From optimum yield to maximum profit: how to develop solar projects with O&M in mind

O&M | Rarely does the planning and design phase of solar farms consider the subsequent operational management and its costs. Jörn Carstensen, managing partner at greentech, explores how unforeseen effects from development, procurement and construction can have a significant impact on the economic viability of PV plants.

Credit: greentech.

Partial shading from vegetation can increase the risk of hotspots forming on modules.

The yield assessment is highly relevant for the realisation of PV parks. It serves to determine the subsequent performance of the system and provides the various stakeholders with valuable information about their (possible) project. For project developers, it provides information about the yield potential of a site or land area. Banks and investors use it to decide whether the financing of the project or an investment is profitable or not. However, the electricity yield obtained is not the only decisive factor for the success of the park, which can sometimes lead to illusive profit prospects.

The expectations of lenders or owners regarding the yield of their plant are regularly disappointed. Whether a project will be successful in the long term depends not only on the yield of the plant. The investment costs (capex) and the operating costs (opex), as well as later dismantling costs, also contribute to the overall success of the solar park. Set in relation to the total lifetime, they determine the levelised cost of energy (LCOE) of the system. The lower the LCOE, the higher the economic efficiency of the system. It is therefore important to find the optimal balance between these determining factors.

Only a holistic and integrated approach enables low LCOE in the long term

Nevertheless, plants are still predominantly planned "unintegrated": project development focuses on the highest possible output from the available land – because it increases the sale price of the project rights.

The procurement of components and construction is carried out according to the premise of keeping investment costs as low as possible or obtaining the best possible payment terms. They account for most of the total costs of a PV system – their influence on the LCOE is correspondingly large. Unfortunately, quality, service concept and maintenance effort are not always at the forefront of the decision.

Rarely does the approval, planning and design phase consider the subsequent operational management and its costs. However, even though the operating costs for photovoltaics (to be estimated at about 1.5-2.5% of the total costs per annum) are by far the lowest of all renewable energy sources, these costs can cumulate to a substantial amount, especially, due to previously unforeseen effects from development, procurement and construction that could have been avoided. They can have a significant impact on the LCOE and have a lasting negative effect on the economic viability of the PV system.

Obtain O&M expertise at an early stage

Certain impacts on the LCOE from O&M costs can be identified at various core stages of project development and execution by experienced O&M professionals. If you do not have an integrated team at hand, relevant know-how can be obtained from external service providers. Occasions for cooperation include:

Did you know?

With costs between €0.03-0.055/kWh (US$0.03-0.062/kWh), ground-mounted PV systems of 1MWp and larger can produce by far the cheapest electricity of all renewable energies in Germany, according to the Fraunhofer Institute for Solar Energy Systems ISE. Although the information is from 2021 and it can be assumed that the costs will rise in the near future due to the current high demand and continuing inflation - PV investments are still attractive as a viable investment in a sustainable energy supply.

Site analysis. A PV site analysis involves the recording of all relevant information about a PV site and the route, which are necessary for project development, plant design, construction and subsequent operation. If necessary, it is supported by the creation of an exact digital elevation model of the surroundings using drone technology or by an analysis of the ground conditions. Among other things, they determine the preconditions for construction and already provide certain framework conditions that must be considered in the further course and can have an impact on economic viability. Ditches or hedges, for example, can have an impact on the accessibility for technicians or the accessibility for greenkeeping; nearby wind turbines or buildings can also provide additional shading. In an in-depth site analysis, these risks and their effects are highlighted.

Early exchange with the relevant authorities. Not all risks of a site can be derived from a site analysis. For example, environmental authorities may impose strict regulations on the construction and operation of solar parks in certain areas or set high requirements for the creation and maintenance of compensation areas. This can cause costs that are not apparent at first glance, but later have an impact on operating costs. An early check and active exchange with authorities can not only serve to influence later concepts but can also lead to refraining from a project at an early stage in case of unsolvable challenges.

Review of the yield assessment. As a basis for investment and financing decisions, a yield assessment must above all show a realistic picture of the expected result. If relevant risks or general conditions are underestimated, expectations may not be met in the end. Experience and performance indicators from operational management help to provide a picture of the developed plant which is as realistic as possible. It can therefore be helpful to have the results of the yield assessment neutrally reviewed by a specialist with many years of O&M experience.

Review of the system design. Today, software tools for creating PV plant designs and yield simulation software offer the possibility to quickly, easily and flexibly determine the optimal system design for the land and the local conditions with the best possible yield prospects. Among other things, different row spacings and tilts of the module rows can be precisely simulated and their effects on the yield determined. The use of different inverter and module products also has an impact on the yield. Here it is important to choose the models that offer the best solution in terms of price and quality for the given conditions. Once this has been done, it is essential to have an experienced O&M specialist look over the design from the point of view of its effects on later operational management. For example, it may be that the use of low-maintenance inverters is more expensive to purchase, but experience has shown that this can significantly reduce maintenance costs later on. In this case, it is important to provide the necessary cost transparency for both options to be able to make the right decision for the project regarding the LCOE.

Other ways to incorporate suggestions from O&M during the development and design phase include a review of the plant IT regarding remote monitoring and control. It is important to implement a reliable, secure and least complex system from the very beginning, which is less prone to faults and does not have to be rebuilt soon after the start of the operating phase. If, for example, the monitoring's remote access to the components of

Case study: Vegetation maintenance as a risk factor for LCOE

The following example shows that seemingly small challenges can lead to a significant increase in LCOE. In this case study, the lower edge of the modules of the ground-mounted system is at a relatively low level of 60cm, meaning that invasive and fast-growing vegetation gradually shades the lower module rows quickly. This aspect is not considered in the yield report as the basis for financing the system, but – as determined by greentech's operational management – leads to a long-term yield loss of 4% on average per year.

In terms of operating costs, this is accompanied by an increased need for green maintenance to keep the vegetation flat and, above all, to keep the lower rows of the modules permanently free from shading. Partial shading also increases the risk of hotspots forming on the modules, which can lead to shorter inspection intervals in the long term and, as the system ages, to higher repair costs.

In addition, the rack system installed has diagonal braces, which means that it is not possible to work efficiently with larger equipment underneath the tables. This leads to greater manual effort and correspondingly high costs. In addition, the mown greenery must be disposed of outside the site due to planning requirements. The authorities generally prohibit mowing between March and August due to the protection of species of ground-nesting birds. Permanent grazing with sheep is also not permitted for this reason. In this particular case, an individual solution was found in consultation with the environmental authority, which allowed an earlier grass cut under the supervision of an ornithologist.

In the long term, these non-negotiable framework conditions result in 15% higher O&M costs, an 8% increase in LCOE and a failing financing model for the plant.

How could things have gone better?

In this case, the O&M experience and perspective could have provided informative and solution-finding support from the very beginning.

Early contact and exchange with the environmental authority could have made the existing animal welfare measures and green maintenance conditions that later resulted more transparent at the beginning of the project development phase. In this way, it would have been possible to participate in the development of the ecological concept for the facility at an early stage and thus contribute to solving the problem at an early stage. It would have been conceivable, for example, to use slow-growing plant species to keep the operating costs as low as possible through less mowing activities per year. If this had not been possible, at least the prevailing environmental regulations of the authorities and the mowing ban could have been identified and communicated early on as a risk and significant influencing factor on the LCOE.

In this case, changes in the plant design and yield calculation might have been more obvious, leading to a more realistic picture of the plant's yield, LCOE and economic profit. For example, a different design might cause less shading, or a different substructure of the modules might allow better implementation of green maintenance at lower cost.

At the very least, the yield assessment could have anticipated the shading of the lower module rows due to the mowing ban and made the long-term effects on the yield transparent, leading to an appropriate price for the project rights.

the plant goes over several routers with different access rights, this makes the monitoring process more difficult and can mean a considerable amount of extra time per day. This also increases the likelihood of failures of the system and costs of operation management accordingly.

The technical input from operations management can also be useful when developing a concept for plant security. For example, to protect against theft, plants are usually secured with a fence to prevent unauthorised access. However, wire mesh fences need to be regularly repaired or maintained as they are repeatedly damaged by wildlife or heavy weather. Pole mats fences may be more expensive to purchase, but they are also more stable and less likely to need repairs later. This is especially relevant to consider for systems with sheep grazing. Often this type of stable fencing is also sufficient to obtain the required insurance cover for the facility. Other high level security technology with high maintenance requirements can then be avoided. In any case, it is necessary to look closely at which combination of security measures in construction and operation makes sense and are sufficient to protect the facility efficiently, to obtain the required insurance cover and to contribute to a low LCOE in the long term.

Thinking outside the box promotes low LCOE, high plant quality

Only the creation of transparency about the risks of all project phases enables a realistic picture of the economic potential of a photovoltaic system. It is important to identify and analyse the existing LCOE-relevant aspects as early as possible and to determine their scope for each project phase. This should be done with an interdisciplinary approach from a common perspective, because from "inside the box" many risks do not appear as such at first or are possibly underestimated in their significance and scope.

Experience from O&M can help to find solutions for certain challenges at an early stage and even eliminate them altogether as risks for high LCOE. For other risks, suitable options for action must be thought up so that subsequent operating costs and the impact on LCOE are as low as possible. If no solutions for relevant risks can be thought of or implemented, the sales price can be adjusted or in the worst case the project can be stopped early to avoid high planning efforts and unnecessary costs.

A great added value of this interdisciplinary look "outside the box" is certainly also the sensitisation of the individual disciplines to LCOE-relevant aspects in the PV value chain. The findings not only enable new best practice approaches in project development, but also ensure reliably and economically operating plants and satisfied operators and investors in the long term. ■

Author

Jörn Carstensen joined greentech in 2014 as business development manager and has played a key role in shaping the company's growth path. In addition to entering several European markets, he built up the engineering and technical advisory division. Today, as managing partner, Jörn is responsible for the energy services unit of greentech, which covers O&M, asset management as well as engineering and technical advisory.

Credit: greentech.

Slow-growing plant species can be used to keep operating costs as low as possible.