

# WHITE PAPER ///

## OPEX reduction plus performance improvement

Introducing advanced  
data analysis to asset  
management



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# 1. Advanced data analysis for PV plants

The PV industry has experienced both dynamic change and growth in recent years. Changes include the maturation of renewable energy markets and the expiration of feed-in tariffs and incentives for PV plants in Europe and elsewhere. Not only has this initiated a massive consolidation of the industry, but it has also increased the commercial pressure on PV asset owners and managers to optimize their PV plant operations and reduce their OPEX in a sustainable manner.

Furthermore, the consolidation of the industry has resulted in numerous companies owning or managing hundreds of PV plants with slim in-house teams and, therefore, a very real need to industrialize their PV plant supervision and analysis.

To serve this purpose, providers of advanced data analysis are increasing in number and vary in type and scale. Despite this established offering, the concept of advanced data analysis is still relatively new and has experienced a slow integration into the traditional PV asset management structure.

This paper will expand on the subject of advanced data analysis in combination with the current key asset management component of operations and maintenance (O&M). Furthermore, this paper will attempt to shake up the current thinking around the operation and management of PV assets, and offer solutions for a way forward appropriate for the times.

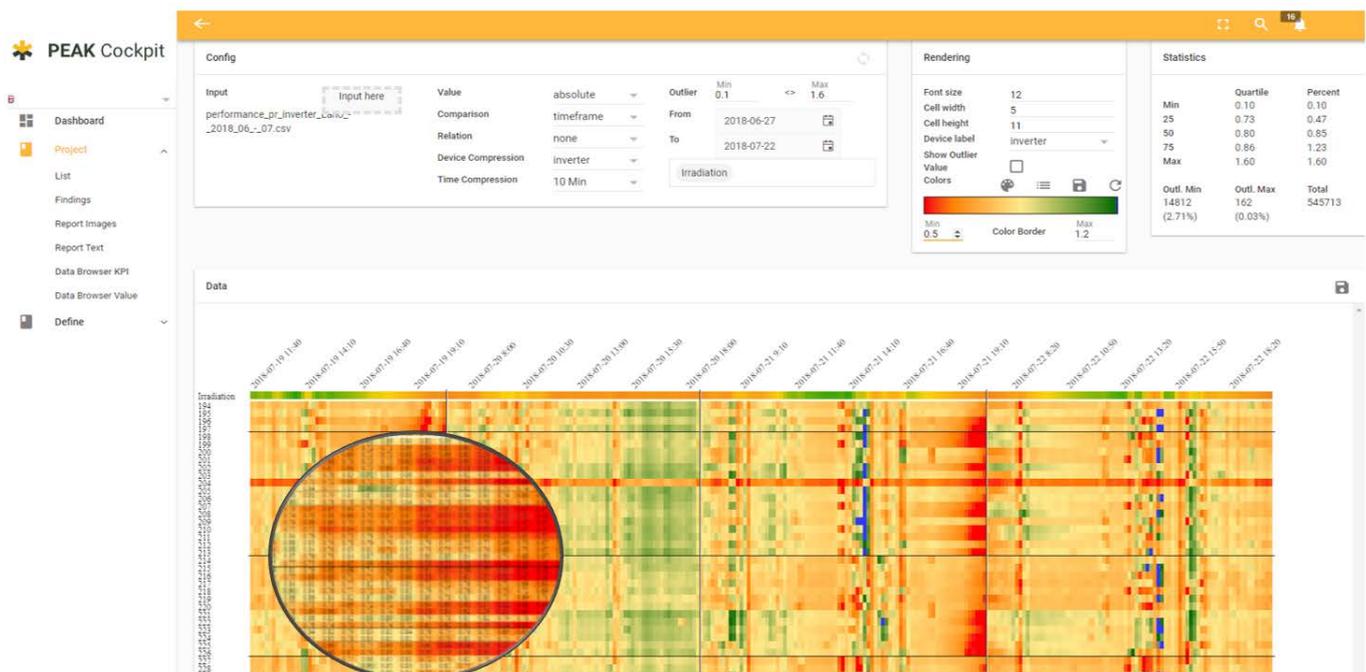


Figure 1 - Example of advanced data analysis



## Operations & Maintenance

O&M contracts, by definition, are an essential aspect of the functioning of PV plants and are intended to guarantee plant performance for the duration of a PV plant's life. Contract durations vary from long-term contracts beyond twenty years to short-term contracts between one and five years. The advantages of the longer-term contracts are guaranteed cost bases and predictability. Whereas, the shorter contracts allow for flexibility and adaptation to market and cost developments.

Alteso conducted a benchmarking to gain more insight, and to offer our clients a point of reference, into the actual OPEX (figure 2) and O&M costs (figure 3) in various regions of the world.

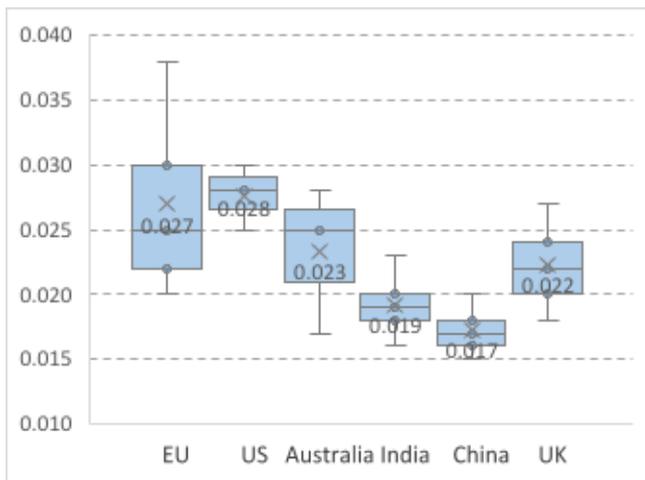


Figure 2 - OPEX benchmarking [EUR/MWp/year]

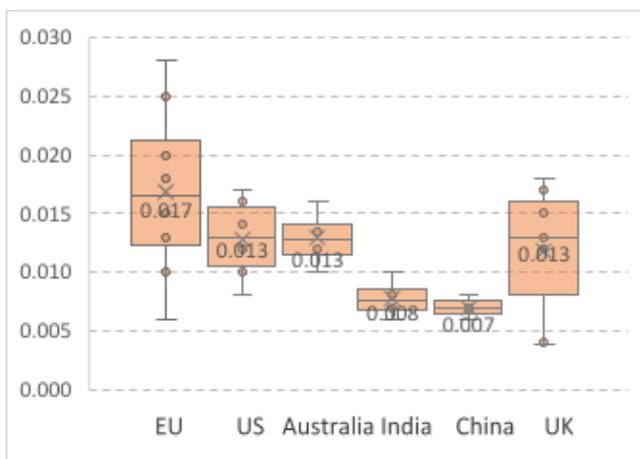


Figure 3 - O&M cost benchmarking [EUR/MWp/year]

In addition to this, using the example of the United Kingdom, figure 4 shows a significant decrease in O&M contract fees over the last eight years.



Figure 4 - UK O&M contract fees converted from GBP/MWp to EUR/MWp<sup>1</sup>

The majority of plant operators are not benefitting from these developments and are still locked into lengthy, old-school O&M contracts. These contracts tend to be based on corrective, scheduled and preventive maintenance and rarely include bonus schemes incentivizing the O&M service provider towards higher-than-guaranteed performance. From the O&M service provider's point of view, scheduled maintenance work is naturally preferred and desirable, in the context of the significant downward pressure on O&M fees that they are facing. Scheduled maintenance allows for clear resource planning and a wide service capacity. Additionally, scheduled maintenance work is unlikely to fail, whereas newer and more outcome-focused approaches are more challenging to fulfil. This is due to the fact that the bias is on solutions and improvement, not just on replacing consumables following a standard procedure.

<sup>1</sup> modified from John O'Toole, Gresham House New Energy, contribution to PV Operations Europe, 13-14 February 2018, Munich



Major industry players in Europe have informed us that their operational and analytics teams have to focus most of their available time on the 10-20% of problematic plants, while the other 80-90% of plants remain out of focus. Their slim teams deal with the day-to-day operations by fixing plants with bad availability (e.g. 10-20% of the plants showing 40 times more faults than the remaining 80-90%). The reasons for bad availability of these plants are often known but the maintenance and repair measures take a significant amount of time resulting in limited time to proactively optimize the plants with good availability (80-90% of the plants). Therefore, a renegotiation and rethink of the standard O&M contracts seem to be overdue.

## 2. What is advanced data analysis?

There is an avalanche of buzz terms like big data analysis, cognitive approach, actionable intelligence, industrialization and prescriptive analytics, to name a few, being used to describe the industry 4.0 trend towards automation.

As previously mentioned, lengthy repair measures and a concentration on plants with bad availability leave little time for optimization of remaining plants and also make a clear case for the industrialization of analytics.

Companies continue to focus mostly on growing big, either organically or through mergers and acquisitions, and to collect data without conducting in-depth analysis. Another outcome of the acquisition of numerous plants from many different former owners (common in Europe due to strongly diversified development of the PV plant business and consolidation of many small plants nowadays) results in vastly differing qualities of monitoring systems and monitoring data. This creates the need for analysis engines with maximum compatibility and flexibility in collecting and processing such data.

Industrialization, by definition, implies automation and enables more insights with less effort.

***“The ability to capitalize on data insights and analytics can make or break a company. And big data, artificial intelligence, and predictive analytics have every organization scrambling for an advantage.”<sup>2</sup>***

PV plants collecting large amounts of data through their monitoring systems require an automatic or semi-automatic analysis of such data to gain actionable insights for plant improvement. Despite the abundance of data and the increasing desire to extract the most value from it, many companies still struggle to turn their big data into impactful insights and financial benefits.

Asset management generally requires Enterprise Resource Planning (ERP) and ERP software for support, a remote monitoring and control system at plant-level, operated by the O&M contractor, and a Central Monitoring and Asset Management System (CMAMS) for supervising the asset portfolio. It is at the monitoring level that plant improvement is often capped.

The avoidance of losses and the resulting increase in kWh of weather-corrected electricity generation significantly boosts profits. Descriptive, diagnostic and predictive analytics only assist on a limited basis. It is in the interest of asset owners and asset managers to take this further to a prescriptive and solution-focused maintenance approach, as shown in figure 5.

<sup>2</sup>Retrieved 15 August 2018 from <https://www.forbes.com/sites/insights-cisco/2018/08/15/6-reasons-why-investment-in-analytics-is-essential/#52f48105eff4>



Some see 4.0 as a technological revolution, others as a natural and ongoing development of technology; whichever perspective, the trend towards automation in PV asset management cannot and should not be ignored.

### Example 1 – Reduction in labor costs

The examples in this section offer details from reference PV plants based in Europe and focus on two different types of labor cost reduction.

#### 1a – Routine physical checks performed by an on-site O&M team

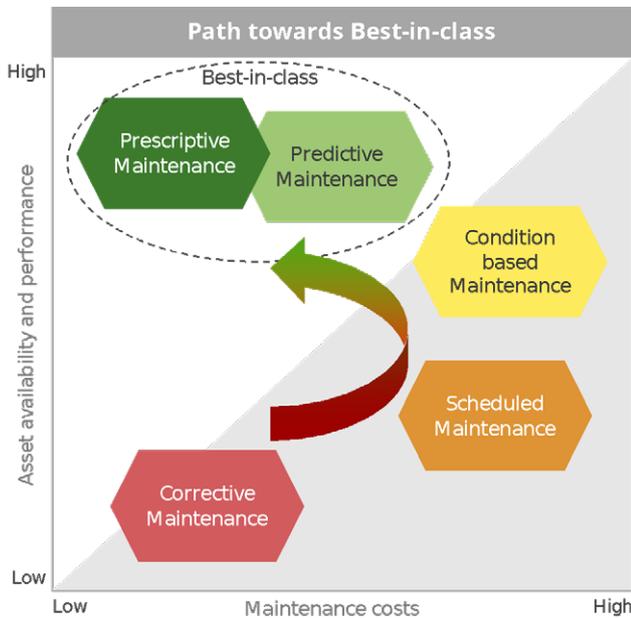


Figure 5 - Path from corrective full-scope maintenance towards predictive and prescriptive maintenance



Using advanced data analysis, it is possible to provide the O&M team with clear and targeted areas for inspection, as shown in the data visualization above, which highlights faults at the string and combiner box level.

### 3. In practice

Alteso developed PEAK to offer advanced data analysis for quantification and translation into clear improvement measures and actionable recommendations on a collaborative and long-term partnership basis with asset managers and owners. The client plant data, only used by the monitoring team for a fraction of its uses, offers insights into plant behavior and PEAK’s advanced data analysis takes these insights through a process of in-depth, iterative analysis (including machine learning).

In the case shown here, the set-up at the time of our analysis was for the on-site O&M team to physically inspect all strings at this 20 MW plant. Based on the following calculation, the total cost to the client was approximately Euro 38,000 and 4.5 months.

This section provides three practical examples of advanced data analysis resulting in OPEX reductions, whilst keeping performance at a constant or, in many cases, improved level.



Client Cost		O&M	PEAK
Manpower	[mp]	2	0
Number of strings	[#]	4100	4100
Time per string check	[min]	10	--
Number of strings checked per hour	[#/hr]	6	--
Number of strings checked per day	[#/day]	48	--
Duration in days	[days]	85	--
Extra time for report per day	[hr]	1.0	--
Total extra time for report	[hr]	85	--
Time for check of all strings [hour]	[hr]	1367	--
<b>TOTAL Time for check and reporting</b>	[hr]	<b>1452</b>	<b>1 (monthly reporting basis)</b>
Number of hours per month (excl. repair time)	[hr]	160	160
Number of months (excl. repair time)	[month]	4.5	1
Number of checks possible to perform per year (excl. repair time)	[#/yr]	2.64	--
Salary and personnel related costs per month based on 2 MP	[EUR]	8,400	--
PEAK fee (1,500/MW/YR)	[EUR]	--	30,000
<b>TOTAL COSTS PER ROUTINE PHYSICAL CHECK</b>		<b>38,117</b>	<b>N/A</b>
<b>TOTAL ANNUAL COSTS</b>		<b>100,800</b>	<b>30,000</b>

Table 1 - Client cost calculation for O&M vs PEAK

Once an advanced analysis service cooperation is in place, the remote inspections are reported on a monthly basis. In the case of the client highlighted here, this equates to a time saving of 3.5 months for repairs to be conducted, resulting in swift performance restoration and performance improvement of 1-3% in most cases. The annual fee for such an advanced analysis service on a continuous basis is an additional OPEX factor for the asset manager. However, the result is still an OPEX reduction per year, on a comparable continuous physical check basis, of approximately 70%. The analysis results continue to be reported on a monthly basis and more frequently where appropriate, avoiding time lags and preventable performance losses.

### 1b - Preventive maintenance only checks

This example is for a 6 MW PV plant based in Europe.

Our initial analysis of this plant was finalized shortly before the client was about to commence preventive maintenance checks through its O&M provider. The client had

already scaled down its O&M contract to cover only basic/preventive maintenance checks at a cost of Euro 48,000 per year, as opposed to the Euro 72,000 the client had been paying prior to this for full-scope O&M, making a saving of 34% per year.

Similar to the situation described in example 1a, the advanced data analysis provided the client with a targeted check overview, reducing the time necessary to carry out the preventive maintenance checks. The O&M team required five days for their usual preventive maintenance checks and the targeted checks reduced this time to two to three days, a saving in time of approximately 40%.

An O&M contract based on a further reduction in price for only on-demand O&M would probably not result in the full 40% cost reduction. The O&M provider would need to factor in a more flexible approach and is on a reduced mandate and would, therefore, insist on a less significant fee reduction. Even taking this into consideration, this could still result in a saving of between 30-35% in O&M costs. Factoring in the fee for advanced data analysis of approximately Euro 1,500/MW/year this is



an OPEX reduction of 10-15% for a case where substantial O&M reductions have already been made prior to the use of advanced data analysis in combination.

Asset managers, who are starting from the point of full scope O&M and reducing down to on-demand contracts in combination with the use of advanced data analysis, would profit from the combination of the full decrease of approximately 40% (on-demand O&M contract plus advanced data analysis fee). This decrease allows for a reduction in preventive maintenance checks to every two to three years as opposed to annually.

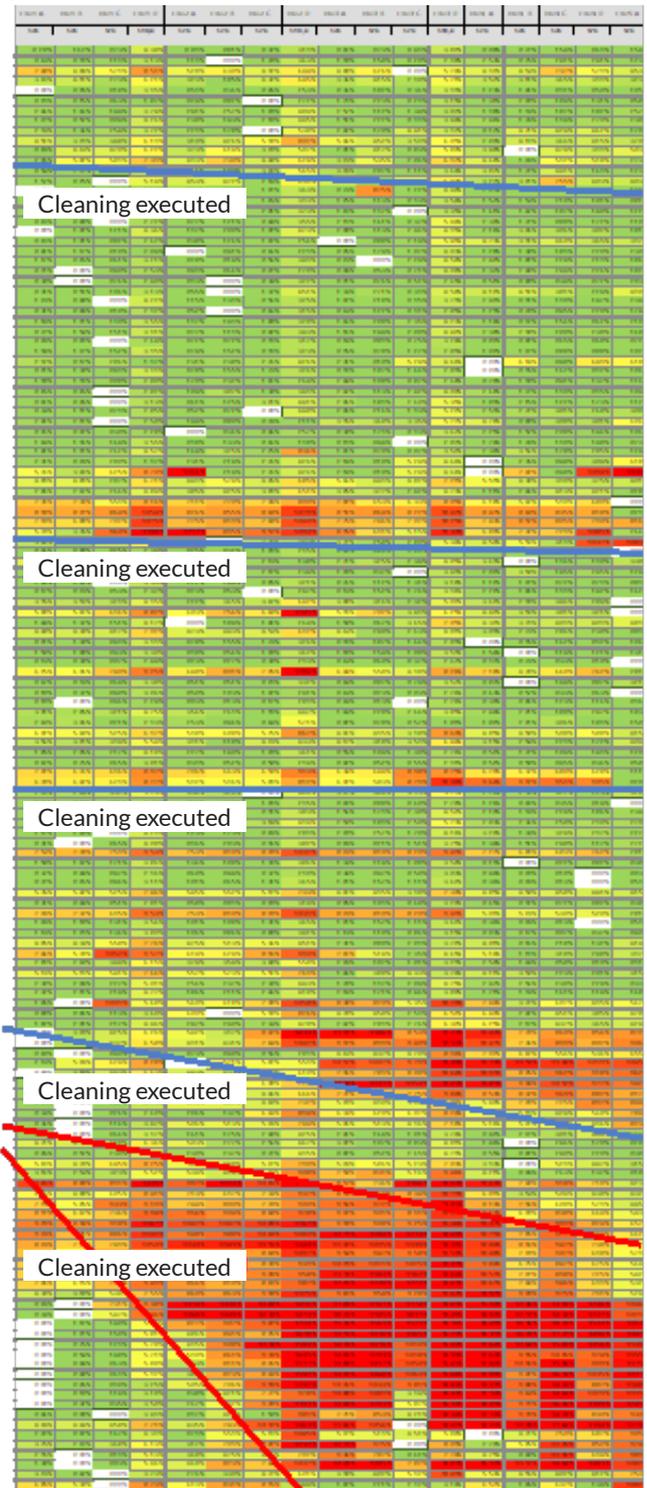
For this example of the 6 MW plant, as for the previous example, there was also a performance improvement of 2.1% as a direct result of the actions implemented.

### Example 2 – Scheduled cleaning Europe

Scheduled cleaning, although often an additional maintenance aspect and cost factor, is negotiated in the O&M contractual set-up as a standard with approximately two to three cycles per year, in the majority of cases that we have come across. A large number of older O&M contracts still use the basis of Performance Ratio (PR) guarantees. For the O&M team, vegetation control and cleaning are the few aspects that are, in the current set-up, seen as being areas of influence for them in guaranteeing PR<sup>3</sup>.

<sup>3</sup>Retrieved 15 August 2018 from <http://www.solarpowereurope.org/wp-content/uploads/2018/08/OM-Best-Practices-Guidelines-V2.0-1.pdf> page 56.

### 2a – Optimised cleaning processes



In this example of a 20 MW plant in southern Europe, we focus on the performance improvement gains and OPEX reduction as a result of optimized cleaning processes.



Through advanced data analysis we were able to provide a location-optimized cleaning strategy for cleaning the dirtiest areas first.

The PEAK analysis revealed soiling losses of 5% impacting 35% of the plant, which equates to losses in kWh. The soiling of the plant indicated partial soiling on locations, where the cleaning team did not clean for an extended period of time. Additionally, the soiling intensity varies depending on the location. A tailor-made cleaning strategy (as opposed to a standard cleaning schedule) allowed the team to focus their efforts on cleaning the most affected areas, reducing soiling losses by at least 50% and resulting in an annual increase of approximately 175 MWh, equating to Euro 35,000 (assuming a PPA level of 200 EUR/MWh).

This type of analysis requires a six month observation period of detailed string data with verified cleaning dates for each string.

The optimized cleaning schedule included:

- Regular PEAK cleaning recommendations, including the location of the modules with the highest impact on production due to soiling and an optimized route for the cleaning team
- Alteso verified success of the cleaning strategy.

In this case, the client was spending approximately Euro 80,000 on two scheduled cleaning cycles per year. Our optimized schedule cut this down to the dirtiest areas covering 35% of the plant. This results in an annual saving of approximately Euro 50,000.

Our advanced data analysis shows if, when and where to clean first.

<b>Production loss mitigation</b>	€35,000 (170 MWh)
<b>OPEX optimisation</b>	€50,000
<b>Total annual monetary benefit</b>	€85,000

This is an approximate calculation and, due to complexity, does not include all the details specific to this reference client. However, it does allow for plus/minus on the number of cleaning cycles and the fact that there was some mitigation in the original scheduled cleaning.

The annual fee for the advanced data analysis services of Euro 30,000 (1,500/MW/year) would be justified by these savings alone, and this is just one part of what was covered and identified for the client.



## 2b – Eradication of scheduled cleaning

A common finding of our advanced data analysis for European plants, on the subject of cleaning, is that no scheduled cleaning is necessary. However, this is often included as a standard, with approximately two to three cycles per year calculated into the offer, or charged in addition as in the previous example. Due to rainfall of more than 1 l/m<sup>2</sup>/min at a plant with a 30° tilt, as assessed for a number of our client plants, modules are cleaned sufficiently to skip cleaning procedures.

In such cases, cleaning can be removed from the O&M service offering completely or reduced



to once every three years. Using the figures from the previous example to illustrate the cost savings for a 20 MW plant, this would mean an annual OPEX reduction of approximately Euro 80,000 or approximately Euro 65,000 for one cycle every three years shared across the annual budget. Again, here the annual fee for advanced data analysis needs to be considered, but only partially, as this is just one aspect for which the analytics is beneficial.

For each of the examples in this section, there has been no calculation made for water costs, which would be an additional cost aspect in each calculation.

### Example 3 – spare part management optimization

Here we provide an example of advanced data analysis translated into actionable intelligence. The prioritized action item lists, which act as a guideline and working instruction for fixing defects and mitigating underperformance, are incorporated in the ticketing system of the CMAMS. These action items provide insights for inventory and optimized spare part management.

The reference client's existing CMAMS included a "Spare Part Management" feature for which we coded extra scripts for integration of PEAK insights into the CMAMS. This resulted in a spare part inventory overview and clear instructions for an increase or reduction of parts.

Our work with the client was focused on three plants, totalling 100 MW and based in a 100 km radius. Spare parts were based in three warehouses located at each of the plants.

Total warehouse costs for all three plants were approximately Euro 15,000 annually (Euro 150/MW/year) and spare parts costs for all three plants totalled approximately Euro 400,000 annually.

This optimization of spare part management based on predictive maintenance insights and near future needs for spare parts versus spare parts on stock results in a 30-40% reduction. This reduction, whilst not possible to implement immediately, results in future annual CAPEX savings of Euro 120,000 to 160,000.

In the longer term, it is also possible to implement central spare part management and one warehouse governing all spare parts, resulting in an additional 30-40% saving on warehouse costs. This leads to an OPEX saving of Euro 4,500 to 6,000.

This total saving of between Euro 125,000 and Euro 165,000 annually was a by-product of the main analysis findings, OPEX reductions and performance improvements achieved for this particular client, for which a fee of Euro 150,000 annually was paid.

The timely mitigation of defects, coupled with targeted actions ultimately frees up the O&M team's time to focus on all plants to an equal extent and keep performance at an optimum level.

With enhanced considerations and involvement regarding the requirements for the debt provision, the role of the lender is becoming more and more "smart" and less passive.<sup>4</sup> An increase in performance and reductions in OPEX are not desirable but necessary in today's market and the early cooperation with an advanced data analysis partner to further guarantee shorter start-up phases (through identification of early failures) and an efficient set-up can only add to the security of a PV plant.

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<sup>4</sup>Retrieved 15 August 2018 from <http://www.solarpowereurope.org/wp-content/uploads/2018/08/OM-Best-Practices-Guidelines-V2.0-1.pdf> page 11.



## 4. A new approach

Through our close partnerships with our clients, we are aware that more and more asset owners and asset managers are switching to outcome-focused and on-demand maintenance approaches and this section elaborates on the possibilities and advantages of such an approach.

Our own findings are also supported by those expanded upon in the O&M Best Practices Guidelines by SolarPower Europe. SolarPower Europe describes a new trend in the industry, which goes beyond the usual reporting to cover actual activities. A requirement is that the O&M Contractor has a CMMS (Computerized Maintenance Management System) and can measure O&M KPIs, such as reaction and resolution time, as well as equipment performance.

“A loss due to a fault is considered major when PR and availability are affected by more than a certain threshold throughout the ongoing monitoring (or reporting) period. A best practice is to set this threshold to 1 % of availability or 1% PR within a reporting period of one month.”<sup>5</sup>

One independent European investment company, which was forced to adopt a different approach to its operations and maintenance, in Italy, is Platina Partners. “The ‘smart’ monitoring system is powerful but only remains a tool; it cannot optimize the performance of the plants unless it is implemented correctly. More specifically, its benefits rely on comprehensive and efficient procedures governing the analysis of the plants’ data and on subsequent interventions. In particular, this involves the systematic logging and following of plant issues and alarms, even minor, as well as the

assessment of how historical interventions and corrective maintenance have impacted the performance, costs and revenues of the plant, and how the actions taken compare with other potential responses.”<sup>6</sup>

Prescriptive maintenance - incorporated in a cooperative O&M, advanced data analysis and asset management structure - provides a move away from the problem focus and towards prescribing a solution.

PEAK addresses the following points which we see as preconditions for bringing prescriptive maintenance to life:

1. **Speed** - The on-demand O&M service provision concept requires fast and automated order and working instructions to the O&M team (with a working order approval possibility for the asset owner or manager)
2. **Clarity** - simple decision making to efficiently oversee the management of hundreds of PV plants with slim in-house teams requires focused communication of findings, impacts, solutions, working order approval and working instructions instead of delivering extensive regular reports (which an asset manager often has no time to read). The extensive background information, results and report files should be ready for download on the analytics platform, but should not veil the concrete actions to be taken.

<sup>5</sup>Retrieved 15 August 2018 from <http://www.solarpowereurope.org/wp-content/uploads/2018/08/OM-Best-Practices-Guidelines-V2.0-1.pdf> page 22

<sup>6</sup>Retrieved 15 August 2018 from <https://www.platinaenergypartners.com/assets/files/21-Managing-PV-assets-in-Italy.pdf>



**3. Cooperation** – close communication and cooperation between O&M and the analytics platform ensures the best possible service. An on-demand O&M contractual set-up\* is the best basis with insights and recommendations which must be accepted and a two-way feedback process developed for the O&M team to feed back the resulting maintenance actions and findings from the plant site into the analytics. As the analytics grow smarter over time, the full improvement potential will be further fulfilled. Full integration of the monitoring and asset management systems, O&M processes and advanced analytics resulting in one unified powerful set-up should be the aim of every asset manager.

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*\*Action items from the analytics need to be implemented promptly whenever required instead of executing a standard maintenance program for one plant after another. This approach implies more complex resource planning for the O&M service provider, as its team needs to be flexible with regard to timing of maintenance actions. One consequence for the O&M service provider is a reduction of its plant/staff ratio and the factoring in of a resource buffer. Another consequence is that the O&M service provider is more under observation regarding the actual outcome of its work and the execution of routine maintenance work is reduced, which also results in different skill sets and levels of experience required for O&M experts.*

## 5. Summary

More and more companies are shifting away from full-scope and scheduled/preventive maintenance towards predictive or prescriptive maintenance to achieve the highest performance at the lowest cost. Although the concept is relatively simple, the transition from the status quo to the more effective set-up is often more complex, but not impossible. The return on investment of including an analytics provider in the budget, considering the O&M direct cost savings as well as the extra time and effort invested to create the new set-up, speaks for itself.

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