Guidelines for revamping and repowering solar assets

Repowering | Simone Mandica of asset manager WiseEnergy details how solar installations can be repowered to extend their service life and maintain high standards of technology.

Revamping usually involves the replacement of defective or obsolete PV technologies with modern, more efficient, and more reliable equipment. Most commonly revamping plans are implemented to address the problem represented by underperforming assets in comparison to the long-term expectations. If the improvement plan also results in increasing the original capacity of the plant, then it is referred to as repowering.

However, there are many facets to revamping and it would be misleading to associate it with an exercise that, although potentially challenging, is only limited to few specific technical actions, e.g. the replacement of the inverters or of the solar panels. Indeed, the full benefit of revamping is only realised when it is not limited to the immediate and urgent need to solve a particular issue but is based on a holistic approach. An approach that includes considerations about the expected health and condition of the plant in the remaining years of operations and results from a detailed understanding of the technical, planning, regulatory and financial aspects of the asset.

A revamping plan should start from reviewing the operational performance of the equipment, the engineering design of the PV project, its planning and regulatory compliance and continue with the assessment of how different scenarios would impact the plant over time. Each scenario will correspond to a different technical solution and, among all possible scenarios, the one delivering the best combination of financial and technical performance and of planning and regulatory robustness should be selected. Effective revamping will extend the plant's productive lifecycle, increase its commercial value, enhance its profitability, and make the PV project more bankable by retrofitting equipment with improved specification and design.

In the last three years, WiseEnergy has been supporting plant owners in modernising their fleet of 'first-generation' plants to secure revenue streams well beyond the assets' initially envisaged operational life of 20-25 years. From our experience, we can point to four useful metrics that can be assessed when considering revamping: (i) underperforming asset, (ii) unserviceable technology, (iii) ageing technology and (iv) investment opportunity, as discussed in detail below.

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i. Underperforming assets

Revamping is generally associated with solving the serious economic problem represented by a plant performing below the long-term expectations.

For example, this is the case when the level of equipment anomalies or degradation is higher than expected and therefore the production of the plant is below certain predefined limits. Then replacing the defective or sub-optimal equipment can be the solution to increase the plant efficiency and to bring its production to or above the expected level. This situation may also entail remedying poor installation practices which might have been due to the rush imposed by tight construction schedules or the lack of experience when the plant was initially constructed.

ii. Unserviceable technology

Expired or unenforceable warranties or the lack of technical support are becoming increasingly common reasons for deciding to replace PV equipment. Several module and inverter manufacturers have exited the market leaving serious challenges in terms of warranty claims and technical assistance behind them. In many instances, the most effective solution is the replacement of the modules or of the inverters with modern equipment from global, financially stable manufacturers that can also guarantee a robust after-sale service.

iii. Ageing technology

The inherent ageing of the key PV technologies may represent a sufficiently strong case for revamping, independently of underper-

forming equipment or construction defects.

For example, after eight to 10 years of operation, inverters will start experiencing more frequent faults resulting in the failure of their most sensitive and valuable components (for instance, IGBTs) or even of the entire device itself. Thus, replacing the ageing inverters will result in improved availability and reduced operational costs and this can be a valid alternative to extending their warranty, which is usually costly, or to the procurement of spare parts, for which storage and installation costs should also be considered.

As for PV modules that have been in operation for 10 years or longer, they may have lost 10% or more of their output power due to natural degradation; this decrease in production can be compensated through their replacement. This is usually a viable option for plants benefiting from a high feed-in tariff, as is typical for older assets.

iv. Investment opportunity

Even if the performance of an asset is meeting the initial expectations, a repowering plan, designed to increase the value and bankability of the asset, can represent a very attractive investment opportunity, which becomes particularly valuable if the plant is going to be bought, sold, refinanced, or reinsured. The question 'Does the proposed price fully capture the value of the plant?' will trigger a series of considerations on the present and potential value of the asset to which repowering can provide the answer. The answer is not always the replacement of the old technology with new products, but revamping also entails the installation of additional technical solutions that can optimise the plant performance and increase it beyond the predefined base case.

Example: Italy

A market particularly favourable to revamping is Italy, one of the first countries in Europe where the PV market started developing back in 2008-2009. At that time, and for some of the following years, the PV industry was literally in its infancy and relying on certain construction practices and equipment that nowadays would be deemed as sub-standard.

The focus was mainly on reducing capex and on short-term performance, while disregarding or only marginally considering the requirements for the long-term health of the plant. It is then this opportunity to improve the performance of old assets, in combination with the high feed-in tariff from which the same first-generation plants benefit, that makes the Italian market so attractive for revamping investments. These investments are made even more appealing by the fact that the process that must be followed to revamp old PV projects without compromising their original feed-in tariff is generally well defined and supported by an established practice. Indeed, the regulatory framework for revamping was defined by GSE., the Italian government regulator of the renewable energy market, already in 2016, and in 2020, new legislation was introduced to simplify the planning application for works aiming at modernising PV assets.

WiseEnergy has been designing and managing revamping projects in Italy since 2020. Initially, the key drivers for renovating old plants were mainly related to the need to replace underperforming or unserviceable technologies. An excellent example of this is the work we did on a portfolio of plants in preparation for its sale. The assets had been in operation for nine years or longer and had an aggregate capacity of approximately 100MWp.

We started reviewing the plants' historical operational performance, and the tests performed on the equipment to identify the most critical assets and technologies for which a revamping would be most beneficial. From our initial analysis it transpired that a staggering 35% of the portfolio's aggregate DC capacity corresponded to panels whose manufacturer exited the market long ago.

Not only were the associated panels not covered by a warranty, but also it was unsurprising to find that serious issues impacted their performance (e.g. excessive degradation, thermal anomalies, backsheet delamination or chalking, micro cracks) with a significantly higher incidence than that observed for the other modules. Our feasibility studies indicated that the case for replacing these modules was very attractive, with an internal rate of return (IRR) greater than 11%-12%. Based on these results, we managed the replacement of 12MWp of panels. This was a particularly rewarding project as our subsequent monitoring of the revamping costs and of the revamped plants' operational performance has shown that all interventions have had the predicted high IRRs delivered in practice.

From the second half of 2021, the approach to revamping in Italy became much more radical than simply replacing the modules or the inverters and was not necessarily related to solving the problem of suboptimal equipment and plant performance. Indeed, optimisation plans started being implemented involving the replacement of the fixed structures with single-axis trackers, of the old solar panels with modern bifacial modules and of the existing central inverters with string inverters.

In essence, by just keeping the total DC capacity and the connection to the grid unchanged, it became evident that it was possible to modernise every other aspect of a PV plant and to increase the annual production of even normally operating assets by more than 25%. Crucially, the original feed-in tariff assigned to the plant is paid also for the increased generation and this may make the revamping investment feasible even for a plant that is meeting the long-term expectations.

Revamping portfolio

WiseEnergy is currently planning this type of revamping on a portfolio of 35MWp; our feasibility studies indicate that there is a strong financial case to proceed and the aim is to break ground in Q1 2023.

It should be noted that one of the aspects that facilitate the design of a very effective revamping plan involving the replacement of the fixed structures with trackers is the high capacity of modern solar modules. The benefit of these panels is that they make it feasible to use tracking systems with one panel in portrait (1P trackers), and these usually allow (i) an optimal use of the existing area to (re)install the original DC capacity minimising the inter-row shading, and (ii) to achieve a maximum height of the new panels not deviating significantly from that of the original modules. The latter aspect is one of the requirements to access the simplified planning application process available in Italy.

The high-capacity modules offer the additional opportunity to include in the revamping plan the development of a new subsidy-free section. Indeed, new panels with a capacity of 650Wp or bigger have at least three times as much power as the corresponding technology of eight years ago; this means that less than a third of the area is now needed for the same generation.

Therefore, if old panels are replaced with new higher capacity modules, then, in the space freed up by the revamping, a new subsidy-free section of the plant could be built. We have increasingly experienced that the possibility to expand plants is becoming one of the key drivers in designing repowering strategies. In addition, requests to assess constraints related to permitting or to power export which could prevent

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the construction of a new section of the plant are made with increased frequency by owners. Further, it can be envisaged that as the market for grid energy storage systems grows, the freed-up space will also represent an opportunity to develop co-located battery systems.

Example: UK

The UK is another country where WiseEnergy has been very active in revamping activities. The British PV market started in 2011, later than many other countries in Europe, and therefore some of the lessons learnt in Germany or Italy, for example, were applied to the solar projects that were being constructed in the UK. This resulted in assets that have generally better design and improved equipment specifications than, for example, the Italian first-generation plants. Nevertheless, the ageing of the PV technology and the lack of technical support from equipment manufacturers are still taking their toll on the performance of the PV projects in the UK.

Based on our direct experience, most of the revamping works in the UK involve the replacement of inverters manufactured by companies that either left the PV market (Emerson, for example) or that, after the expiry of the standard five-year warranty, find it difficult to provide the necessary technical support such as spare parts and corrective maintenance to operate their equipment (Fimer and Gamesa, for example). Therefore, inverter stoppages that could be resolved promptly, usually have an excessively long duration and result in high revenue loss. Further, it can be envisaged that in the long run, as the inverters' fault rate increases, this situation will make the operation of these assets unsustainable. We have worked on projects so badly affected by the inverters' underperformance that our assessments indicate that the investments for their replacement can be expected to have an IRR greater than 12% and a pay-back period shorter than six years.

By managing the implementation of these projects, we have also had the opportunity to experience first hand another benefit of revamping: the newest inverters have a more robust design that guarantees their compliance with the latest development in the grid codes, therefore improving the integration of the variable solar resource into the electricity grid. It should be observed that while in the UK there are now established procedures that should be followed to guarantee the regulatory compliance of the inverters used in the revamping projects without compromising the energy tariff, the situation is not clear at all when it comes to the large-scale replacement of modules. However, WiseEnergy has been able to support customers through the lack of clarity and guidance from the regulator which is holding back many asset owners from embarking on modernising their portfolio following the example of the Italian market.

Equipment management

One important aspect of revamping plans is the management of the equipment which is replaced. The old panels should be disposed of in compliance with the national legislation for treating electrical and electronic equipment. In the European Union, asset owners have the obligation to organise the collection, the waste treatment, and the financing of the disposal of electrical equipment (including solar modules) in compliance with the Waste Electrical and Electronic Equipment, or WEEE, directive. This is usually achieved by relying on the services of companies that offer tailor-made WEEE-compliant waste management. The positive news is that the main materials of PV modules have high recyclability; for example, as for silicon panels, aluminium has 100% recyclability, glass 97%, silicon 85% and copper 78%. However, how much of the material is recycled effectively depends also on the process followed at the waste management facility.

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A similar approach is followed with inverters; but, it is also very common that replaced inverters are cannibalised for spare components that can be used on other compatible inverters. We have also seen that the remarketing of old modules is an economic opportunity that brokers in the solar sector have started to exploit. Used panels even of nine or ten years of age, still operating at the expected level of efficiency and with no visual defects, have a market in developing countries in the Middle East or in Africa.

In conclusion, revamping represents a clear opportunity for owners to modernise their portfolios with the latest technology, to meet our industry's evolving and new standards and to harness higher percentages of solar energy and ultimately to achieve a significant economic benefit. As the PV sector matures (also through the increased importance that investors, lenders and insurers are putting on higher levels of reliability, serviceability, and bankability), the 'revamping approach' should become an integral part of the initial project planning as opposed to an emergency solution to address operational issues.

In other words, considerations about improved technical specifications to guarantee plant longevity and stable revenues over the life of the system should not be postponed to the moment when it becomes clear that it will be challenging to meet the long-term expectations; rather, these considerations should be included in the initial planning process. The most beneficial outcome of the current revamping activities would be that their distinctive focus on improved, more robust specifications will become the cornerstone of the lifecycle of future plants. ■

Author

Simone Mandica joined WiseEnergy three years ago and developed the company's team specialising in designing and executing plans to optimise plant performance. This includes technical advisory services for revamping activities, the implementation of novel technical solutions for increasing the production and the design of strategies for the long-term management of the assets. Prior to this, he spent three years as senior technical manager at Innova Capital and almost five years as technical advisor at Mott MacDonald.