section highlights significant outcomes resulting from the successful execution of revamping or repowering initiatives. Data recorded by Bluefield's in-house engineering team

European PV case study

Italy

In Italy, widespread adoption of photovoltaic systems resulted from generous incentives, leading to installations that might not have been optimally designed due to time constraints and fluctuating incentives. As incentives waned and regulations remained unclear, fears of losing incentives deterred plant owners from making improvements. In 2017, Italian authorities introduced regulations promoting revamping to address premature degradation and inadequate designs without sacrificing economic benefits.

Bluefield has been involved in various revamping for example in Italy, Bluefield acquired a 10 MW operationally distressed portfolio in Puglia. Following which, a CAPEX plan of ca 800k EUR was implemented to improve reliability, security and optimize generation. Some of the activities under these 3 umbrellas were:

- DC cable management and stringing for quicker reactions and better generation
- Grid studies to identify root cause of lower-than-expected generation
- Inverter ventilation optimisation
- Frequent thermographic analysis to identify any problems on strings or modules (e.g. PID or Hot Spots)
- Replacement and updating of relays for the protection of the PV plats against grid
- Improvement and updating of the Monitoring system for a quick check of all the information from or anomalies

As part of the revamping, Bluefield performed a complete replacement of existing central inverters with string inverters. The revamping was carried out on 3 different sites. The revamping now guarantees a higher performance of the PV plants, drastically reducing DC problems during start-up in the morning. The forced air extractors have also been reset and calibrated to ensure a correct temperature inside the cabins, especially during the summer season.

The revamping activities combined with restructured financing and commercial & tax optimization led to a high double digit Equity IRR on exit. Over a quarter of this upliftment in IRR can be credited to revamping

Due to low DC isolation issues and very high temperature in the User Stations, BSL performed a complete revamping of existing inverters (Ingeteam centralized) with Sungrow string inverters, including AC switches, transformers, and main CBs. The revamping was carried out on three different sites.

The revamping now guarantees a higher performance of the PV plants, drastically reducing DC problems during start-up in the morning. The forced air extractors have also been reset and calibrated to ensure a correct temperature inside the cabins, especially during the summer season.

European wind case study

UK

In Northern Ireland, there has been a focus on repowering portfolios of single turbines. This involves the replacement of existing wind turbines with newer, more efficient turbines on the same site. The newer turbines have a higher capacity factor and are able to generate circa three times the amount electricity as the older turbines. The repowering process is a multi-stage process which involves the following milestones.

- Planning permission must be sought for the replacement turbine
- The lease in place with the landlord may need to be renegotiated
- Management of the construction process which involves the construction of a new foundation, erection of the new turbine and the dismantling of the former turbine
- Notifying the regulatory authorities (OFGEM) during the repowering process

Bluefield are actively involved in the repowering of a portfolio of 17 turbines in Northern Ireland. The overall capital spend of the repowering program is expected to be circa £20m and once complete the electricity generated from the portfolio is anticipated to increase from circa 7.4 GWh to circa 20 GWh. The projected IRR of the investment program was a mid-double-digit figure.

Another such example would be a 38 MW project in the UK where Bluefield acquired this portfolio where a large percentage of the equipment had serial defects, which affected generation and safety. Bluefield carried out activities such as:

- Replacing monitoring system for quicker reactions
- Replacing Defected transformers
- Better planning remedies and regular audits & tests

This project generated a high double return with majority of this upside coming from revamping activity.

Conclusion

In conclusion, repowering and revamping activities help optimise the assets leading to better returns. The metrics for determining the right moment to revamp or repower are usually based on a benchmark such as PR, plant availability, yield and inverter health. The case studies presented further validate the effectiveness of these strategies, with Italy's success story demonstrating enhanced reliability and security, and the UK's example showcasing significant electricity generation increase.

Definitions

- Inverters: An inverter is a device that converts the direct current (DC) produced by solar panels into alternating current (AC).
- Bi-Facial Modules: Bifacial solar panels are a type of photovoltaic (PV) module that captures solar energy on both its top and bottom sides.
- Photovoltaic systems: A photovoltaic system is an electric power system that uses photovoltaics to supply usable solar power.
- Performance ratio: In the solar photovoltaic (PV) industry, the performance ratio (PR) is a metric used to measure the efficiency of a solar power system.
- P50: P50 is a statistical level of confidence that represents the best estimate of the predicted solar resource/energy yield.
- DC Capacity: DC capacity refers to the total wattage of all the solar panels in a solar power system.
- PID: Potential Induced Degradation (PID) is a phenomenon that can significantly impact the performance and lifespan of PV modules.
- Hot Spots: Hot spots are another issue that can occur in PV modules. They are areas on a solar panel where the temperature is higher than the surrounding area.

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