Asset Management

Best Practice Guidelines / **Version 1.0**

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FOREWORD

Welcome to SolarPower Europe's Asset Management Best Practice Guidelines. Following a year of intensive work, we are proud to present this first version which involved over thirty leading solar experts including Asset Managers, O&M contractors, asset owners and software solution providers active in Europe and around the world. Feedback and suggestions are welcome; if you are interested in being part of this initiative, we invite you to join our Task Force.

As opposed to Operation and Maintenance (O&M) service providers, who take care of the solar power plant on a technical level, Asset Managers are responsible for the commercial and financial management of a solar investment, and sometimes also the supervision and control of technical activities. They manage a company or a portfolio rather than a power plant, often across different geographies, dealing with a variety of regulatory frameworks and business models. Asset Management is also defined as the coordinated activities of an organisation to generate value from its assets (ISO 55000).

With the professionalisation and globalisation of solar investors and investment portfolios, service quality expectations have been rising steadily, putting increasing requirements on Asset Managers, who are expected to continuously improve the return on investment via various processes including revenue optimisation, cost reduction, financial restructuring, contractual renegotiation and technology adaptation. To achieve this, Asset Managers are increasingly expected to transition from simple tools such as self-made spreadsheets to advanced digital Asset Management platforms, which enable efficient and effective management of wide and diverse solar portfolios.

To help Asset Managers deal with these challenges and increase service quality and transparency in the market, our O&M and Asset Management Task Force decided in early 2019 to develop the Asset Management Best Practice Guidelines. The document is inspired by SolarPower Europe's O&M Best Practice Guidelines and defines minimum requirements, best practices and recommendations for high-quality Asset Management service provision. It is based on the experience of leading Asset Management experts as well as related stakeholders such as O&M contractors, investors, software developers and technical advisors. We covered the main business areas of Asset Management including technical, commercial and financial Asset Management, procurement, as well as other important topics such as asset handover and data management.

The Task Force was very productive in 2019 on the O&M front as well. Most notably, we developed Version 4.0 of our O&M Best Practice Guidelines, translated the O&M Best Practices into German; and a French translation will be ready by Q1 2020. Moreover, we have launched www.solarbestpractices.com, a platform which collects all our reports and tools for quality solar service provision, including the Best Practice Guidelines in all available languages, as well as self-evaluation checklists for O&M contractors, monitoring tool providers and aerial thermography providers. The platform also features a directory of companies that comply with the best practices.

We thank our members for their extraordinary level of engagement, which reflects the importance of O&M and Asset Management for the solar sector. We will continue the work in 2020 and invite interested stakeholders to join our Task Force to be part of this undertaking.

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Project Information: The SolarPower Europe O&M Task Force officially started its work in April 2015, and it became the O&M and Asset Management Task Force in early 2019. It operates through frequent exchanges and meetings. The Task Force's flagship reports are the O&M Best Practice Guidelines and the Asset Management Best Practices Guidelines, which reflect the experience and views of a considerable share of the European solar O&M and Asset Management industry today. There has been no external funding or sponsorship for these reports.

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AC	Alternating current
AHP	Analytical Hierarchy Process
AM	Asset Management
AMP	Annual Maintenance Plan
AMR	Automatic meter reading
AMS	Annual Maintenance Schedule
API	Application Programming Interface
CCTV	Closed Circuit Television
CMMS	Computerised maintenance management system
COD	Commercial operation date
CSMS	Cybersecurity management system
DC	Direct current
DMS	Document management system
DOR	Division of responsibility
DSCR	Debt service coverage ratio
DSL	Digital Subscriber Line
EH&S	Environment, health and safety
EMS	Energy Management System
EPC	Engineering, procurement, construction
EPI	Energy Performance Index
ERP	Enterprise Resource Planning System
ESS	Energy Storage System
FAC	Final acceptance certificate
FIT	Feed-in tariff
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
H&S	Health and safety
HV	High voltage
IEC	International Electrotechnical Commission
IGBT	Insulated-Gate Bipolar Transistors
IPP	Independent power producer
IR	Infrared
IRENA	International Renewable Energy Agency
KPI	Key performance indicator
kW	kilowatt
kWh	kilowatt-hour
kWp	kilowatt-peak
LAN	Local area network
LCOE	Levelised cost of electricity
LTE-M	Long Term Evolution, category M1
LPWAN	Long-power wide-area network
LV	Low voltage
MAE	Mean absolute error
MIT	Minimum irradiance threshold
MPPT	Maximum Power Point Tracking
MV	Medium voltage
MW	Megawatt
O&M	Operation and Maintenance
OEM	Original equipment manufacturer
OS	Operating system
PAC	Provisional acceptance certificate
POA	Plane of array
PPA	Power purchase agreement
PPE	Personal protective equipment
PR	Performance Ratio
PV	Photovoltaic
RMSE	Root mean square error
ROI	Return on investment
RPAS	Remotely Piloted Aircraft System (drone)
SCADA	Supervisory Control And Data Acquisition
SLA	Service-level agreement
SPV	Special purpose vehicle
STC	Standard Test Conditions (1000 W/m^2, 25°C)
UPS	Uninterruptible Power Supply

EXECUTIVE SUMMARY

With the professionalisation and globalisation of solar investors and investment portfolios, service quality expectations rising steadily, putting increasing requirements on Asset Managers, who are expected to continuously improve the return on investment via various processes including revenue optimisation, cost reduction, financial restructuring, contractual renegotiation and technology adaptation. To do so, Asset Managers rely increasingly on advanced digital platforms, which enable efficient and effective management of wide and diverse solar portfolios. The present Guidelines are intended for Asset Managers as well as for investors, asset owners, financers, software solutions providers, O&M contractors, technical consultants, and all stakeholders in Europe and beyond interested in improving solar Asset Management services.

This document starts by contextualising Asset Management, defining the roles and responsibilities of various stakeholders such as the Asset Manager, the Operations Service Provider and the Maintenance Provider and presenting an overview of technical and contractual terms to achieve a common understanding of the subject. It then walks the reader through the different business areas and other key activities of solar Asset Management, identifying for each segment "minimum requirements", "best practices" and "recommendations".

Lifecycle project management

Asset Managers can be involved in all phases of the solar power plant's lifecycle: from development through construction and operation to decommissioning and disposal. The document focuses largely on Asset Management during the operational phase – the longest phase of the project lifecycle – but this chapter presents an overview of lifecycle Asset Management with roles and tasks in all project phases. Key competencies related to lifecycle Asset Management include stage-gate management, documentation management, lifecycle risk management and warranty management (in relation to the EPC warranty).

Handover of solar assets

The journey of an Asset Manager starts with a handover (or on-boarding) process. This chapter addresses the importance of the handover process when an operational asset is transferred from an Asset Manager to another or when an asset owner decides to internalise the AM services. It presents the categories of site information and data to be handed over (such as real estate, power plant design and construction, production data, EPC and O&M contractor information), as well as the key documents to be collected and reviewed in the on-boarding process (such as the O&M manual, permits, contracts in place, warranties etc). It also underlines the importance of interoperability and compatibility between systems in case data needs to be migrated.

Technical Asset Management

Technical Asset Management (TAM) encompasses *support activities to ensure the best operation of a solar power plant or a portfolio* (i.e. to maximise energy production, minimise downtime and reduce costs). In many cases, the O&M contractor assumes some technical Asset Management tasks such as planning and reporting on Key Performance Indicators (KPIs) to the asset owner. However, in cases where the Technical Asset Manager and the O&M contractor are separate entities, close coordination and information sharing between the two is indispensable. TAM also includes ensuring that the operation of the PV plant complies with national and local regulations and contracts, and advising the asset owner on technical asset optimisation via, for instance, repowering investments.

Commercial and Financial Asset Management

Commercial and Financial Asset Management encompasses *support activities for the best operation of a business*, including accounting, cash flow management, contract management, equity/debt financing management, tax management, as well as liaising with key stakeholders such as investors and banks. Financial reporting is an important component of Commercial and Financial Asset Management and involves regularly providing the asset owner with financial statements, capital structure analyses, profitability analyses, cash flow and debt compliance overviews. Financial asset optimisation activities that should be performed by Asset Managers include cost reduction, financial restructuring and contractual renegotiation.

Procurement

Procurement involves identifying and selecting key suppliers involved in the operation of the solar businesses and solar power plants, such as O&M contractors, insurance and IT solutions providers, security service contractors and in some cases providers of ancillary services such as electricity, panel cleaning and vegetation control. The Asset Manager should identify the right trade-off between price, quality of services and key contractual terms and constantly balance them in line with market conditions. For example, in order to evaluate and select O&M contractors, Asset Managers are recommended to use SolarPower Europe's O&M best practices checklist, which can be downloaded from www.solarbestpractices.com.

People and skills

It is important that all personnel from Asset Management companieshave the relevant experience and qualifications necessary to perform the work in a safe, responsible and accountable manner. These Guidelines contain a list of skills needed for technical, commercial and financial Asset Management..

Data and monitoring requirements

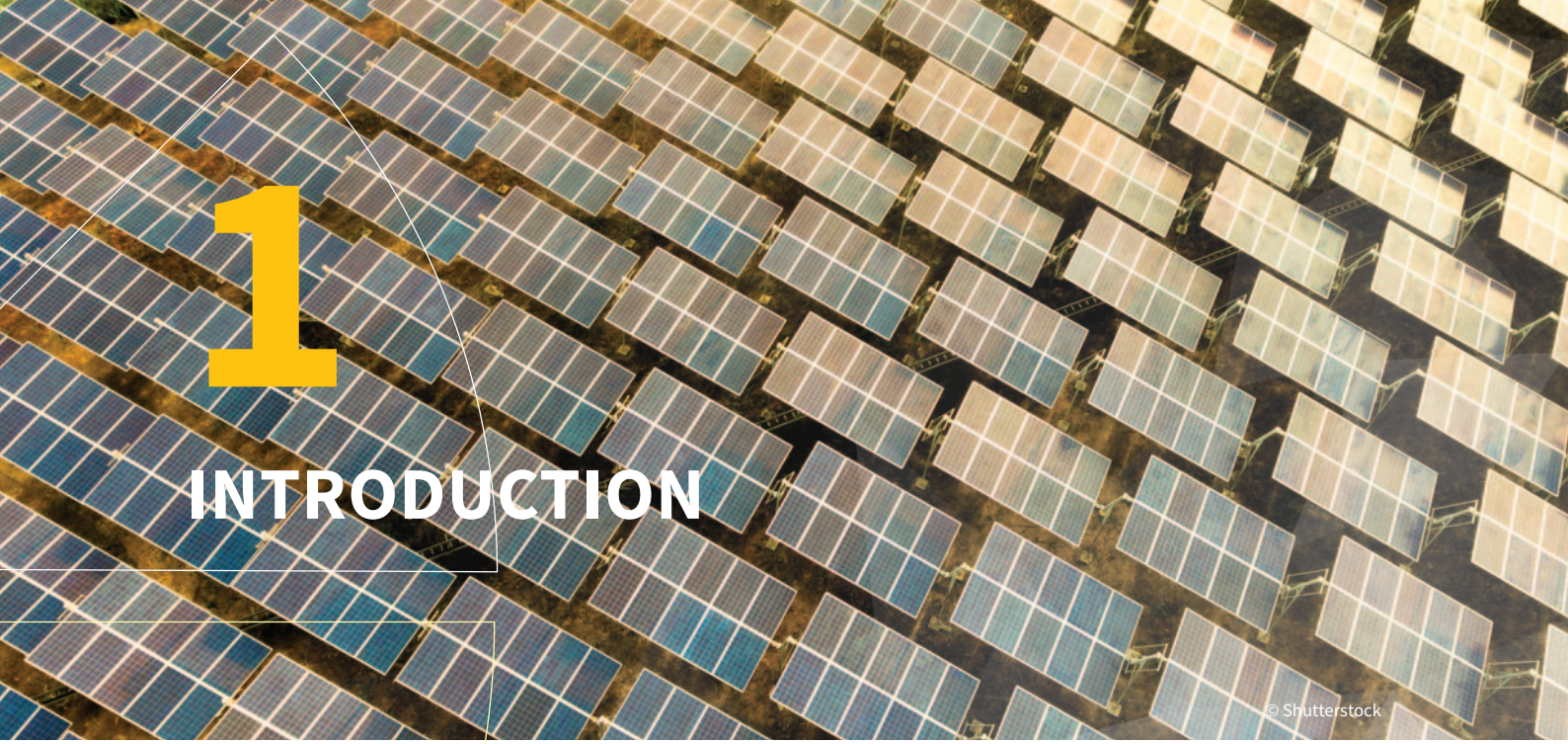
Asset Managers should rely on a specialised Asset Management Platform to store and manage technical and non-technical data and information collected from and relating to the solar asset, portfolio or SPV. Such a platform makes it possible for the solar industry to transition to an asset-centric information-based management approach, which addresses three key challenges: (1) loss of generation and income; (2) loss of time; and (3) lack of transparency, which is in contrast to the traditional linear Asset Management approach, where information flows from the asset through the O&M contractor to the Asset Manager and ultimately to the asset owner.

Key Performance Indicators

A close monitoring of Asset Management procedures is required to ensure implementation effectiveness. This can be achieved through the definition of clear and objective Key Performance Indicators (KPIs), which need to be continuously assessed. KPIs used to measure Asset Management service quality include Reports Compliance Rate, Invoicing Compliance Rate, Contracts Optimisation Rate, Requests Treated and Timely Response Rate. In general, one of the most important indicators is the track record of the Asset Manager.

Contractual framework

The scope of a full-service Asset Management agreement corresponds to the structure of this document, with the main business areas being Technical, Commercial and Financial Asset Management, and procurement and lifecycle project management. Asset managers do not provide any contractual guarantees comparable to the "availability guarantee" provided by O&M contractors, however the Asset Manager is obliged to provide the services in accordance with all laws, authorisations, good industry practices and current market standards.



1 INTRODUCTION

1.1. Rationale, aim, and scope

A professional and dedicated Asset Management (AM) service package ensures that photovoltaic (PV) plants, individually and as part of a wider portfolio, achieve their maximum potential from both technical and financial perspectives.

Owners, investors and lenders in the solar PV industry have increasingly acknowledged that AM services are not limited to basic day-to-day administrative tasks. I Instead, the role of a competent and multidisciplinary AM service provider is crucial to minimising operational and interface risk whilst maximising the return on investment of solar PV assets.

Asset managers can be involved in all phases of the solar power plant's lifecycle from development to decommissioning, however these Guidelines focus on AM during operation – the longest phase of the project lifecycle. (For more information on lifecycle project management, see *Chapter 3*.)

- Development (typically 1-3 years)
- Construction (a few months, size-dependent)
- **Operation (typically 30+ years)**
- Decommissioning and disposal (a few months)

The in-depth knowledge of the assets developed during the operational phase of the PV lifecycle puts Asset Managers in a key position to influence the performance of the sites and their longevity. Asset Managers also provide vital feedback to the stakeholders involved in development and construction with the aim of optimising further the ROI of solar investments from the earliest stages of the lifecycle.

Although the solar PV industry is still developing, it already presents a wide range of well-established practices and approaches for Asset Management. This facilitates the creation of innovation niches for example in the field of digitalisation, however it also generates the lack of clarity as to what is a widely acceptable level of AM service fulfilling the main requirements of stakeholders, specifically owners, investors, lenders and other funding authorities, as well as local communities.

While a variety of international technical standards have been developed, the current level of standardization in AM remains insufficient. The typical AM scope of work varies significantly, and so does the use of advanced digital tools, both of which aspects are important factors in determining the efficiency and effectiveness of AM services.

The aim of these Guidelines is to identify the requirements for high quality AM services and promote best industry practices. The importance of Asset Management grows steadily, as the industry finds itself at an inflection point with subsidies continuously being reduced and subsidy-free PV assets requiring even tighter management to ensure that owners and investors meet their objectives.

In line with SolarPower Europe's Operation & Maintenance (O&M) Best Practice Guidelines, the value proposition of this report is its industry-led nature, gathering the knowledge and experience of well-established and leading companies in the field of project development and construction (EPC), Asset Management, O&M, utilities, manufacturers and monitoring tool providers. The scope of the current first edition includes the utility scale segment and more specifically, systems above 1MW. The Guidelines are based on the experience of companies operating globally (with a concentration in Europe), and identify high-level requirements that can be applied worldwide for the most performant AM services. Specific national considerations such as legal requirements are not included and should therefore be considered separately if the Guidelines are to be used in specific countries. The Guidelines refer to AM services as provided by a third-party service contractor - differences in approach between third-party and in-house AM are highlighted where materially relevant.

The content covers technical and non-technical requirements, classifying them when possible into the following:

1. **Minimum requirements**, below which the AM service is considered as poor or insufficient, and which form a minimum quality threshold for a professional and bankable service provider;
2. **Best practices**, which are methods considered state of-the-art, producing optimal results by balancing the technical as well as the financial side;
3. **Recommendations**, which can add to the quality of the service, but whose implementation depends on the considerations of the asset owner, such as the available budget.

As for the terminology used in this document to differentiate between these three categories, verbs such as "should" indicate minimum requirements, unless specified explicitly otherwise, as in, "should, as a best practice".

1.2. What is Asset Management?

1.2.1. Overview

Over the past 30 years, Asset Management (AM) has evolved to become a standalone discipline. The PAS 55 ("Specification for the optimised management of physical assets"), published in 2004 by the British Standards Institution, was the first attempt at clarifying and standardising the meaning of physical AM systems. Industries such as mining, manufacturing, utilities and transport widely adopted PAS 55 and as a result the standard was accepted as a platform to develop the ISO 55000 series of international standards on "Asset Management" that was published in January 2014 and supersedes the PAS 55 documents.

The Global Forum on Maintenance and Asset Management (GFMAM), consisting of a number of maintenance and AM organisations around the globe, was established in 2010 with the objective of aligning the Asset Management Body of Knowledge (AMBOK) through a collaborative process. The GFMAM published the first Asset Management Landscape document in November 2011, which is an attempt to build a common perspective or collective view on the discipline of AM (GFMAM 2011; IAM 2015b; Saunders, C. 2016).

AM concepts have developed over time and stem from the financial services industry that has been using the term for decades to describe the management of risk and reward within financial portfolios.

Many definitions of AM exist within literature and in practice and ISO 55000 intentionally provides a very general definition to allow the Asset Manager to apply the principles to whatever form the asset takes and determine how to derive value (IAM, 2014a). ISO 55000 defines AM as:

"the coordinated activity of an organisation to realise value from assets"

The definition provided by ISO 55000 is then qualified by the following notes:

- Realisation of value will normally involve a balancing of costs, risks, opportunities and performance benefits.
- Activity can also refer to the application of the elements of the Asset Management system.
- The term "activity" has a broad meaning and can include, for example, the approach, the planning, the plans and their implementation.

Considering the sections above, this document is a first attempt aiming at defining AM best practices in the scope of the solar industry.

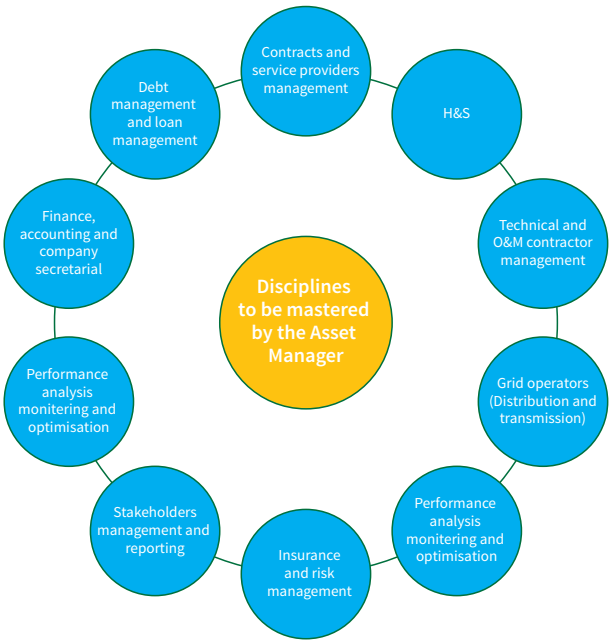
Asset Managers provide a variety of services relying on multiple disciplines and skills to asset owners, investors and funders. Services provided range from technical management and site optimisation to contract and financial management. The nature of the services is multidisciplinary, as shown in Figure 1 and the best performance results are achieved through a wide and comprehensive range of services.

While the depth of services rendered to owners and investors varies depending on the risk attitude of the stakeholders, good quality service providers should be able to undertake responsibilities covering the business areas summarised in Figure 2. The scope illustrated in Figure 2 is in line with the structure of this document (and the structure of the O&M Best Practice Guidelines) and reflects the experience of the solar industry specifically.

The interaction with O&M service providers forms a critical part of the services rendered by Asset Managers. There is a component of oversight and control of the O&M providers performed by the Asset Manager on behalf of owners to ensure that the contractual obligations are successfully fulfilled by both parties, as well as that the PV plant is properly maintained in order to increase its performance. There are however a series of potential overlaps between the two service providers particularly in relation to Technical Asset Management and performance analysis.

These overlaps may create duplications of workload and analysis conducted by the two service providers, which is a situation that owners who perform AM in-house might be able to avoid and exploit. This generally occurs when performance analysis is carried out not only in terms of basic key performance indicators (KPIs) calculations, but also in terms of root cause analysis and subsequent warranty and/or insurance claim management. Well-established O&M contractors with significant market scale tend to extend their services to cover these Technical Asset Management tasks. How these tasks are contractually allocated to the service providers is ultimately a function of an owner's operational risk policy, as well as corporate governance requirements. However, an AM provider should be able to perform a complete assessment of the technical health of a site, not only for reporting purposes, but also to comply with its general oversight responsibilities.

FIGURE 1 DISCIPLINES TO BE MASTERED BY ASSET MANAGEMENT SERVICE PROVIDERS



1 For detailed information on PV power plant KPIs and O&M Contractor KPIs, see chapter *11 Key Performance Indicators of the O&M Best Practice Guidelines*.

FIGURE 2 ROLES AND RESPONSIBILITIES BY DIFFERENT STAKEHOLDERS IN THE FIELD OF AM AND O&M

ENGINEERING

Engineering

- Plant (re)commissioning
- Quality audit/inspection
- Re-powering and upgrades
- Monitoring install / retrofit
- As-built design documentation
- Plant design overview

ASSET MANAGEMENT

Lifecycle project management

Support to the owner throughout the project phases:

- Development
- Construction
- Operation
- Decommissioning

Contract scoping
Risk identification & tracking
Cost management
Execution of obligations

Commercial and Financial Asset Management

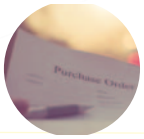
Strategy management
Corporate administrative services
Financial reporting
Accounting
Customer relationship
Accounting assistance
Invoicing / billing and payments
Revenue control

Cash flow management
Working capital reconciliation
Financial control
Contract management
Suppliers account management
Suppliers penalites invoicing
Interface with banks and investors
Equity/debt financing management
Tax preparation, filing and administration

Procurement

Supplier selection and evaluation
Supply account control

Supply chain control



Technical Asset Management

Reporting to asset owner
Site visits and non-instrusive inspections
Management of ancillary service providers
Interface with local energy authorities
Regulatory compliance

Warranty management
Insurance claims
Contract management
Asset optimisation
Environmental management
Health & safety mangement

Power Plant Operation

Documentation Management System
Plant performance monitoring and supervision
Performance analysis and improvement
Optimisation of O&M
Power plant controls
Power generation forecasting
Grid code compliance

Reporting to Technical Asset Manager
Management of change
Power plant security
Maintenance scheduling
Spare parts management
Decommissioning

Power Plant Maintenance

Preventive maintenance
Corrective maintenance
Predictive maintenance
Extraordinary maintenance

Spare parts storage

Additional Services:

- PV site maintenance (panel cleaning, vegetation control, PV waste disposal & recycling etc)
- General site management (pest control, waste management, buildings maintenance etc)
- On-site measurements (meter readings, thermal inspections etc)

OPERATION AND MAINTENANCE

NOTE: THE RESPONSIBILITIES OF THE ASSET MANAGER AND THE O&M CONTRACTOR OVERLAP SOMETIMES, AND TECHNICAL ASSET MANAGEMENT AND EVEN SOME ASPECTS OF PROCUREMENT CAN BE ASSUMED BY EITHER THE O&M CONTRACTOR OR THE ASSET MANAGER

1.2.2. Asset Management key targets

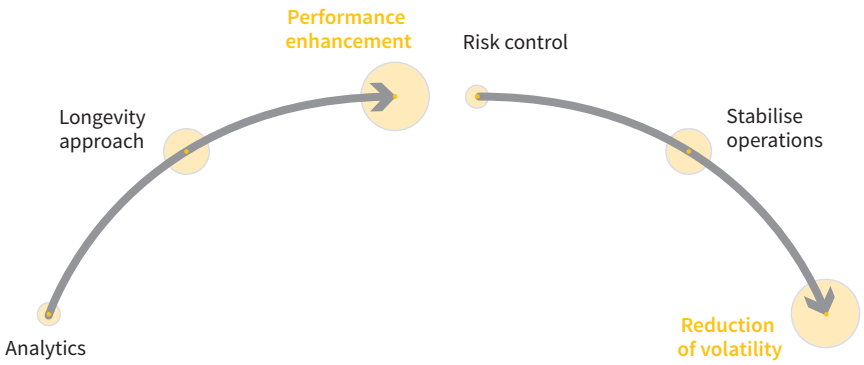
AM services should consider each solar power plant or Special Purpose Vehicle (SPV) as a stand-alone business, aimed at improving profitability by increasing revenues and reducing the levelised cost of solar electricity (LCOE).

At the strategic and risk management levels, an AM service provider should offer the site owner a clear plan to increase performance and reduce volatility, as shown in Figure 3. Solid data analytics is the basis of any performance enhancement effort. The result is not only increased production from the site, but also financial performance, which means improved cost control and reduced operating costs by holding tenders and leveraging economies of scale at portfolio level where possible.

At the tactical level, risk management is carried out within the boundaries of the contract and obligations undertaken by each SPV , whilst the diligence of an AM service provider is critical to ensure that risks are kept up to date and are used to stabilise operation. Risk control is central to the operations of an Asset Management provider, as it is the basis for mitigation and contingency plans to be deployed on behalf of the owners.

A proactive Asset Manager will provide regular advice to the owner from both a technical and contractual perspective. This is one of the main aspects in which Asset Managers generate value jointly with the project developers and construction managers. Asset Managers can share their wealth of operational knowledge and hard data/statistics so that new projects can benefit from the lessons learned during the operational phase of existing sites. This support can range from considerations on contractual terms and operating cost assumptions to technical reports, effectively helping asset owners to validate their business cases.

FIGURE 3 STEPS TO AGREE STRATEGIC APPROACH TO INCREASED PROFITABILITY



From an operational perspective, there are four pillars which should guide the work of an AM service provider in order to achieve the ultimate goal of increased profitability. These are presented in Figure 4. They apply to both technical and financial services equally, ensuring that sites are managed in a fully rounded manner.

- **Monitoring**: focus on KPIs and 'red flag' analysis, facilitating the identification of any portfolio-wide issues from a technical, commercial and contractual point of view;
- **Reporting and Communication**: as service providers, Asset Managers must produce tailored and timely reports to ensure that key stakeholders are informed and in control of their assets. Consistency and frequency in communication should be minimum standards set up by each AM service provider. Whilst it is widely accepted in the industry that Asset Managers provide regular monthly reports, emphasis must be given to ad hoc communications in case of emergencies, specific failures or claims;
- **Managing**: focus on problem solving of both technical failures and commercial claims;
- **Optimising**: focus on both technical improvements (whether trials of performance enhancer, repowering of key equipment) and financial improvements including tendering and re-financing.

1.2.3 Asset Management commitments and policies

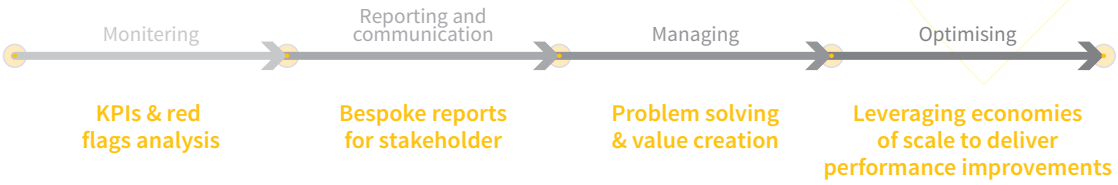
AM service providers should ensure that their commitment toward stakeholders is clearly documented and reflected in both their customer and internal policies. The policies should be part of the induction and staff training to ensure they are properly understood and embraced in their current form as well as future revisions. As any other corporate policy, the Asset Management Policy should be intended as a living document, to be reviewed and updated regularly with contributions from employees, customers and other key stakeholders.

Compliance with both regulatory requirements and stakeholders' undertakings are at the heart of a successful delivery of services. Achieving this result should lead the AM service provider to set up an appropriate Asset Management System, intended as both a digitalised repository of key site information and a robust and documented set of processes and procedures to be reflected in suitably automated workflows.

This leads to a high level of standardisation and efficiency in the Asset Management services, aiming at minimising non-conformities and ultimately reducing operational risk while ensuring that stakeholder and customer requirements are met satisfactorily.

Continuous improvement programs to further increase the effectiveness of the Asset Management System should be undertaken across the organisation regularly and fed into the revision of the Asset Management Policy.

FIGURE 4 DRIVERS OF OPERATIONAL ASSET MANAGEMENT SERVICES



1.2.4 Stakeholders and roles

As described in the SolarPower Europe O&M Best Practices Guidelines, multiple stakeholders interact during the operational phase of a solar PV plant lifecycle, each with different responsibilities and facing multiple possible overlapping areas,(i.e. O&M and AM providers). Some of the key roles can be summarised as follows:

- Asset Owner: The stakeholder that contributes to the financing of construction and operation of the PV power plant is normally the investor (or a group of investors), who can be classified as a group of private individuals, financing investors or investment funds, Independent Power Producers (IPPs), or utilities. Assets are generally owned by "Special Purpose Vehicles" (SPV), i.e. limited liability companies, specifically incorporated for building, owning and operating one or more PV plants.
- Lender: The lender or debt provider (financing bank) is not considered as an "Asset Owner" even if the loans are backed up by securities (collateral). In principle, the interests and performance expectations are different between the investor (equity provider) and the lender who normally measures the risk based on the debt service coverage ratio (DSCR). The role of the lender is becoming increasingly "smart" and less passive, with a focus on the requirements for the debt provision.
- EPC Contractor: The entity in charge of the engineering, procurement and construction of the solar power plant. The EPC contractor is in charge of delivering the full solar power plant to the asset owner from authorisation to commissioning and grid connection. Their role is very important in ensuring the procurement of quality components and quality installation, which have a large impact on the long-term performance of the solar power plant. Many EPC contractors offer O&M services for the solar power plants that they have developed. EPC Contractors often provide a 2-year performance warranty period after the Commercial Operation Date (COD) lasting until the Final Acceptance Certificate (FAC). In many cases it is after FAC that a third-party O&M Contractor is contracted to take over the O&M of the solar power plant. In certain mature markets the EPC role is increasingly split between different entities.
- Asset Manager: The service provider responsible for the overall management of the SPV, from a technical, financial and administrative point of view. The Asset Manager ensures that SPV and service providers fulfil their contractual obligations, and manages the site with the aim of ensuring optimal profitability of the PV power plant (or a portfolio of plants) by supervising energy sales, energy production, and O&M activities. Asset Managers also ensure the fulfilment of all administrative, fiscal, insurance and financial obligations of the SPVs. Asset Managers review the performance of the sites regularly and report to asset owners, and seeks to balance cost, risk and performance to maximise value for stakeholders. In some cases, when the SPV belongs to large asset owners, such as utilities or IPPs, the Asset Management activity is done in-house.
- O&M service provider: The contractor in charge of O&M activities as defined in the O&M contract including Power Plant Operation and Power Plant Maintenance and, in some cases, Technical Asset Management. A comprehensive set of O&M activities (technical and non-technical) is presented in SolarPower Europe's O&M Best Practice Guidelines, which can be downloaded from www.solarpowereurope.org.
- Technical Advisors and Engineers: Individuals or teams of experts that provide specialised services (e.g. detailed information, advice, technical consulting). Their role is important since they ensure that procedures and practices are robust and of high quality – according to standards and best practices – to maintain high performance levels of the PV plant. Technical advisors can represent different stakeholders (e.g. investors and lenders), but often an Independent Engineer is employed, whose opinions on the technical aspects of the project are not biased in favour of any stakeholder.
- Specialised suppliers: Providers of specialised services (e.g. technical or operational systems consulting) or hardware (e.g. electricity generating components or security system).
- Authorities: Local (e.g. the municipality), regional (e.g. the provincial or regional authorities supervising environmental constraints), national (e.g. the national grid operator), or international (e.g. the authors of a European grid code).

- **Off-taker**: The entity that pays for the produced electricity. This role is still evolving and is often subdivided according to national renewable power support schemes:
  - state or national grid operator / electricity seller(s), or specific authorities for renewable energy (e.g. GSE in Italy) in a feed-in tariff (FIT) scheme.
  - Energy traders or direct sellers in a direct marketing scheme.
  - End customers in schemes that underline autonomy in energy supply.
- **Aggregator**: An entity that combines multiple customer loads or generated electricity for sale, for purchase or auction in any electricity market. From the asset owners, the Asset Managers and the O&M contractors' points of view the aggregator allows the distributed renewable energy production or storage assets to access various energy markets, such as the electricity markets, the balancing markets or other future flexibility markets. This enables direct marketing of the energy produced by distributed assets and can unlock new revenue streams from flexibility services.
- **Data-related service providers**: Providers of hardware and software solutions such as Monitoring Systems, Asset Management Platforms, Computerised Maintenance Management Systems (CMMS) or Enterprise Resource Planning Systems (ERP) that acquire data from the site and also analyse the data to calculate KPIs (analytical tools) and/or provide data repository for key site information whilst facilitating some administrative workflows. Site data is crucial to ensure owners, and AM and O&M providers are aware of what is occurring on site and how the equipment is behaving throughout its lifetime. It is crucial to ensure that prompt action is taken once a fault is identified and to provide vital information on potential areas of underperformance. There is tendency in the industry to opt for solutions that integrate the functionalities of all above mentioned systems and platforms in one software, which has several advantages and can be considered a recommendation.

As pointed out in the SolarPower Europe O&M Best Practice Guidelines, the boundaries between these stakeholders might be blurred depending on the specific risk attitude and business model of each player. For instance, certain owners and investors have reached scale, allowing them to develop their own in-house Asset Management practice; certain O&M service providers have strengthened their monitoring/performance/engineering teams to provide technical Asset Management services; certain off-takers have integrated vertically and became developers, owners and operators of their own assets; corporate off-takers- have shown increasing interest in owning and managing the operational data of the sites they purchase electricity from.

This constant evolution of roles further emphasises how a multidisciplinary approach to AM is necessary to provide successful service to owners and lenders.

1.3. How to benefit from this document

This report includes the main considerations for a successful and professional AM service provision. Although it has not been tailored for each stakeholder, the purpose of the document is similar for all: understanding the mandatory requirements and the necessity of professional AM services and incorporating the recommendations accordingly into the service package for more performant AM services. Any of the directly relevant stakeholders (as described above) can benefit from this work, tailor it to their needs without lowering the bar, and know what to ask for, offer or expect. The Guidelines are particularly useful for the Asset Owners to understand what the standard of a quality Asset Management service should be. Although the focus is European, most of the content can be used in other regions around the world. The requirements described in the Guidelines apply without changes in other regions and additional requirements or modifications can easily be made for other regions with unique characteristics.

2 DEFINITIONS

This chapter introduces a basic set of definitions of important terms that are widely used in solar Asset Management, of which all stakeholders should have a common understanding.

Although there are standards in place that explain some of this terminology, in practice, it is still difficult to agree on the boundaries of certain terms and what exactly is expected under these terms or services (e.g. technical Asset Management).

Rather than reaching a conclusive list for the field of Asset Management, the aim of this section is to provide a short, non-exhaustive collection of terms (alphabetically ordered) that reflects the content of this guide. Normative references such as ISO 55001:2014, SolarPower Europe's Operation & Maintenance Best Practice Guidelines (Version 4.0), European Norm 13306, and PAS 55-1:2008 (3.9) were used as a basis.

Asset portfolio	Group of assets that are governed by the same regulations and obligations. A portfolio is typically established and assigned for managerial control purposes and is usually defined by country, monitoring provider, O&M contractor or another category.
Asset Management Platform	A software package or suite of tools that is used by the Asset Manager to store and manage technical and non-technical data and information collected from and relating to the solar asset, portfolio or SPV. It combines the abilities of a Computerised Maintenance Management System (CMMS) and an Enterprise Resource Planning System (ERP).
Cash management	Managing treasury activities and monitoring the cash available in every period for a PV plant or an SPV. Examples of these activities are adjusting payments according to predicted income dates, assuring liquidity to comply with debt service schedule, making repayments of loans (interest and principal), and distributions to the SPV shareholders.
Computerised Maintenance Management System (CMMS)	A software designed to measure and record various O&M KPIs (e.g. Acknowledgement Time, Intervention Time, Reaction Time, Resolution Time) and equipment performance (e.g. Mean Time Between Failures) and thus optimise maintenance activities.
Contract management	Building, developing and maintaining business relationships with counterparties of different contracts. This includes selecting service providers, holding negotiations with banks, landowners and operations providers, managing insurance and warranty claims, as well as ensuring compliance of the contractual obligations, such as notifying, filing and reporting.

Corrective maintenance	Actions and techniques (immediate or deferred) taken to correct failures, breakdowns, malfunctions, anomalies or damages detected during inspections, or through monitoring, alarming, reporting or any other source. These measures typically generate follow-up work orders, which are formal requests assigned to an authorised person so that a job or task can be carried out.
Degradation	Decrease in the efficiency of a solar plant with the passage of time. Usually, at least 80% of the original output is expected within a 20-year period.
Distribution System Operator (DSO)	Entity responsible for distributing the electricity from the transmission grid to end users (households/businesses) and maintaining the distribution networks.
Engineering, procurement, and construction (EPC)	EPC refers to companies that deal with the design, sourcing, and installation of solar systems.
Enterprise Resource Planning	A business management software that a company (such as an O&M contractor or an Asset Manager) can use to gather, store, manage and analyse all types of data relevant for their operations.
Environment, Health & Safety (EH&S)	EH&S indicates the policies and guidelines formulated to ensure environmental protection, occupational health, and safety at work and on site, applicable to staff and visitors according to European and national laws and regulations.
Event	An unplanned occurrence related to the SPV the PV plants it owns. The event can be a technical incident or an issue in business operations. Examples of events are component failures, vandalism, theft, grid outage, storm damage, and landscaping issues.
Feed-in tariff (FiT)	A policy mechanism (designed to accelerate investment in renewable energy technologies) which remunerates, through a long-term contract, a fixed electricity price to renewable energy producers for each unit of energy produced and injected into the electricity grid.
Generation forecasting	Estimation of the amount of energy a solar power plant will generate in the future in order to determine a project's financial risk. Commonly used estimates are P50, P75 and P90. P50 is essentially a statistical level of confidence suggesting that we expect, with 50% probability, that the predicted amount of generation may be exceeded.
Good industry practice	Good Industry Practice means those practices, methods, techniques, standards, codes, specifications, acts, skills and equipment generally applicable in the international solar power industry (including construction and installation of solar power facilities) and followed or used by good contractors that, in the exercise of prudent, proper and good judgment, in light of the facts known or that reasonably should have been known at the time a decision was made or an action taken or omitted, would have been expected to accomplish the desired result in a manner consistent with applicable laws and permits, are reliable and safe, protect the environment, are economically efficient and are done with the degree of skill, diligence and prudence that would ordinarily be expected.
Irradiation	The solar radiation incident on a solar panel over time, relative to its area. It is usually expressed in watt-hours per m^2. It plays an important role in the determination of the optimal inclination angle of PV modules and the profitability of a PV system.

Key Performance Indicators (KPIs)	Technical and financial parameters that help stakeholders to evaluate the operation and performance of an SPV and the PV plants the SPV owns. Solar KPIs include: Nameplate Capacity, Irradiation, Generation, Availability, Performance Ratio, Free Cash Flow and IRR.
Monitoring System	The digital platform used for the overall monitoring of the functioning, energy generation and reference data of the PV plant and its components, which is performed through real-time monitoring software. The monitoring operates 24 hours a day, all year, and is fed by in-plant data logging systems that collect data from different plants as well as by irradiation and temperature measurements from particular sensors and other sources such as meteorological information.
On-site consumption	The consumption of all or part of the energy from a PV plant at the same location where it is produced. If the energy is consumed by the person or entity that owns the PV plant, this is referred to as self-consumption or auto consumption. If the PV plant is owned by a different entity than the entity who consumes the energy, this is referred to as "third party ownership" and the consumption is typically governed by a PPA.
Operation and Maintenance (O&M)	O&M includes all the services that ensure maximum efficiency and maintenance for a PV plant. The services include monitoring and supervision; predictive, preventive and corrective maintenance; performance analysis and improvement; power generation forecasting and site security management.
Operating expenses	Operating expenses for a PV plant include rent, insurance, security, O&M service, Asset Management service, PV monitoring, utility fees, and bank fees.
Power Purchase Agreement (PPA)	Contract of electricity supply between a party generating and selling electricity, and a party purchasing electricity. The PPA defines the conditions of the agreement, such as the amount of electricity to be supplied, point of interconnection, applicable rate schedule, production guarantees and penalties for non-compliance.
Preventive Maintenance	Actions, testing or measurements to ensure optimal operating conditions of equipment and of the entire PV plant, hereby preventing defects and failures. Preventive maintenance takes place periodically, and according to a specific maintenance plan and maintenance schedules.
Project financing	PV projects are often financed by a combination of equity and debt. Loan agreements for project finance will rely on the project's cash flows for the repayment of principal and interest. The project's assets and asset rights are held as collateral by the financing institution.
PV Power Plant	An independent electricity generating entity (PV panels and Balance of System), which possesses its own set of operational and financial contracts.
Regulatory and statutory compliance	Compliance to any law, statute, directive, regulation, policy or rule issued by a competent public authority: either by the government (statutory) or by a regulatory agency (regulatory). The compliance is applicable in the country or in the corresponding administrative unit where the SPV and PV plant is based and/or where services are provided.
Reporting	Regular deliverables to various project stakeholders (investors, banks or management), detailing operational and financial performance of an asset portfolio, SP or individual PV plant, Reports usually include KPIs in graphical and tabular form, comparison of the KPIs against forecast, events, risks and a narrative detailing performance for the period.

Revenue Management	Set of practices and activities aimed at maximising the revenue from PV plant operations. This includes electricity invoicing, verifying settlements, day-ahead or intra-day generation forecasting, sale of certificates, efficient incident resolution and receivable management.
Risk management	The practice of identifying and analysing the risks to which solar power systems and operations are subjected and taking precautionary steps to mitigate them. The major categories of PV risks include, but are not limited to counterparty risks, security risks, revenue risks, operational risks, tax risks, and regulatory risks.
Spare parts management	Activities that ensure the availability of the right amount and type of components, equipment, and parts, either on site or in warehouses or in O&M service provider's stocks, for prompt replacement in order to minimise the downtime of a PV plant.
Special Purpose Vehicle (SPV)	A company with its own rights, assets and liabilities, created for building, owning and operating one or more solar power plants. The SPV is also referred to as SPE (special purpose entity) or as a project company.
Technical Asset Management	Technical Asset Management includes monitoring the production and status of a number of PV assets, visiting PV plants to conduct field-based assessments, working with O&M contractors, and producing performance reports to internal and external stakeholders, as well as preparing any documentation needed for public and governing bodies.
Transmission System Operator (TSO)	Entity responsible for controlling and operating the transmission grid, which usually comprises the voltage levels of 220 kV and 380 kV in Europe. The operations include monitoring and controlling the current grid topology (position of breakers and switches within the grid), as well as the voltage, in all parts of the transmission grid. Any planned PV plant outages need to be communicated to the TSO.

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3 LIFECYCLE PROJECT MANAGEMENT

Asset Managers can be involved in all phases of the solar power plant's lifecycle, from development to decommissioning. Most of the content of the Guidelines focuses on Asset Management during the operational phase – the longest phase of the project lifecycle – but this chapter presents an overview of lifecycle Asset Management with roles and tasks in all project phases.

3.1. The key stages of a project

Over the lifetime of an asset, from inception to disposal, the generating plant and its operating company – typically a special purpose vehicle (SPV), which is the primary counterparty to the contracts and ownership documents that underpin the value of the plant – move through a number of definable stages.

These stages are typically marked by changes in contractual liability and obligation, and the transitions or 'stage-gates' between phases are usually marked by the execution of contractual documentation, such as contracts or 3rd party certification defined by the contracts and underpinned by appropriate supporting documentation.

An effective Asset Manager will ensure that at each of these 'stage-gates', risks are managed effectively through the transition and activities during the phases between the stage gates are well managed on behalf of the plant owner, from a financial, technical, as well as contractual perspective.

This activity may be described as 'lifecycle project management' and the characteristics of the stages on either side of the operational phase are outlined in this chapter. Asset Management activities covered throughout the rest of this document relate to the management of the plant and SPV during the operational phase.

3.2. Overview of the role of Asset Manager through the lifecycle of the project

Typically, an Asset Management team or function will draw upon, support and oversee the activities of other teams of specialists in each phase. In the case of the operational phase, this will typically mean the O&M contractor, with the Asset Manager acting in a supervisory role with responsibility for managing escalations and validating delivery.

At other stages, the Asset Manager will work with the key delivery partners shown in Table 1 to ensure that value is protected, risks managed, and contractual obligations are fulfilled.

TABLE 1 KEY STAGES OF PROJECT LIFECYCLE

	STAGE (OR PHASE)	DURATION	STAGE-GATE(S)	PRIMARY FOCUS OF ASSET MANAGEMENT TEAM	KEY DELIVERY PARTNERS
1	Development	1-3 years	Pricing; Investment Committee; Financial Close;	Contract scoping; documentation & certification requirements; risk identification and tracking	Developer/ owner/investor
			Start of construction		
2	Construction	A few months	Construction milestones; connection; commissioning;	Cost management; milestone documentation; risk tracking; variance tracking	EPC Contractor
			Provisional Acceptance Certificate (PAC); Transition from Construction to Operation		
3	Operation under EPC warranty	Up to 3 years	Intermediate Acceptance (IAC)	Performance oversight; warranty maintenance; financial management	EPC Contractor
			Final Acceptance Certificate (FAC)		
4	Operation under ownership	30+ years	Handover; Onboarding; Repowering	Financial; technical; contractual management – as detailed throughout this document	O&M Contractor
			Start of decommissioning		
5	Decommissioning & disposal	A few months	Completion of decommissioning	Execution of obligations	O&M Contractor

3.3. Core competencies needed for lifecycle project management

Throughout the lifecycle of the plant and at each stage, the Asset Manager will manage six core competencies – listed below – across the technical, financial, and contractual functions of the role. In this section we focus on those competencies, which are particularly important to maintain throughout the stage-gates of the project lifecycle.

Stage-gate management The Asset Manager should ensure, at each transition between stages and at milestones (such as construction milestones or interim acceptance testing), that the required documentation associated with risk management, value protection and performance is validated and stored.

Documentation management The Asset Manager should ensure that there is an index and dynamic mechanism for the storage, version control and retrieval of static and dynamic documents which underpin the value of the plant and relate to the technical, financial and contractual management of the plant.

Information management is something the Asset Manager will develop throughout the lifecycle of the plant, through an Asset Register. Operational data also needs to be considered utilising systems such as SCADA.

Risk management The Asset Manager will have a mechanism for tracking key risks through each phase of the project lifecycle.

Ideally, this register is pre-loaded at the development phase of the project lifecycle, with key risks being identified as part of the owner's decision to invest and through the due diligence activity of the legal and technical advisors.

It is recommended that Asset Managers consider requesting the certification of power plants through their life cycle to international standards via available international certification schemes or conformity assessment systems.

3.4. Activities at key stages

The best practice activities for the Asset Manager at each stage are outlined below. This is an addition to the core financial, legal and technical responsibilities detailed in the rest of this document.

Crucially, there is a key role to play within the Asset Manager's remit of tracking and managing risk throughout the lifecycle of the plant and the stage-gates between stages offer an opportunity for the Asset Manager to put in place controls.

Stage 1: Development (pre-construction)

This phase covers all the activity undertaken, up to the point where the project may be described as 'shovel-ready'. Usually, the activity at this stage is focused on the technical and financial development of the project, with a series of transactional milestones such as investment committee approval, EPC execution and financial close.

Typically, this activity is driven by the developer and the transaction team of the owner, supported by legal and technical advisors. However, it is at this stage that timely contributions from the Asset Manager serve most effectively to avoid problems later in the lifecycle of the project. Invariably the AM team will be the only group with long-term involvement in the project lifecycle. An experienced AM service provider will know the issues that can emerge later in the process as a result of ambiguous drafting of EPC terms.

This might be illustrated by the example of documentation requirements associated with the earthing of the plant. Typically, a subject of little interest to the deal team and therefore might be reflected under all-encompassing, but generic terms, such as "the contractor will provide all relevant documentation relating to the earthing of the plant" and "all relevant 'as-built' documentation". With timely involvement from the EPC in collaboration with a sound technical advisor a full list of required documentation can be defined, making the job of the Technical Advisor at the point of post-construction acceptance much less liable to interpretation at a point where pressure to complete is high.

In addition, the Asset Manager should be involved at the transition between transaction and construction to ensure that immediate obligations can be met which might otherwise be missed as the legal teams construct and distribute the hard copy forms of the deal bible. For example, a construction bonus may have been agreed with the landowner and with lease agreement typically not requiring the landlord to issue an invoice, this type of payment can be missed during the period immediately after signing.

As a best practice, the AM provider should be able to undertake a review of all key documentation at point of signing and prior to construction starting:

- EPC documentation – requirements relating to milestone sign-off;
- An agreed form of project summary document including summary of key contracts in place (and t.b.d., such as insurance) and key obligations and timing therein;
- An agreed form of risk and variation register or RAID (Risks, Actions, Issues and Decisions) log (to ensure that 'orange' issues raised through legal, technical or commercial due diligence are flagged for monitoring as the project goes live, and any 'red 'flagged items have suitable mitigation actions in place);
- Contract audit – to identity timing of key obligations and expiries (for example, energy import pricing may be on a temporary tariff throughout the construction period and revert to more expensive default tariff during the first year of operation);
- Documentation management system to allow a smooth transition from legal 'Deal bible' to operational documentation management.

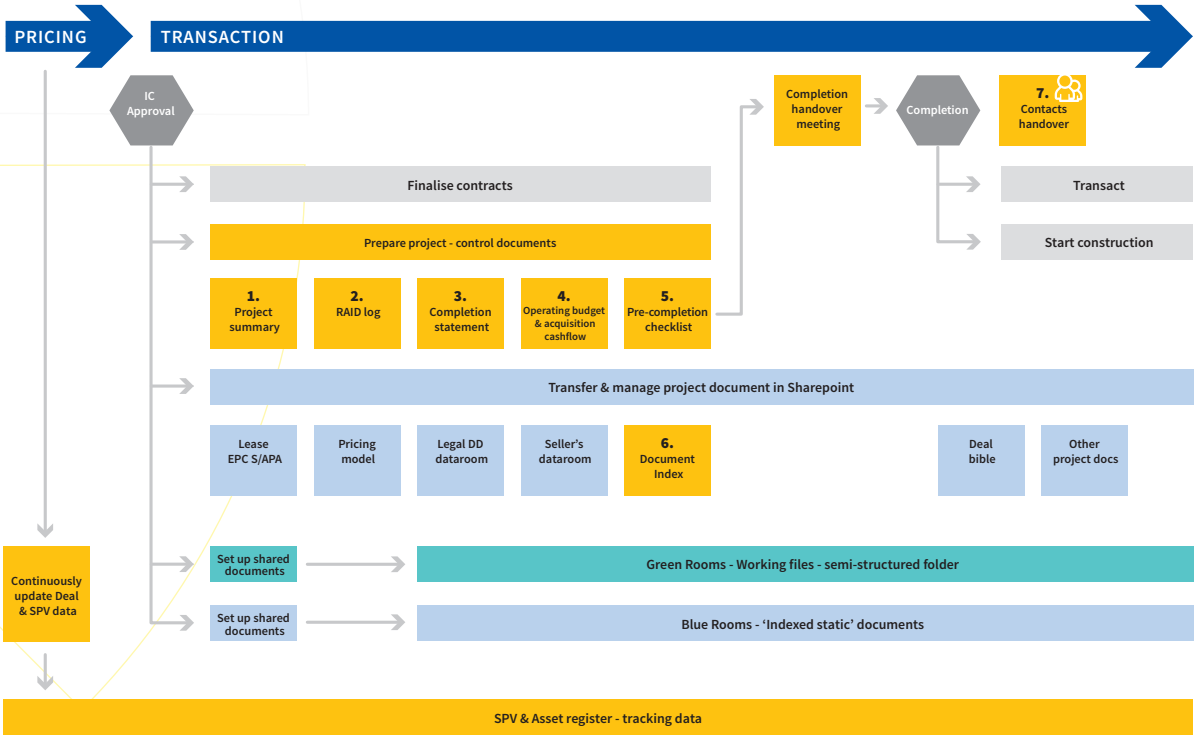
Stage 2: Construction

During the construction phase the Asset Manager will be focused on tracking adherence to planned milestones and ensuring that documentation at each stage of build, relating to components of the plant, is in order. In addition, variations to the plan should be captured.

Stage-gate: Transition from Construction to Operations

Crucial is to ensure appropriate documentation is captured at the commissioning and testing stage. Working closely with the clients and Technical Advisor, the Asset Manager will be ensuring the comprehensive management of documentation relating to commissioning components and capturing issues emerging from audit to ensure effective triage and timely resolution.

FIGURE 5 EXAMPLE OF HANDOVER DOCUMENTATION AND PROCESS AT THE START OF THE CONSTRUCTION PHASE



Stage 3: Operation under EPC warranty

EPC Contractors usually provide a 2-year performance warranty period after the Commercial Operation Date (COD). During the warranty period, it is the responsibility of the Asset Manager to monitor, calculate, report and follow up the values of Performance Ratio and other KPIs guaranteed by the EPC Contractor.

Within this scope, it is the responsibility of the Asset Manager to:

- Manage the interventions done within the scope of the warranty in order to safeguard the performance commitments undertaken under the contract;
- Periodically inform the Asset Owner about the condition of the contracted performance indicators;
- Immediately alert the Asset Owner whenever the levels of the indicators have values or tendencies that could indicate a risk of failure.

As part of best practice, the Asset Manager should pre-empt issues of equipment life expectancy through the effective management of an asset register.

During the warranty period, issues can occur in the plant, which the EPC provider is liable for. The Asset Manager is in charge of resolving these issues in line with what is described in section *5.6. Warranty management*.

Stage 4: Operation under ownership

The activities to be covered by the Asset Manager in the operational phase are described in chapters 5, 6 and 7 of these Guidelines.

Stage 5: Decommissioning & disposal

Once the solar asset reaches its end of life, the Asset Manager should provide the Asset Owner with recommendations of options to do the decommissioning & disposal in line with applicable legal requirements. It is a best practice for the AM service provider to create a matrix of obligations and actions and track its fulfilment.

4 HANDOVER OF SOLAR ASSETS

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The journey of an AM service provider starts with a handover (or on-boarding) process. Whether an asset has just completed its construction phase, as described in Chapter 3, or has been operational for some time, the handover process is critical to ensure the ongoing management of the asset. While the key steps and responsibilities of an AM service provider during the handover from construction is described in Chapter 3, this chapter will address the importance of the onboarding process when an operational asset is transferred from an Asset Manager to another or when an Asset Owner decides to internalise the AM services.

Handover processes are often cumbersome primarily due to the volume of documents and data involved and the need for the receiving AM to learn about asset's history, nuances and current health status to ensure appropriate and continuous management is provided. Depending on the number of assets being on-boarded, the process could last from a few weeks to a few months, it is therefore important that the receiving Asset Manager ensures that appropriate project management resources are dedicated to this process.

Whilst a significant part of the workload associated to the handover process lies with the receiving Asset Manager (whether third-party service provider or within the owner's organisation), it is critical that the receiving Asset Manager secure appropriate assistance from the incumbent AM to ensure appropriate flow of information and documents as well as a suitable transfer of the asset history and outstanding issues lists where applicable.

A thorough handover process is a key enabler for an AM service provider. As described more in detail in this document, the exchange of information and documentation is necessary to allow AM services being carried out appropriately. In this context, the on-boarding process is the cornerstone of the AM service. The key areas of any handover process are detailed below:

4.1. Site data and information

The aim of the Asset Manager is to collect and map the site static details as well as the dynamic information in an asset register (ideally in a dedicated database), effectively creating a "single source of truth" which provides continuity of management for the benefit of the Owner.

- **Static data:** This information comprises a full suite of site data ranging from contact details of the key contractual counterparty to identification numbers of the installation (for instance grid connection identification codes), key corporate information (from VAT numbers to company registration numbers and directorships), key equipment and components details as well as key contractual terms.

- **Dynamic information:** This includes information that provides the history of site. A collection of key events, incidents, inspections, tests and ad hoc studies (above characterised by a certain level of materiality) that have shaped the lifecycle of the site since commissioning as well as currently outstanding events that will require immediate action by the new AM. This type of information provides a story line and history of the site which is incredibly relevant to the AM as it constitutes the basis of the understanding of the site technical and commercial behaviour and will educate management decisions in the next phases of the site lifecycle.

The table below summarises the key categories of site information and data that should be part of the on-boarding process.

4.2. Document acquisition and management

The solar PV market has developed complex contracting structures for solar PV sites, often driven by the requirements of investors, lenders and funders. Documentation and contracts management is therefore at the core of any AM service as it sets the boundaries and shapes the services to be provided. During the handover process two main tasks are carried out with regards to the documentation management:

- **Document checklist**: The Asset Manager should be able to advise a minimum and essential set of documents required to enable the normal carrying out of the services as well as a wider selection of documents which might be considered as additional. This does not comprise contracts only but also technical documents from construction and operations documentation. The outcome of this process will identify and gaps and ensure that documentation is properly migrated in the document management system agreed between the owner and the Asset Manager.

TABLE 2 KEY CATEGORIES OF SITE INFORMATION TO BE COLLECTED BY INCOMING ASSET MANAGER

CATEGORY	EXAMPLES OF SUB-CATEGORY INFORMATION FIELDS*
Real Estate & Planning	Site location and access. Lease and landlord details. Planning permits details
Technical and Design	Details of capacity for both grid connection and subsidies purposes
Production	Details of yield budget and forecasts
Construction and Accreditation	Commissioning dates and subsidies accreditation/registration milestones
Corporate	Special Purposes Vehicle details (registration offices and numbers, directorships)
Counterparties contacts	Main contractual counterparties contact details
Metering	Meters identification/serial number and contracts details
Comms and Monitoring	Communication and monitoring/SCADA systems access details and key features
Equipment & Warranties	For each key component should include manufacturer, serial number, product warranty details. This should include all factory EL and Flash reports for the modules
EPC (during warranty period)	EPC contractor details and key milestones dates and results. This could also include grid connection contractors should this part of the construction services be outside of the scope of the EPC
O&M Contract (post warranty period)	O&M contractor details, key contractual terms and obligations, historical performance information (if available)

*THE LIST IS NOT EXHAUSTIVE AND PROVIDES ONLY SOME EXAMPLES FOR EACH CATEGORY.

- **Document checks:** The handover process should allow enough time for the Asset Manager to run through the essential documents to both (*i*) collect static information that will feed in the asset register; (*ii*) understand and map the key milestones and process required by the different contracts; and (*iii*) learn the history of the site.

The table below summarises some of the key documents to be collected and reviewed during the on-boarding process. These documents originate from the construction and operational phases:

TABLE 3 KEY DOCUMENTS TO BE COLLECTED AS PART OF A PROJECT HANDOVER

CATEGORY	DESCRIPTION	SOURCE	LIFECYCLE PHASE
O&M Manual	Full set of design and commission and O&M instructions. See details in O&M Best Practice Guidelines - Annex B	EPC Contractor	Construction
Land Lease	Details of the land lease and any associated access agreements	Developer	Construction
Planning Permission/ Permits	Details of the permissions and ongoing duties/requirements for the government approval for the construction and continuing operation of the plant. List of any amendment subsequently submitted and/or approved. Include environmental conditions necessary for the ongoing operation	Developer	Construction
Grid Connection Agreements	Agreement with the Electricity Network operator	Developer / EPC	Construction
Warranties	Warranties in place from installers and equipment manufacturers for the site and associated equipment	EPC (Some will be included in O&M Manual)/ Procurement agreements	Construction
Insurances	Insurances that may be in place for the asset	Developer/EPC/Owner	Construction
Contracts in place	All contracts currently active, including EPC, Equipment Supply Contracts, O&M providers, sub-contractors	Developer/EPC/Owner	Construction
PPA Contract	The agreement for the purchase of the electricity produced by the plant	Developer/Owner	Construction
FIT / Incentive Schemes	The certification and ongoing agreement for the payment of associated incentives (if applicable)	Developer/Owner	Construction
Planned Maintenance Records	Records of testing and inspections carried out since commissioning. To include as much information as possible from the last and all previous operational years. Should include any records from previous contracts/providers. Aim to have all records in PDF or the original digital format	O&M Contractor and/or Incumbent/off boarding Asset Manager	Operation

TABLE 3 KEY DOCUMENTS TO BE COLLECTED AS PART OF A PROJECT HANDOVER - *Continued*

CATEGORY	DESCRIPTION	SOURCE	LIFECYCLE PHASE
Reactive Maintenance Records	Records of reactive interventions carried out. Might be contained in monthly reports but ideally a full download/ record of the individual tickets/intervention reports	O&M Contractor and/or Incumbent/off boarding Asset Manager	Operation
Details of all Claims (In progress and Complete)	Log and associated correspondence of all claims initiated that are relevant to the plant. Details of any open claims should include all relevant records and correspondence to allow them to continue to be progressed	O&M Contractor and/or Incumbent/off boarding Asset Manager	Operation
Monitoring System Historic Data	Full set of collected plant information from the maximum number of measured devices. This may be less critical if the monitoring system is transferred to the new provider completely, but a full backup is advisable. Particular attention should be paid to the data from any legacy monitoring systems that may have operated at earlier stages of the plant	O&M Contractor and/or Incumbent/off boarding Asset Manager. Likely via Monitoring provider	Operation
Spares Inventory	Up to date list of all Spare equipment relating to the plant. This should include details of equipment, serial numbers, associated purchasing information, any expiry/recalibration dates and storage location	O&M Contractor and/or Incumbent/off boarding Asset Manager	Operation
Contractual Records	All contracts relating to the plant and SPV	Incumbent/Off boarding Asset Manager	Operation
Construction Contract Project Milestones	Details of Interim and Final Acceptance stages of the EPC contract and associated inspections, reports, contracts	Incumbent/Off boarding Asset Manager	Operation
Financial Records	All financial records related to the plant and SPV	Incumbent/Off boarding Asset Manager	Operation
Monthly and Annual reports	A complete set of all monthly and annual reports produced under the O&M and Asset Management contracts	Incumbent/Off boarding Asset Manager	Operation
Ongoing/outstanding Issues lists	Brief memorandum for each site highlighting key historical events/incidents that affected the site and list of ongoing matters that require immediate attention	Incumbent/Off boarding Asset Manager	Operation

4.3. System and tools

There are many software and data solution providers in the market and therefore, it is important to recognise that data might need to be migrated between systems during the on-boarding process; this activity should not be underestimated and will have a direct impact on the accessibility and usefulness of the data. This dependency could affect asset information included in an asset register and the document management system but also the financial information (bookkeeping, ledgers and financial forecasting).

The owner and receiving Asset Manager will need to decide which systems and tools to use, should they not wish to deploy the systems used by the incoming asset, or ensure appropriate data mapping and communication protocols between the systems are established. Both parties should account for significant support from the respective IT teams to ensure that the migration takes place smoothly and successfully. For more information on Asset Management Platforms, please refer to Chapter 9, *Data management and high-level monitoring*.

5 TECHNICAL ASSET MANAGEMENT

Technical Asset Management (TAM) encompasses *support activities to ensure the best operation of a solar power plant or a portfolio*, i.e. to maximise energy production, minimise downtime and reduce costs. It comprises the activities presented in this chapter.

It is not easy to draw a sharp line between the high-level tasks of the operations team and the more technical responsibilities of the Asset Manager. A simple way to provide some clarity would be that Asset Managers are policing the activities of the O&M providers and reassure compliance and contractual conformity. In many cases, the O&M Contractor assumes some tasks related to Technical Asset Management such as KPI reporting. The below tasks can be regarded as Technical Asset Management and can be performed by the O&M Contractor or the Asset Manager. In line with this, this chapter is also featured in SolarPower Europe's O&M Best Practice Guidelines. In cases where the Technical Asset Manager and the O&M Contractor are separate entities, a close coordination and information sharing between the two entities is indispensable. This involves integral knowledge about how much a project should be producing for any given time, considering factors such as weather, seasons, or degradation of assets, and ensuring long-term energy infrastructure reliability. It represents the entire value chain from investors to Asset Managers and service providers.

5.1. Technical reporting

The Technical Asset Manager is responsible for preparing and providing regular reporting to the Asset Owner and other stakeholders defined in the agreement between the Asset Owner and the Technical Asset Manager.

The frequency of the reporting can be set daily, weekly, monthly, quarterly or annually (with monthly being the most common and considered a best practice), with specifically defined content for each of these reports. Generating a report for any specific time range in the past can also be possible. Detailed time-series data should also be reported or at least archived in the reporting system in order to improve the correct availability calculations. The spatial resolution of reports should be on the level of each inverter to better detect under-performing sections of the plants managed.

Table 3 includes some proposed quantitative and qualitative indicators which should be in reports as a minimum requirement, a best practice or a recommendation. For more details on the individual indicators, see Chapter 11, *Key Performance Indicators of SolarPower Europe's O&M Best Practice Guidelines*.

A new trend in the industry is to extend the reporting beyond the pure PV plant indicators and to incorporate reporting on the actual activities. This means that both the Asset Manager and the O&M Contractor can operate with a CMMS (Computerised Maintenance Management Systems) in order to measure various O&M KPIs (e.g. Acknowledgement Time, Intervention Time, Reaction Time, Resolution Time) and equipment performance (e.g. Mean Time Between Failures). The Technical Asset Manager should also report on Spare Parts Management and in particular on spare parts stock levels, spare parts consumption, in particular PV modules on hand, spare parts under repair. With the emergence of Predictive Maintenance, the Technical Asset Manager can also report on the state of each individual equipment. Furthermore, the periodic reporting can include information on the status of the security and surveillance system. In this case, the security service provider is responsible for providing the relevant input to the Technical Asset Manager.

TABLE 4 PROPOSED INDICATORS/VALUES REQUIRED FOR THE REPORTING

TYPE OF DATA	PROPOSED INDICATOR	TYPE OF REQUIREMENT
Raw data measurements	Irradiation	Minimum Requirement
	Active Energy Produced	Minimum Requirement
	Active Energy Consumed	Best Practice
PV Power Plant KPIs	Reference Yield	Recommendation
	Specific Yield	Recommendation
	Performance Ratio	Minimum Requirement
	Temperature-corrected Performance Ratio	Best Practice
	Energy Performance Index	Best Practice
	Uptime	Best Practice
	Availability	Minimum Requirement
	Energy-based Availability	Recommendation
O&M Contractor KPIs	Acknowledgement time	Minimum Requirement
	Intervention time	Minimum Requirement
	Response time	Minimum Requirement
	Resolution time	Minimum Requirement
Equipment KPIs	Mean Time Between Failures (MTBF)	Recommendation
	Inverter Specific Energy Losses	Recommendation
	Inverter Specific Efficiency	Recommendation
	Module Soiling Losses	Recommendation
Environmental KPIs	Environmental and Biodiversity KPIs may vary depending on the geography, the micro-climate and the conditions of each site.	Best Practice
Incident Reporting	Main incidents and impact on production	Minimum Requirement
	Warranty issues	Best Practice
	HSE issues	Best Practice
	Spare parts stock levels and status	Best Practice
	Physical and Cyber Security Issues	Minimum Requirements
	Preventive Maintenance tasks performed	Best Practice

On top of the periodical standard reports (monthly, quarterly or yearly) where operations activities are reported by the Technical Asset Manager to the Asset Owner, it is a best practice for the Technical Asset Manager to provide an intermediate operation report when a fault is generating a major loss. 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. The report should be sent as soon as the fault is acknowledged or solved and should contain all the relevant details related to the fault together with recommendations for Extraordinary Maintenance when the necessary operations are not included in the maintenance contract.

- Typically, this maintenance report should contain: Relevant activity tracks (alarm timestamp, acknowledge time, comments, intervention time, operations on site description, pictures etc)
- The estimated production losses at the moment of writing the report
- The estimated production losses for the total duration of the period, counting on the estimated resolution time if the issue is not solved yet
- The device model, type and Serial Number when the fault is affecting a device
- The peak power of the strings connected to the device(s)
- The alarm and status log as provided by the device
- The resolution planning and suggestions. Eventual replacement needed
- Spare parts available
- Estimated cost for the extra-ordinary maintenance

5.2. Site visits and non-intrusive inspections

It is recommended as a best practise that Technical Asset Managers undertake a bi-annual site visit in coordination with the O&M provider to perform a non-intrusive visual inspection, address current maintenance issues and plan out in cooperation with the O&M contractor and the ancillary service providers (if different) a maintenance improvement plan.

5.3. Management of ancillary service providers

When the O&M Contractors do not have an all-inclusive contract, Technical Asset Managers may be responsible for managing providers of ancillary (additional) services related to PV site maintenance such as panel cleaning and vegetation management; general site maintenance such as road management, site security; or on-site measurement such as meter readings and thermal inspections. For more information on additional services, please refer to SolarPower Europe's O&M Best Practice Guidelines Section *7.5. Additional services*.

This requires managing a process which spans from tendering for those services all the way to assessing the deliverables and reassuring in coordination with the O&M compliance with environmental, health and safety policies.

5.4. Interface with local energy authorities & regulatory compliance

The Technical Asset Manager is responsible for ensuring that the operation of the PV plant is in compliance with the regulations. Several levels of regulation have to be considered:

- Many countries have a governing law for the operation of energy generating assets or renewable energy and PV plants in particular. This is something the O&M Contractor should be aware of in any case, even if the O&M Contractor and the Technical Asset Manager are separate entities.
- Power Purchase Agreements (PPA) and Interconnection Agreements must also to be known and respected by the Technical Asset Manager.
- Power generation license agreements need to be made available by the Asset Owner to the Technical Asset Manager so that the Technical Asset Manager can ensure compliance with the regulations of these licenses.
- Further to the regulatory compliance, Technical Asset Manager will be responsible to ensure corporate compliance especially on the new post-subsidy environment, which is dictated by corporate PPAs and stricter contractual obligations by the owner.
- Specific regulation for the site such as building permits, environmental permits and regulations can involve certain requirements and the need to cooperate with the local administration. Examples include restrictions to the vegetation management and the disposal of

green waste imposed by the environmental administration body, or building permits restricting working time on site or storage of utilities.

- It is the O&M Contractor's responsibility to ensure grid code compliance. See *6.7. Grid code compliance* of the O&M Best Practice Guidelines. It is the responsibility of the Asset Manager to engage the DNO on discussions which will minimise outages and identify measures to safe-guard export capabilities.
- The Technical Asset Manager plays an important role in supporting the cooperation between the aggregator and the grid operator by informing the aggregator about plant production data, unavailable times, transferring network unavailability information from the grid operator, assuming discussions with the grid operator about the attachment to the balancing portfolio of the respective aggregator, and executing plant shutdown requests (in case of negative prices identified in the day-ahead market).
- Other issues requiring formal compliance include reporting of safety plans and incidents, historic/cultural resource protection, noise ordinances that may limit work at night, and any other regulations imposed by an authority having jurisdiction.

As a minimum requirement the agreement between the Technical Asset Manager and the Asset Owner should list all the relevant permits and regulations and specify that the Asset Owner makes relevant documents available to the Technical Asset Manager.

As a best practice, all regulations, permits and stipulations should be managed within the electronic document management system. This allows the Technical Asset Manager to track reporting and maintenance requirements automatically and report back to the Asset Owner or the administration bodies.

5.5. Warranty management

The Technical Asset Manager can act as the Asset Owner's representative for any warranty claims vis-à-vis the OEM manufacturers of PV plant components. The agreement between the Asset Owner and the Technical Asset Manager should specify warranty management responsibilities of the Technical Asset Manager and the Asset Owner and set thresholds under which the Technical Asset Manager can act directly or seek the Asset Owner's consent. The Technical Asset Manager or the Operations team will then inform the Maintenance team to perform warranty related works on site. Usually the warranty management scope is limited by Endemic Failures (see definition below in this section). Execution of warranty is often separately billable.

For any warranty claims the formal procedure provided by the warranty provider should be followed. All communications and reports should be archived for compliance and traceability reasons.

Objectives of Warranty Management:

- Improve the efficiency in complaining processes
- Help to reduce the warranty period costs
- Receive and collect all the warranty complaints
- Support the complaint process
- Negotiate with manufacturers more efficient complaint procedures
- Study the behaviour of the installed equipment
- Analyse the costs incurred during the warranty period

Types of warranties on a PV Plant:

- Warranty of Good Execution of Works
- Warranty of Equipment (Product Warranty)
- Performance Warranty

Warranty of good execution of works and equipment warranties

During the warranty period, anomalies can occur in the facility, which the EPC provider is liable for. The anomalies must be resolved according to their nature and classification, in accordance to what is described in the following sections.

The anomalies or malfunctions that might occur within the facility warranty period might be classified in the following way:

- **Pending Works**, in accordance to the List of Pending Works (or Punch List) agreed with the client during EPC phase;
- **Insufficiencies**, these being understood as any pathology in the facility resulting from supplies or construction, that although done according to the project execution approved by the client, has proven to be inadequate, unsatisfactory or insufficient;

- **Defects**, these being understood as any pathology resulting from supplies or construction executed in a different way from the one foreseen and specified in the project execution approved by the client;
- **Failure or malfunction of equipment**, being understood as any malfunction or pathology found in the equipment of the photovoltaic facility – Modules, Inverters, Power transformers or other equipment.

Anomalies Handling

During the Warranty Period, all the Anomaly processing should, as a best practice, be centralised by the Technical Asset Manager/O&M Contractor, who is responsible for the first acknowledgment of the problem and its framework according to its type and is the main point of contact between the internal organisational structure and the client in accordance to the criteria defined below.

Pending Works, Insufficiencies and Defects

In the case of anomalies of the type "Pending Works", "Insufficiencies" or "Defects", the Technical Asset Manager must communicate the occurrence to the EPC provider, who shall be responsible to assess the framework of the complaint in the scope of the EPC contract, determining the action to be taken.

Resolution of failures in the case of anomalies of the type "Failures"

The Technical Asset Manager should present the claim to the equipment supplier and follow the claims process.

Endemic Failures

Endemic failures are product failures at or above the expected failure rates resulting from defects in material, workmanship, manufacturing process and/or design deficiencies attributable to the manufacturer. Endemic failure is limited to product failures attributable to the same root cause.

Performance Warranty

EPC Contractors usually provide a 2-year performance warranty period after the Commercial Operation Date (COD). During the warranty period, it is the responsibility of the Technical Asset Manager to monitor, calculate, report and follow-up the values of Performance Ratio and other KPIs guaranteed by the EPC Contractor.

Within this scope, it is the responsibility of the Technical Asset Manager to:

- Manage the interventions done within the scope of the warranty in order to safeguard the performance commitments undertaken under the contract;
- Periodically inform the Asset Owner about the condition of the contracted performance indicators;

Immediately alert the Asset Owner whenever the levels of the indicators have values or tendencies that could indicate a risk of failure.

Warranty Enforcement

A warranty may be voided by mishandling or not observing instructions or conditions of the warranty. For example, storing modules improperly onsite, such that the packaging is destroyed by rain, may void a warranty. In another case, partial shading of a thin-film module voids the warranty. Failure to provide adequate ventilation may void an inverter warranty. The manufacturer's warranty might cover replacement but not labour to remove, ship, and re-install an underperforming module. A warranty often gives the manufacturer the option to "repair, replace, or supplement," with "supplement" meaning to provide modules to make up the difference in lost power. For example, if a system has 10,000 modules that are underperforming by 5%, the guarantor could satisfy the performance warranty by providing 500 additional modules to make up for the lost power, rather than replacing the 10,000 modules. However, increasing the plant size by 500 modules to restore guaranteed power might not be possible due to lack of rack space or electrical infrastructure. Also, expanding the system "nameplate" capacity would generally trigger a new interconnect agreement and permitting. Manufacturers also often have the option of paying a cash-value equivalent to the lost capacity of under-performing modules, but as the price of modules declines, this might be less than originally paid for the modules. Given the complications described above, this option is often preferred by system owners unless there is a required level of performance that must be maintained.

5.6. Insurance claims

The agreement between the Technical Asset Manager and the Asset Owner should specify the insurance management responsibilities of the Asset Owner and the Technical Asset Manager. The Technical Asset Manager will at least be responsible for the coordination of site visits by an insurance provider's representative or

technical or financial advisors in connection with the information collection and damage qualification, as well as for the drafting of technical notes to support the reimbursement procedure. The coordination of the insurance claim and the liaison with the insurers, brokers and loss adjusters, as well as finding the best insurance providers, is usually with the Commercial/Financial Asset Manager (see section *6.13. Suppliers account management*).

For any insurance claims, the formal procedure presented by the insurance provider should be followed. All communications and reports should be archived for compliance and traceability reasons.

Types of insurance related to PV plant operations and maintenance include:

- Property insurance, hazard insurance: coverage commensurate with the value of equipment and other improvements to a property; may also cover against other risks if included or unless excluded.
- Commercial general liability insurance: in a form covering all actions by owner or contractors, written on an occurrence basis, including coverage for products and completed operations, independent contractors, premises and operations, personal injury, broad form property damage, and blanket contractual liability. Liability of a fire started by the PV system has increased required liability coverage levels for PV systems. A liability policy should cover negligence claims, settlements, and legal costs too.
- Inland insurance or marine insurance: insures against loss of equipment in shipping or not on the property premises. Inland insurance is often covered under property insurance policy.
- Workmen's compensation: covers costs for employee accidents.
- Professional liability insurance: insures against errors and omissions often required by board of directors.
- Commercial vehicle insurance: insurance for owned and rented vehicles or personal vehicles used on company business
- Warranty insurance: equipment warranty issued by manufacturer but backed up by an insurance company in the event that the manufacturing company goes out of business. Many insurance companies do not offer warranty insurance but rather cover such risk under property insurance.
- Business interruption insurance covers lost revenue due to downtime caused by covered event – this can be important in PPAs where revenue is essential for debt service and O&M expenditures.
- Energy production insurance covers cases when energy production is less than previously specified, which can improve access to debt financing and reduce debt interest rate.

The procedure for making claims described in the insurance policy should be followed to the letter, keeping copies of all submittals and correspondence with the insurance company. The insurance company (claims adjuster) will need to have access to the site provided to them in order to assess damage and to collect the information needed to process the claim.

5.7. Contract management (operational contracts)

Contract management encompasses both technical and commercial/financial aspects. This section looks at contract management from a TAM point of view. Section *6.12. Contract management (financial contracts)* takes the perspective of the Commercial/Financial Asset Manager.

The Technical Asset Manager is in charge of ensuring compliance with the operational contracts in place, such as contracts related to O&M services, land lease, insurance, site security, communications and in some cases ancillary (additional) services such as panel cleaning and vegetation control or component procurement. (For more information on procurement, please refer to chapter *7. Procurement.*)

Indeed, the oversight of and coordination with the O&M Contractor is one of the key responsibilities of the Technical Asset Manager. Thus, the Technical Asset Manager is responsible for performance supervision too: proper oversight of O&M, detecting when systems are underproducing, and quickly and accurately diagnosing an under-performing plant.

The Technical Asset Manager oversees various contractual parameters, responsibilities and obligations of the Asset Owner and the contractual partners linked to the respective solar power plant. Contract management responsibilities depend largely on factors such as geographic location, project size, construction and offtaker arrangements.

As a minimum requirement, the initial step in this process is a comprehensive analysis of the contracts

followed by a well-defined Division of Responsibility (DOR) matrix that clearly delineates which entity is responsible for which action on both the short and long term. Upon mutual agreement between the parties, the DOR can serve as the driving and tracking tool for term of life contractual oversight.

As a form of best practice, the Contract Manager's responsibilities often also extend to functioning as the initial contact for all external questions. This allows the Asset Owner optimal access to all areas of the service provider's organisation and adherence to the contractual responsibilities. The Contract Manager also assumes the responsibility for invoicing of the O&M fees to the Asset Owner.

For quality purposes, the Technical Asset Manager should also track their own compliance with the respective contract, either O&M contract or Asset Management contract, and report to the Asset Owner in full transparency.

5.8. Asset optimisation (technical)

Technical Asset Managers also start being responsible for providing data and information analysis on assets they manage, as well as to provide asset optimisation solutions, primarily based on the following key areas:

- Plant performance
- Operation cost reduction
- Technology adaptation and upgrades (e.g. Revamping and repowering[2])
- Technical People management and training

It is the role of the Technical Asset Manager to initiate and coordinate discussions with both the Owners and the O&M Contractors to future-proof the assets and come up with a financial proposal based on data analysis which can assist the owners in making informed decisions.

Note that asset optimisation has commercial and financial aspects too, such as contract optimisation, presented in chapters *6. Commercial and Financial Asset Management* and *7. Procurement*.

5.9. Environmental management

Depending on local and international environmental regulations, as well as on the Asset Owner's CSR and Environmental internal policies, the Asset Owner may have incentives to reduce or control negative environmental impacts.

An increasing body of scientific evidence indicates that well-designed and well-managed solar energy can support wildlife habitats and contribute significantly to national biodiversity targets. In fact, solar parks can have several additional advantages over other agricultural landscapes, in that they are secure sites with minimal human and technical disturbance from construction, require little or no use of chemical pesticides, herbicides or fertilizers, and typically incorporate ecological features such as drainage ponds and hedgerows, which can be designed to maximise the value of their habitat.

The approach to managing biodiversity will be different for every solar park, and it is recommended that a site-specific plan be devised in each case.

Therefore, the Asset Manager is obliged to assess the impact or limitations of environmental legislation on the supplier's existing contracts. Furthermore, the Asset Manager is required to develop an action plan to address existing problems and minimise their impact.

As an example, the Asset Manager must oversee the O&M provider's operational field work to ensure compliance with local environmental regulation (use of chemicals to control vegetation, use of diesel cutting machines, etc.); the security contract must be adapted, if possible, according to the wild life existing around the photovoltaic plant and the appropriate security equipment, such as loudspeakers, spotlights and fences, must also be adapted.

Long-term environmental requirements can also include water tank installation, tree clearing, installation of drainage systems, amphibian follow-up, edge plantation, and installation of reptile rock shelters. As a best practice, the Technical Asset Manager's (or the O&M Contractor's) environmental preservation activities should go beyond legal obligations.

5.10. Health & safety management

The Technical Asset Manager should oversee that the solar asset and the relevant suppliers comply with health & safety (H&S) requirements. If necessary, the Technical Asset Manager should hire an H&S expert to ensure compliance. For more information, see chapter *3. Environment, Health & Safety* of the O&M Best Practice Guidelines.

2 For detailed information about revamping and repowering, please refer to chapter 8. *Revamping and Repowering* of the O&M Best Practice Guidelines.

6

COMMERCIAL AND FINANCIAL ASSET MANAGEMENT

Commercial and Financial Asset Management encompasses *support activities for the best operation of a business.* By definition, the scope of Commercial and Financial Asset Management goes from the contact with external entities on behalf of the Asset Owner until the conversion of operational data into useful and understandable financial information. It comprises the activities presented in this chapter.

6.1. Financial reporting

In addition to technical reporting (see section 5.1. Technical Reporting), financial information is incorporated into the individual monthly report that is usually centred in a cost structure analysis. The individual report should also include information regarding relevant operational incidents, corrective maintenance interventions and security incidents statuses (when provided by the O&M and security supplier).

An additional consolidated report may be produced. This document should include the information disclosed in the individual monthly reports (operational and financial), as well as a set of consolidated financial information with the purpose of providing an integrated portfolio vision. The following financial information should be included in the consolidated report:

- Consolidated financial statements (income statement: balance sheet and cash flow).
- Capital structure analysis.
- Detailed OPEX items or net financial expenses breaking down analysis by type of expense, comparing with previous homologous period (when available), and highlighting material contributions per cost figure.
- Profitability analysis.
- Cash flow overview (on a backward and forward-looking perspective).
- Debt compliance and follow-up – loan administration, including settlements supervision, supervision of interest rates fixing and remuneration of current accounts.

6 COMMERCIAL AND FINANCIAL ASSET MANAGEMENT

/ CONTINUED

The focus of the Asset Manager is to monitor the business and provide recommendations for improvement of overall status and performance of the photovoltaic plant. By providing specialized management based on reporting individual and consolidated figures of the Asset Owner's portfolio (portfolio perspective) and breaking down the contribution of each SPV to compare it with the financial model assumptions and historical years (whenever available), the Asset Manager is able to differentiate their service and add value to the Asset Owner. Such analysis will comprise a concise financial interpretation and understanding of the results, and such a periodic report may be fine-tuned in accordance with the Asset Owner's needs.

The role of the Asset Manager includes the capability of contributing to the development of new indicators and of innovative reporting solutions. The Asset Manager may contribute significantly to the improvement of the performance of the photovoltaic plant by managing all the activities which have an impact and should be reported in the periodic financial reporting.

Furthermore, the Asset Manager is in charge of coordinating a set of corporate financial services that are essential to assess the economic and financial performance of the plant. These actions are relevant for the periodic financial reporting and should be previously agreed upon with the Asset Owner.

6.2. Strategy management

The business should develop and implement a strategic framework for all its Asset Management activities. It should be based upon the business strategy, future demand patterns, stakeholder concerns and asset-related risks. The output is an AM policy or future statement of intent, an AM strategy to achieve it, various AM plans and a scorecard of AM KPIs with improvement targets. This framework should be implemented with the required change management process and monitored through regular audits and management reviews.

6.3. Corporate administrative services

The Asset Manager is usually in charge of providing corporate administrative services for the managed SPV, including coordination of the board of directors' meetings, and general management services, including domiciliation of the company, operation of the bank accounts etc.

6.4. Accounting

Accounting is the support area responsible for meeting local and international legal, regulatory and tax requirements as the reporting of financial transactions pertaining to business.

In Accounting, one must ensure that the local and international accounting standards (IAS) are met and align with the international financial reporting standards (IFRS) in order to produce financial information that is in a common global language for business affairs. This way, the accounts of a company are understandable and comparable across international boundaries.

Therefore, Accounting means processing all the financial information of a business and converting it into standardized outputs that are universally understood and comparable financial statements.

The Accounting service can be included in the Asset Management contract as a provided service regardless of whether it is an internalised (Asset Manager's responsibility) or externalised (outsourced) service. The main activities under the scope of Accounting Services are detailed in section *6.6. Accounting assistance*.

6.5. Customer relationship

The main customer of the Asset Manager is the Asset Owner. Consequently, all the third-party relationship management carried out by the Asset Manager must align with the Asset Owner's work ethic, company culture, expectations and needs.

The Asset Manager is responsible for acting on behalf of the Asset Owner in all contact and relations with external entities (third-party) in accordance with the predefined Asset Management contract. The Asset Manager should source solutions, make negotiations and present all the collected information and its critical analysis to the Asset Owner for examination and for final decision-making.

The key customer of the SPV is the final recipient of the electricity generated by the photovoltaic plant, whether it is a local utility or a final consumer. The Asset Manager must: ensure compliance with the power purchase agreement, fulfil the contract requirements and deliverables, and verify if the settled tariff is being paid correctly. Furthermore, the Asset Manager is responsible for sourcing alternatives or renegotiating, when needed, the energy sale contract.

Thus, it is the Asset Manager's responsibility to make the bridge between the Asset Owner and the SPV (Asset/photovoltaic plant) customers.

This requires a high level of responsibility, so the Asset Manager must be able to act promptly and effectively in the best interest of the Asset Owner at every instance.

Moreover, the Asset Manager should hold periodic meetings in order to inform the Asset Owner of the status of ongoing negotiations and other relevant events. The meeting and its agenda should be proposed by the Asset Manager.

Therefore, in order to streamline all relevant processes and to avoid any undesirable delays or missed deadlines, the Asset Manager is responsible for informing the Asset Owner of important correspondence, assuring maximum control of relevant external communications (local tax authorities, banks, suppliers and others).

Although the Asset Owner's role is not to perform operational management activities, their awareness of relevant events happening inside the plant or in its immediate vicinity is of higher importance for their decision-making process.

In this respect, it is advised that the Asset Manager follows up relevant events with the help of a "Follow-up Report". This document will assist in monitoring occurrences that may arise in the day-to-day operation of the project, as well as in tracking serious issues and establishing action plans and priorities.

6.6. Accounting assistance

The Accounting Service is obliged to comply with local and international legal, regulatory and tax requirements in accordance with the IAS and IFRS, as mentioned in section *6.2. Financial reporting*, *6.3. Accounting* and *6.4. Customer relationship*. Therefore, establishing processes and procedures in order to have a complete understanding of the local legal, regulatory and tax requirements applicable to the reporting of financial transactions pertaining business should be done accordingly. Consequently, the Asset Manager should be supported by an Accounting Service that is knowledgeable in local market practices.

The Asset Manager ensures that the Accounting Service meets its obligations of Book-keeping and Administration as well as Accounting Procedures. Monthly and annual activities of the Accounting Service are stated below.

Bookkeeping and administration

- Registration of book-keeping entries for the project company's operations.
- Keeping the project company's accounting books (general ledger, VAT registers, inventory book and depreciable assets book).
- Calculation and entering of the corresponding amortisation allowances into the project company's books and keeping a complete record of all fixed asset balances.
- Calculation and entering of remittances, where applicable, into the project company's books.
- Registration of the project company's financial operations.
- Registration of time period adjustments (accruals and prepayments, including interest accruals) in the project company's accounting books.
- Management of the project company's correspondence.

Accounting procedures

- Establishment of Accounting and Administrative procedures.
- Preparation and assistance during tax audits.
- Preparation of monthly financial statements (balance sheet and income statement) of the project company.
- Advise on financial and accounting matters in the daily operations and matters that may impact the accounting operation of the project company.
- Elaboration of the project company's statutory annual accounts.

Furthermore, the main outputs of the Accounting Service include the elaboration of the SPV's (asset/PV plant) statutory annual accounts, general ledger listings, accurate financial statements (balance sheet and income statement), and the design of an appropriate chart of accounts or analytical accounting issues namely, with regards to a portfolio, to ensure the correct allocation of income and expenses across the PV plant(s).

6.7. Invoicing/billing and payments

An invoice is a commercial document that itemises a transaction between a buyer and a seller. If goods or services were purchased on credit, the invoice usually specifies the terms of the deal, and provides information on the available methods of payment. An invoice is also known as a bill or sales invoice.

Therefore, the invoice is the most important document for the Asset Manager to control the revenue. It allows the Asset Manager to verify if the invoiced amount is in accordance with the produced energy amount. This is the first step to control the SPV's income. As a note, the invoice is a key document to control costs. The Asset Manager must ensure that all suppliers' invoices are consistent with what was agreed in the service providers' contracts.

One can consider that the biggest challenge of the Asset Manager is the control of revenues and expenses through rigorous invoicing monitoring.

6.8. Revenue Control

The Asset Manager is responsible for confirming the reading of the meters based on the information collected on site by the O&M Team, and for validating and comparing it with the billing issued by the electricity purchaser. These activities are called Revenue Control and include:

- Calculation of revenue corresponding to energy generation using the production data downloaded from the production meters.
- Verification of the production data read and registered as well as the issuance of relevant invoices and self-billing invoices, if applicable.
- In case differences occur between the actual energy produced and the energy registered, processing of the corresponding claims and following up until the claims are completely resolved.
- If incidences that arose affected the reading of production meters, coordination of necessary actions to guarantee the accurate invoicing of the energy fed into the grid.

6.9. Cash flow management

The Asset Manager is responsible for managing the treasury activities and for monitoring the cash available in every period. Cash management is crucial for the expenditures' decision-making process. The Asset Manager is accountable for ensuring the proper balance between income and expenses plus revenue and cost.

Adequate treasury operation allows the Asset Manager to manage and adjust payment dates in accordance with the predicted income dates. This way, the expenses can be incurred at a more appropriate timing.

Moreover, the cash flow management gains importance when one considers the variability of the revenues of a PV plant. The latter depends on:

1. Weather conditions.
2. Equipment status and performance.
3. Tariff nature (fixed vs. variable).
4. Local tariff legislation and contract in place (FiT, PPA, Pool Price).

The cost structure of a solar power plant has the opposite behaviour, which is relatively stable throughout the lifetime of the project. The highest costs are associated with operational contracts, such as Operation and Maintenance, Land Lease agreement, Asset Management and Debt Financing. These contracts are not usually negotiated by the Asset Manager as they are typically long-term, entered by the Asset Owner and sometimes tied to Project Finance terms. However, for lighter costs, such as insurance policies, communications, independent audits and security, the Asset Manager is in a position to negotiate and should strive for continuous improvement and optimisation, not only in terms of cost, but also in terms of quality of services.

The opposite behaviour of revenues and costs highlights the complexity of ensuring a stable monthly balance between them. For instance, if the monthly revenue is far below the forecast due to a decrease in the monthly irradiation levels, it may represent a risk of a decrease in liquidity for the SPV (photovoltaic plant), especially if significant expenses are required in this specific month.

An additional challenge to cash management is the few degrees of freedom the Asset Manager has to influence cash flows: Inflow of cash is dependent on external or random events as described above, whereas outflows are mostly fixed in long-term contracts. The single most powerful lever for ensuring liquidity is determining the appropriate level of investor dividends. In most cases the amount of cash paid out in an annual dividend payment model directly determines the level of cash available for the next 12 months.

Imminent to the nature of a PV plant is a 12-month cycle in cash flows, with shorter cycles of cash balance minima at times, when low production periods coincide with debt repayment (typically around March/April in the Northern Hemisphere). To continuously ensure sufficient cash balance, the Asset Manager needs a rolling cash flow model at least for the following 12 months. Extending the rolling forecast period to 18 months provides additional security and comfort to the Asset Owner.

Dividend calculation therefore should not only take into account the constraints posed on cash flow management by financing schemes (covenants) and investor expectations, but also the expected cash balance of the liquidity planning cycle.

Concluding, cash management is a crucial part of the scope of work of the Asset Manager.

From a cash management perspective, the Asset Manager is responsible for:

- Managing accounts payable/receivable (providing notice to the Asset Owner for authorisation of payments).
- Repayments of shareholder loans (interest and principal) and any other distributions to SPV's shareholders.
- Cash flow statement (forecast vs. actual).
- Payments under SPV's contracts (O&M, surveillance, land lease, security, monitoring and others).
- Repayments of shareholder loans (interest and principal) and within other financing schemes, as well as any other distributions of the SPV's shareholders.
- Validation (of interest and other bank charges).

6.10. Working capital reconciliation

The revenue stream of a solar power plant is variable due to the indexation of electricity production that is mainly dependent on the weather. However, the cost structure is relatively stable. Taking that into consideration, the need for close monitoring of accounts payable and accounts receivable assumes a higher importance.

Therefore, the Asset Manager should manage accounts payable and accounts receivable through rigorous client and supplier contract negotiation, ensures that the days payable outstanding are convenient to the SPV, according to the days receivable outstanding. The days receivable outstanding should be lower than the days payable outstanding in order to ensure that the accumulated revenue generated is enough to meet the supplier's payment (to guarantee proper availability of the cash short-term). Furthermore, in order to stabilise the revenue stream when unpredictable events happen (for example, machinery breakdown) resulting in downtime, the Asset Manager must ensure that response times of the O&M contract are being respected. Hence, it is the Asset Manager's responsibility to guarantee a close monitoring of revenue stream, working capital and cash flow variations.

6.11. Financial Control

Financial control is the set of processes, policies and procedures which enable the analysis of a company's actual activities from different perspectives at different times, compared to its short, medium- and long-term objectives and business plan. This analysis requires control and adjustment to ensure compliance with the business plan and in the event of anomalies, irregularities or unforeseen changes. The Asset Manager is responsible for conducting such analysis in order to achieve the company's performance optimisation and the company's financial goals.

Financial control processes, policies and procedures must be defined according with local and international legal, regulatory and tax requirements, the Asset Managers' experience and shareholders' remuneration. There are different types of financial control processes and procedures, such as accounting standards, financial statements (balance sheet, income statement, cash-flow statement, statement of changes in equity), budgets, business plans, operating metrics (such as profit

margins, KPIs), and external financial audits, as well as different types of policies regarding general ledger, chart of accounts, recognition of revenue, reconciliations, invoicing, payment processing, inventory, among others. The job of the Asset Manager is to ensure the SPV compliance with the defined financial control processes, policies and procedures through coordination with the teams involved (Accounting Department, Treasury Department, Tax Consultant).

The Asset Manager oversees the preparation of the annual budget forecast and updates it with actual data, analysing the deviation between the forecast and actual data. The budget forecast should be validated by the Asset Owner and used as a comparison (to the actual data) in the corresponding periodic financial reporting.

The annual budget forecast includes:

- Monthly estimation of OPEX
- Monthly estimation of production and revenues, according to the technical data or project finance
- Financial expenses
- Taxes
- Tangible fixed assets depreciation costs.

Adequate interpretation of the current year's activity will allow the Asset Manager to adopt higher levels of certainty when elaborating the budget forecast for the following year, thus being more accurate in terms of predicting the financial efficiency of the project.

In order to complement the micro-level analysis for the upcoming year (budget), the Asset Manager should analyse the SPV's Business Plan in order to understand if the business' actual data is aligned with assumptions considered in the Business Plan or if there are any deviations. Should deviations happen, the Asset Manager must propose and define a strategy, along with the Asset Owner, to overcome them. The business plan is often elaborated by the Asset Owner or by the Asset Owner's Financial Consultants.

As a final step to ensure proper financial control, the Asset Manager should advise the Asset Owner on the need to contract an external auditor to certify the accounts and to approve the annual accounts and report. The Asset Manager should assist the auditing team.

6.12. Contract management (financial contracts)

Contract management encompasses both technical and commercial/financial aspects. This section looks at contract management from a commercial/financial AM point of view. Section *5.7. Contract management (operational contracts)* takes the perspective of the Technical Asset Manager.

The Commercial/Financial Asset Manager is responsible for the sourcing of service providers, contract optimisation, supervising contract compliance, relationship management, liaising with suppliers in case of non-compliance or claims, as well as coordinating with other entities.

Also, contracts not managed by the Technical Asset Management, such as FiT and PPAs, and any other support scheme reporting and accounting are managed directly by the Commercial/Financial Asset Manager due to their financial requirements and contract deliverables.

The Asset Manager must regularly conduct a comprehensive review of all contracts concluded and record them in a relevant document or software: the start and end date of the contracts, actions and deliverables (what, when and how) that must take place in order to ensure contract compliance, prices indexation and updates, the type of payment and payment dates, requirements for notification of termination of the contract, indexation to other contracts, services provided, breaches of the contract, and useful information. This will provide the Asset Manager with the proper information to manage, negotiate and comply with the contracts and their requirements. It is imperative to ensure that the contract requirements and periodic deliverables are met in a timely manner to avoid contractual penalties and therefore unforeseen expenses.

Whenever necessary and possible, the Asset Manager should actively identify and solicit alternative service providers to guarantee contract optimisation in terms of conditions, price, service and quality. (For more information, see also chapter *7. Procurement*.)

When it comes to PPA management, the Asset Manager should always consider the financial soundness of the counterparty, the transparency, and bankability of the contract by relying on rating reports, financial statements and warranties provided.

Contract management is a very time-consuming element of business and automation of the contract management system is an efficient tool to save time and costs allowing the allocation of resources to other pending matters.

6.13. Suppliers account management

In sections 5.7. and 6.12. on *Contract management* we explore the Asset Manager's role in operational and financial contract management, contractual requirements compliance, contract monitoring and contract optimisation and negotiation. In the present topic we will emphasise the importance of regular activities performed by the Asset Manager such as: monitoring of the operational contract execution, relationship management, event accessing, decision-making and administrative management (for instance, following up an insurance claim), and evaluating financial impacts (for instance, extracontractual O&M activities).

The Asset Manager is responsible for sourcing, evaluating the financial impact, negotiating, managing and ensuring the execution of all supplier contracts. Moreover, in the occurrence of an abnormal event, it is the Asset Manager's obligation to assess whether this event is or is not extracontractual, estimate damages and financial impact, find the adequate solution and perform the necessary administrative tasks in order to quickly establish normality in the business. Lastly, throughout the process, the Asset Manager should report to the Asset Owner.

The Asset Manager is a key player in suppliers relationship management. By having a 360º perspective of the operational business, financial performance and the supplier's contracts in place, the Asset Manager can add value by deeply understanding the project's needs and by trying to get individual contracts in order to ensure maximum business optimisation. It is hard to assess business improvements achieved by an experienced Asset Manager, as they go far beyond easily measured quantitative financial improvements. For more details on supplier categories and selection, see chapter *7. Procurement*.

In order to clarify what the Asset Manager's role in supplier account management is, please refer below to the most important suppliers.

O&M Suppliers

Throughout the operation phase, the main task of the Asset Manager is to supervise the O&M supplier in terms of compliance with contractual obligations such as O&M Team response times. In addition, the Asset Manager is also responsible for validating the compliance of the contracted O&M preventive maintenance plan and coordinate corrective maintenance activities.

Furthermore, depending on the type of activities assigned to the O&M Service contract, the Asset Manager may also supervise the contractual compliance related to warranties and processing of necessary claims, if applicable.

Another important role of the Asset Manager is to monitor the additional O&M services not included in the O&M contract and therefore representing additional cost for the Asset Owner and affecting the project cash flow. From this perspective, the Asset Manager is responsible for assessing the operational impact reported by the O&M provider and for evaluating the suitability and necessity of the activities.

In some cases, when specific extra works are frequently executed, representing a high weight on total OPEX costs, this may be a good opportunity to assess the O&M contract and propose to the Asset Owner a revision of the O&M contract to include the referred works under the scope of the contract.

Landowners

The land lease agreement is a long-term contract and it is one of the most important contracts in the solar power generation business. This agreement ensures that the PV Plant can be installed and can be in operation during the asset lifetime (30+ years) on the chosen land. Usually the land lease agreement is negotiated and secured by the development team before the construction phase and can be a contract signed with more than one landowner (if the chosen place to install the PV plant belongs to more than one landowner).

Therefore, the Asset Manager is responsible for managing the land lease contract made between the SPV (special purpose vehicle) and the Asset Owner. This means that the Asset Manager is responsible for:

- Managing a key long-term relationship ensuring good relations between the landowner and the Asset Owner.
- Assessing the land lease's annual price indexation.
- Solving land lease agreement problems: for instance vegetation control issues (For instance disputes with neighbours in case of shared vegetation), manage PV plant access, inform land owner of alterations needed in the PV plant (for instance, DNO access to alter type communications), among others.
- Comply with local legislation with regards to land alterations (planning permit).
- Renegotiate contract extension if needed.

Such efforts shall comprise the procurement of technical and economical solutions and the contractual arrangements and subsequent implementation of the solution previously agreed upon with the Asset Owner.

Insurance

The Asset Manager is responsible for managing the insurance contracts made between the Asset Owner and the Insurance Company.

This means that the Asset Manager is responsible not only for the annual assessment of insured capitals and coverages depending on the evolution of market prices, but also for coordinating insurance claims and the subsequent review of claims with parties involved (Broker, Loss Adjuster, O&M supplier, security company and others).

In case of damages to the Asset which could be covered by the insurance policy, the Asset Manager will work with all parties involved to:

- Ensure the necessary contacts with insurance companies/brokers to guarantee that the operation is restored as soon as possible.
- Ensure adequate indemnities are paid in accordance with the policy conditions.
- Assist the Asset Owner with the execution of insurance contracts and their compliance with the established requirements.
- Ensure that the information required to file the claim (including material damages, business interruption and machinery breakdown) is gathered and submitted to the insurance broker and loss adjusters.

Such efforts shall comprise the procurement of technical and economical solutions and the contractual arrangements and subsequent implementation of the solution previously agreed upon with the Asset Owner.

Security services and surveillance system management

On the one hand, the Asset Manager acts on behalf of the Asset Owner on the procurement and contracting of specialised security services, including, amongst other things, daily interaction with customers, as well as with specialised suppliers (e.g. remote CCTV/alarm filtering and monitoring agreements, mobile response and on-site presence handling) in order to advise on the most suitable solutions available in the market.

On the other hand, the Asset Manager provides clear communication and dispatching protocol in accordance with the terms and conditions set forth by the Asset Manager and gathers business intelligence data on incidents and abnormal operating conditions from a security management perspective. Security information is also included in the Asset Management periodic financial reporting.

Technical consultancy

The Asset Manager acts as the interface and support for external organisations on behalf of the Asset Owner (e.g. operational assessment and technical risk analysis), available on demand, according to the rates agreed upon, as an additional service.

Throughout the operation phase, the Asset Manager may make regular periodic visits to the plants. Depending on the performance, operations, maintenance or insurance claims that may take place related to the plant, the Asset Manager may carry out additional site visits, in order to investigate specific circumstances at the request of the Asset Owner.

The Asset Manager is expected to provide recommendations on the best certified suppliers and specialised technical inspections and consultancy services.

At this level, the Asset Manager develops an integrated approach to risk management, including the development of initiatives for risk mitigation.

Legal consultancy

The Asset Manager will be an interface with the Asset Owner's legal advisors, focused on providing effective and timely assistance and on setting forth a thorough description and understanding of requirements or feedback from legal support.

This role is very challenging and can only be met by wide knowledge of the best legal players and practices in the renewable energy sector (e.g. lawyers and consultants), as well as a deep understanding of the Asset Owner's approach, needs, industry and market.

Whenever the complexity of any legal matter requires external, specialised advice, the Asset Manager will discuss this in advance with the Asset Owner.

Audit and Consultant Services

Whenever necessary, the Asset Manager assists the Asset Owner's financial auditors and other advisors, especially in conducting annual financial audits, including the processing of 'Prepared by Client' lists, assisting the auditors in working meetings, collecting information from the Client and updating the audit progress.

The following activities are considered as an example of the relationship and interdependency between the Asset Manager and the external auditors:

- Monitoring and supporting of financial statements (Local GAAP and/or IFRS) and submission of all tax returns.
- Advice on financial and accounting matters in the daily operations and situations that may have an impact on the accounting situation of the SPV.
- Management of the relationship with the project company's external auditors (if applicable), using best efforts so that the project companies receive audited financial statements within the established deadline: the year following the reference fiscal year.

Finally, the Asset Manager should advise the Asset Owner on the need to hire an external auditor for certifying the accounts and approving the annual accounts and report.

Electricity providers

Throughout the operational phase, the PV plant needs electricity to power auxiliary services and/or ancillary services. Auxiliary services are the services that affect production (e.g. inverters) and ancillary services are the services that are not directly linked with solar power production (e.g. CCTV system, monitoring system, illumination, among others). Electricity provision can be achieved in two ways: having an electricity supplier or using the electricity generated from the PV plant. The latter option is not always achievable due to size constrains of the PV plant.

It is important to secure a good electricity supplier since it can affect the PV plant's core business, electricity generation. Moreover, solar power plants with storage, which will be increasingly common in the future, will need a higher stable energy stream to function properly.

The Asset Manager is responsible for negotiating and managing the electricity supplier's contract established between the SPV and the supplier. This means that the Asset Manager is responsible for:

- Managing the long-term relationship between the Asset Owner and the service provider;
- Assessing and negotiating the annual price indexation;
- Renegotiating contract extension if needed.

6.14. Supplier penalties invoicing

It is not uncommon for EPC and O&M contracts to include penalty clauses linked to specific KPIs to protect the asset owner's interests.

EPC contracts typically include penalty clauses for the first few years of asset operation. Underlying KPIs are highly individual and may include plant PR, plant availability, grid connection date and deadlines for completing punch list items, among others. The responsibility for tracking these KPIs and managing corresponding payments may be transferred to the Asset Manager. In this case, detailed knowledge of the EPC contract and information on any funds withheld by the SPV is crucial.

Likewise, O&M contracts may include bonus or penalty mechanisms linked to KPIs such as PR, plant availability and reaction times, among others. In case of bonus payments, the Asset Manager needs to make suitable

provisions in the financial planning. In case of penalties, the Asset Manager needs to calculate and invoice the penalty amounts to the O&M provider.

6.15. Interface with banks and investors

A photovoltaic plant is considered an infrastructure investment, thus one that requires high capital volume during the construction phase and low capital volume during the operation phase. Project finance is the most common source of financing for infrastructure projects. Project finance creates value by reducing the costs of funding, maintaining the sponsors' financial flexibility, increasing the leverage ratios, avoiding contamination risk, reducing corporate taxes, improving risk management, and reducing the costs associated with market imperfections. Therefore, project financing is a loan structure that relies primarily on the project's cash flow for repayment, with the project's assets, rights, and interests held as secondary collateral. Project finance is especially attractive to the private sector because companies can fund major projects off balance sheet. Usually the sponsors are bank consortia. A PV plant is only rarely financed by a regular commercial bank loan.

Nevertheless, project finance is a very demanding type of financing and entitles a long list of requirements and periodic deliverables that usually come with a heavy set of penalties when not complied with.

The Asset Manager is responsible for having a comprehensive understanding of the financing contract in order to ensure that the periodic deliverables and requirements are met meaning that the Asset Manager assures the elaboration of all the documentation needed to comply with the financing contract requirements. Thus, the Asset Manager is responsible for the elaboration of bank periodic reporting, financial statements, coverage ratio monitoring, escrow accounts monitoring and business plan updates, among other requirements. Additionally, the Asset Manager is responsible for monitoring the non-financing contracts that are indexed to and locked by the project finance (usually land lease, Operation and Maintenance, security).

Although this generally represents a high workload for the Asset Manager, it is their responsibility to avoid penalties raised by contract non-compliance.

6.16. Equity/debt financing management

With regards to funding an infrastructure investment, an alternative to project finance is equity investing (investment funds, private equity firms, private investors and SPV's holding company equity, among others). Usually, a project is not entirely equity financed; in reality, the Asset Owner can opt for a mix between equity and debt.

The Asset Manager is responsible for having a comprehensive understanding of the equity agreement and the bank loan requirements in order to work for the SPV's maximum optimisation and profitability, maximising shareholder remuneration and complying with debt service. As stated in section 6.9. *Cash Management* assumes an important role to ensure liquidity to comply with debt service schedule. Therefore, the Asset Manager is responsible for loan administration (including settlements and contracted interest rates supervision, debt service coverage, and compliance with requirements and deliverables, among other administrative tasks).

This type of funding is less demanding and has less deliverables, as its periodic reporting is usually less rigorous and aligned with the Asset Management monthly reporting.

Solar PV assets are increasingly re-financed during the operational phase, allowing the owners to benefit from more stabilised operations and a lower operational risk profile, leading to better lending terms. In these circumstances, the Asset Manager can provide additional services and support to the owners by feeding the refinancing due diligence process facilitating the collection of site information and documentation, as well as lead the discussion with technical and other advisors.

6.17. Tax preparation, filing and administration

The Tax Management Service includes tax preparation, filing and administration and can be included in the Asset Management contract.

The Tax Management Service is obliged to comply with local and international legal, regulatory and tax requirements. Therefore, a comprehensive understanding of these requirements is indispensable.

The Asset Manager is responsible for coordinating the work between the Accounting and Tax Service, complying with local tax authorities, providing simple tax support and ensuring payment of taxes, and checking if the deliverables required by the local tax authority are met. Moreover, the Asset Manager is accountable for reporting all regular and relevant information to the Asset Owner. Besides management support, the added value provided by the Asset Manager is a deep knowledge of the solar industry together with a critical analysis of the local tax authority's requests, given the financial environment. This could result in distinctive tax legislation interpretations which could have tax exemption as an outcome. Consequently, a positive effect on the SPV's profitability is generated.

Therefore, the Asset Manager conducts regular tax activities such as the preparation and filling of relevant tax returns (CIT, VAT, Stamp Duty, withholding taxes, among others) as well as the handling of tax authorities' correspondence and requests. However, whenever in the presence of unconventional or irregular situations, the Asset Manager should delegate the responsibility to an external local Tax Consultant, as specific expertise and a certified worker are both required. The Asset Manager becomes responsible for providing the Tax Consultant with all the necessary SPV documentation.

A short reference of the tax management activities is presented below.

Tax management

- Regulatory compliance oversight related to tax obligations
- Calculation and filing of the project companies' tax declarations
    - Handling Corporate Tax
    - VAT (registering, periodic filing and refund requests)
    - Handling Property Tax
    - Handling Withholding Tax
- Processing of tax payments
- Control of tax refunds
- Direct relationship with Tax Authorities.

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7 PROCUREMENT

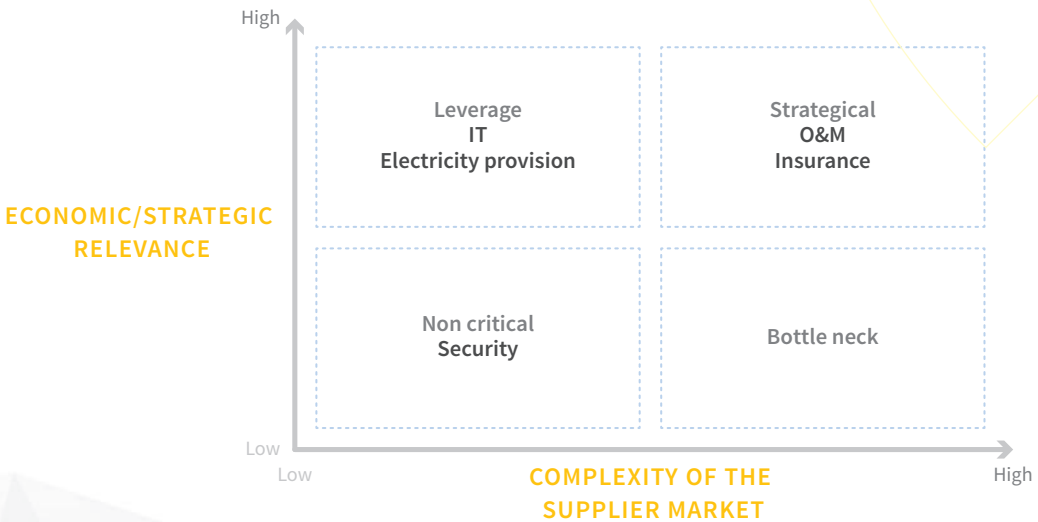
The role of the Asset Manager in the solar sector is crucial in order to identify, select and properly manage the key suppliers involved in the operation of the SPVs and the plants. (On the latter, see section *6.12. Suppliers account management*.) In particular, the Asset Manager should leverage their know-how and network of contacts in order to both identify the right trade-off between price, quality of services and key contractual terms, and constantly adapt all of them to market conditions.

In line with the procurement best practices, before deciding the optimal procurement strategy, the suppliers should be classified based on two key criteria:

- **Strategic relevance**: in terms of value-added, overall costs in the supply chain and impact on profitability and quality.
- **Complexity of the supplier market**, in terms of number of suppliers, features of the supply (scarcity).

Taking these criteria into account, the main suppliers involved in solar power plant operation can be allocated in the following matrix:

FIGURE 6 KRALJIC MATRIX OF MAIN SUPPLIERS INVOLVED IN SOLAR POWER PLANT OPERATION



The position in the matrix drives the optimal approach to manage a supplier. In particular, the following approaches are recommended:

- IT (connectivity), electricity suppliers represent the so called "leverage" services. The impact on the business is very high: good connectivity allows efficient and continued plant monitoring while robust insurance coverage allows CAPEX and OPEX to be reduced in case of damages and thefts. The supply market for all these services is typically abundant. As a consequence, the advisable approach consists of standardising the need, concentrating large volumes of plants wherever possible (to achieve better terms), and involving a large number of qualified suppliers.
- Security represents, in most cases, a non-critical service[3]: the impact on the profitability of PV plants is limited (considering that direct and indirect damages are covered by the insurance policies) and the supply market is abundant. The recommended approach in this case consists of co-sourcing and standardisation of needs and volume bundling (possibly involving surveillance companies with a national presence in order to have the same counterparty in various regions, as also detailed in the following section).
- The O&M contractors and insurance companies (for all risks policies) represent a strategic supplier. The quality and effectiveness of the O&M activity have a relevant impact on the revenues as well as on maintenance costs related to the plants. Although the supply is characterised by a large number of operators, the recent trend in mature solar markets consists of an aggregation of operators (hence reducing the number of potential candidates). In addition, the number of O&M contractors with robust and local structures is very limited. This results in the selection process being particularly complex. It is advisable in this case to apply a collaborative approach and supply base redesign (information sharing, long-term agreements, supplier audit focused on managerial skills) and a value-based (rather than price-based) approach.
- Insurance companies have strategic relevance in the operation of PV plants, as with a solid all-risks policy in place, plant owners receive a relevant mitigation of risks in relation to both direct and indirect damages in case of thefts, fires, equipment failures and cybersecurity attacks. The procurement of insurance policies for renewable energy plants in the last few years has become increasingly complex due to a lower number of suppliers available. This is because several insurance companies left the market due to an actual level of risk being higher than initially expected. The presence of professional Asset Managers and more robust security equipment/clearer component warranties should give comfort to the suppliers in the future and result in more accessible procurement.

7.1. Main supplier requirements

- IT (connectivity): Should provide coverage that is as broad as possible and, in particular, also reach remote areas where PV plants are typically located.
- Insurance: Should cover key operational risks (including cybersecurity for the reasons explained in Chapter 9. *Data management and high-level monitoring*). The role of the Asset Manager in the procurement process is key in order to ensure that the security equipment installed on each site is aligned with the requirements set out in the policies, as such requirements typically represent condition precedent and any inconsistency would result in the coverage being ineffective.
- Security: Should provide a professional service with an effective alarm management process and being able to prove the implementation of the agreed services (e.g. with punching).
- O&M services: Should have a strong technical know-how, a robust organisation structure to manage local interventions and spare parts, and to be able to fix plant unavailability as quickly as possible.
- Ancillary services (electricity provision): Should provide high-quality customer services to support in administrative matters (i.e. bill payments).

3 This is not true for ground-mounted plants (particularly affected by thefts) in some particular geographical areas. In such cases, this service becomes "leverage" and requires the same approach described above for IT and insurance coverage.

7.2. Supplier selection and evaluation

The recommended methodology for an Asset Manager to select a supplier is the Analytical Hierarchy Process (AHP). As illustrated under Figure 7, the AHP considers a set of potential suppliers. Each supplier receives a "rating" based on a set of evaluation criteria which are assessed based on specific indicators. It is important to note that since some of the criteria could be contrasting, it is generally untrue that the best option is the supplier that optimises each single criterion, but rather the one that achieves the most suitable trade-off among the different criteria.

The AHP is very lean and in the selection process it allows not only quantitative but also qualitative elements to be taken into account. It also enables a different weight to be attributed to the different indicators and selection criteria, and hence, to attribute rational importance to the various aspects of the decision-making process.

FIGURE 7 OVERVIEW OF THE ANALYTICAL HIERARCHY PROCESS METHODOLOGY – ANALYSIS PRODUCED FOR EACH SUPPLIER

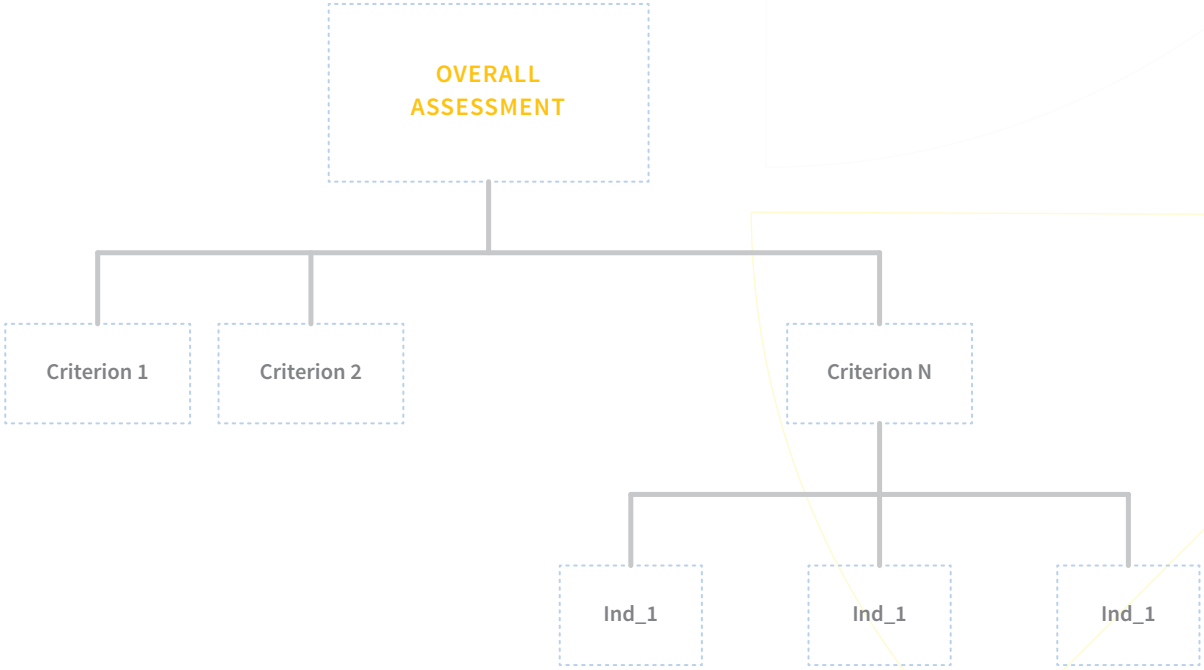


TABLE 5 KEY CRITERIA FOR THE SELECTION OF THE VARIOUS SUPPLIERS

SUPPLIER	CRITERIA	SOURCE OF INFORMATION
O&M[4]	• Organisation structure • Track record • Pricing taking into account the scope of work and service level • Financial soundness • Bankability	• Visit to control room • Q&A • Certifications • References • Internal data collected by the Asset Manager
Insurance policies	• Financial soundness of the insurance company • Effectiveness of the claim management process	• Rating report • Track record provided by the insurance companies / the brokers • References provided by other clients
IT	• Reliability • Geographical reach	• Track record
Security	• Reliability • Local presence (with direct personnel) • Effective management process • Relevant certifications in place	• Track record (including references from other clients) • Visit to control rooms
Electricity provision	• Reliability • Customer service	• Track record

7.3. Further considerations to be taken into account in the selection process

Consideration related to portfolios under management and scale effects

The Asset Manager can add value in the procurement process, not only by leveraging its proprietary know-how (based in particular on its direct observations and historical evidence of the activity of the various suppliers) and network of contacts, but also by allowing its clients to benefit from a scale effect, aggregating, for the purpose of running a tender process, the various portfolios, similar in terms of features, geographic location and client requirements.

Sourcing strategy

As the O&M activity represents a strategic service, if the solar portfolio has sufficient scale, it is advisable to avoid a single sourcing (i.e. allocating 100% of the activity to the same contractor). Instead, either a second sourcing (by identifying a main contractor which would manage the majority of the plants and a second contractor with a more limited exposure) or parallel sourcing (with two or three contractors which manage similar percentages of the portfolios) is recommended. Both these strategies (to be applied based on the features of the portfolios and of the O&M contractor market) have the advantage of a collaborative approach between O&M contractors involved while at the same time leaving the possibility of benchmarking, better peak management and a pre-identified backup operator leading to a smooth switch in case it is needed.

In addition, in the sourcing strategy of the O&M contractor, an Asset Manager/Asset Owner should consider the relevance of its contracts in relation to the activity of each selected contractor. In particular, for large portfolios assigned to relatively smaller operators, since it is very likely that there is a situation of high dependency (i.e. high percentage of the contractors turnover represented by the plant owner), it is advisable to apply either a partnership approach or "responsible

4 To evaluate O&M contractors, it is recommended to use SolarPower Europe's O&M Best Practices Checklist which is based on the O&M Best Practices Guidelines and can be downloaded from www.solarbestpractices.com.

supplier management" by making a long-term commitment in order to allow the contractor to organise their resources and make the relevant investments to reach a high-quality delivery.

The role of financing institutions in the selection process

In case of portfolios with bank financing in place, the process to select the strategic contractors (mainly O&M, insurance companies and PPA counterparties and negotiate the mandate with them) should take the prescriptions of the loan agreement into account, which in some cases may contain a template of the agreement to be entered into. In addition, the selected supplier should be approved by the financing institution following a qualification process.

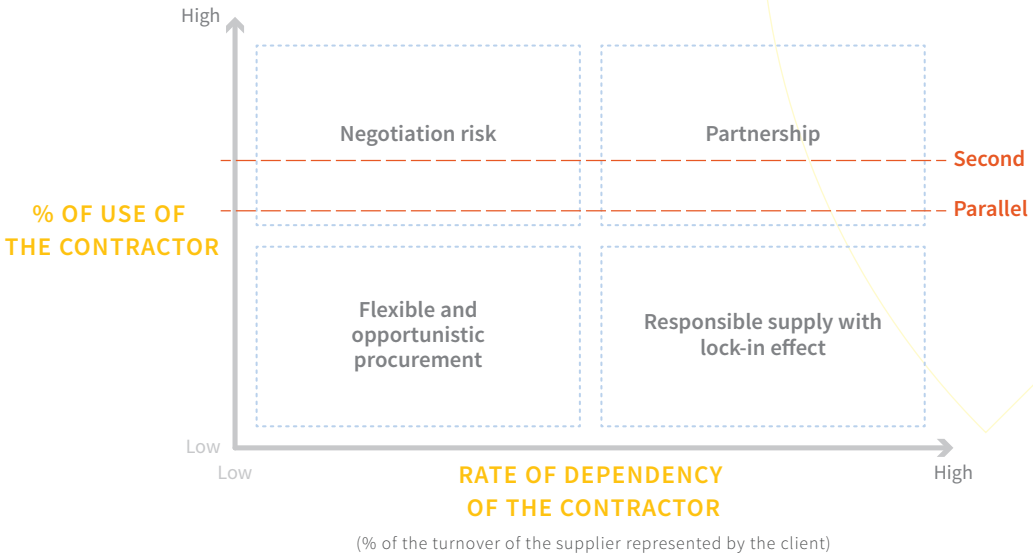
Health & safety considerations

An Asset Manager should also ensure that the O&M contractors and the surveillance companies respect the right H&S requirements by conducting a so called "technical professional verification", i.e. by verifying the compliance with training programs and medical requirements, as well as by reviewing the existing risk rating document.

7.4. Supply account control

The role of the Asset Manager is crucial in order to ensure that each supplier delivers a high-quality service according to market best practice and contractual obligations. In order to monitor the supply account, the Asset Manager should identify some indicators, periodically monitor them, and take appropriate and timely actions in case of situations not aligned with expectations. The most common KPIs are summarised in the table below.

FIGURE 8 MANAGEMENT OF CONCENTRATION RISKS



SOURCE: PROCUREMENT, SDA BOCCONI.

TABLE 6 KEY PERFORMANCE INDICATORS FOR RELEVANT SUPPLIERS

SUPPLIER	KPI	FREQUENCY OF VERIFICATIONS
O&M	• Track record of contractual KPI guatantees (Availability, Response times)[5]	• Monthly
Insurance policies	• Respect of the requirements during the life of the contract • Monitor through the broker the financial soundness of the counterparty • Ensure a smooth and quick process to manage claims	• Continuous
IT	• Days of availability of the services	• Continuous
Security	• Number of thefts that occurred in the plants • Reaction time in case of thefts • Evidence of the activities (e.g. patrols) conducted	• Monthly / in case of events
Electricity provision	• Response time of the customer service in case of issues	• In case of events

7.5. Supply chain control

It is important for each provider to identify and mitigate the risks related to the supply chain, i.e. to avoid the risk of poor service or lack of delivery which may have negative effects on the overall risk-adjusted returns of renewable energy assets.

To this end, the Asset Manager should keep strict control not only on the supply side (through a combination of appropriate controls during the selection phase and ongoing monitoring, and pre-identify back-up plans) but also on the demand side by ensuring smooth interaction and timely communication with the suppliers.

Supply side

The following table presents the main supply side risks and suggested mitigation measures.

TABLE 7 SUPPLY CHAIN RISKS AND MITIGATION MEASURES

SUPPLY CHAIN RISK	RELEVANT SUPPLIER	MITIGATION MEASURES
Poor quality of services	O&M, surveillance	• Ensure the proper KPI as described above and take immediate actions in case of alarming indicators • Avoid single supplier in case of portfolios with critical mass
Unavailability of services	Ancillary services, IT	• Constant supervision and immediate alert of the Asset Manager • Pre-identified alternative suppliers to involve in case of persistent issues
Inflexibility of supply source	O&M, surveillance	• Parallel, Second sourcing
Subcontractor risks	O&M, surveillance	• Verification of the contractor supply chain during the selection process
Bankruptcy of the suppliers/suppliers exiting the relevant market	All suppliers	• Multiple providers (if allowed by critical mass), although this requires a higher management effort – all providers • Request of insurances (e.g. bonds for PPA)
Lack of relevant renewal of legal and H&S certifications	O&M, surveillance	• Constant supervision by the Asset Manager • Parallel/second sourcing to allow a smooth and rapid switch in case of persistent non-compliance

Demand side

As mentioned above, the Asset Manager should also both directly and by providing guidance to its clients, help the suppliers in properly executing their activities. The supply chain can be positively affected by proactive actions on the demand side in the following circumstances:

- Accurate planning: In case of predictable peaks (e.g. in case of a planned relevant revamping interventions or with relevant upcoming plant acquisitions) it is crucial for the Asset Manager to inform the relevant suppliers involved in order to allow them to properly arrange the delivery and avoid resource bottlenecks and be able to serve the client needs in due course.
- Accurate information shared with the suppliers: Both during the handover phase to a new supplier and the ongoing activity, there should be a constant and constructive sharing of information in order for the Asset Manager to be aware of critical aspects and proactively solve them.

8 PEOPLE AND SKILLS

A skilled workforce is key for the solar industry to work. This is especially the case for service providers such as Asset Managers, who rely on their personnel's skills to a large extent to deliver quality services to their clients. Therefore, it is of the utmost importance for AM providers to have human resources with the relevant qualifications to perform the tasks detailed in this document in an efficient and responsible manner.

It is not easy to determine the exact type of skills and profile that an Asset Manager should have. However, we can identify two major groups of skills that people should have.

The first group is Technical Asset Management. In this group there are two different types of employees. Those who have academic studies in Electrical and Mechanical Engineering and those who have practical field experience and relevant electrical and technical qualifications.

Key skills of a Technical Asset Manager are:

- The ability to manage and police the effective service provision of O&M providers
- Read faults/alerts and direct necessary action
- Be able to interpret events into meaningful information for Asset Owners
- Provide reports and present options to the Asset Owners
- Manage H&S and be aware when on-site for inspections.

Therefore, ideally, the Technical Asset Managers would have previous experience in the construction (EPC) or O&M of solar assets. However, with the right raining programme, Asset Managers can develop the skill set needed.

The second group is Commercial and Financial Asset Management. In this group, in the same manner, we have people qualified in financial management and accounting through academic studies and those who have acquired their qualifications by actively working in the sector.

Key skills and activities of a Commercial and Financial Asset Manager are:

- Managing incoming and outgoing accounting flows
- Monitoring income and cost streams and comparing them to a base line scenario (i.e. P50, P90, etc.)
- Ability to forecast the financial impact of specific technical interventions (preventive or corrective) on the assets
- Providing financial management and reporting
- Performing loan management activities
- Knowledge of legislative and regulatory changes that might have a financial impact on the client.

Therefore, previous experience in investment accounting and financial management would be useful.

It is important to note that different countries and markets have distinct requirements for the qualifications and skills necessary for Asset Managers in both key groups to operate. It is important that Asset Managers map those requirements with the help of experts and consider them in their HR hiring requirements.

As the industry develops, technology is advancing rapidly, which requires Asset Managers to be trained regularly on new best practices. Such new best practices are increasingly related to the digitalisation of AM. As data and digital systems become more critical for effective AM, it is expected that very soon Asset Managers will have to employ specialised personnel with skill sets and academic background that combine knowledge of energy data and information systems.

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9 DATA MANAGEMENT AND HIGH-LEVEL MONITORING

Asset Managers have the responsibility of monitoring and overseeing the activities performed by the O&M service providers as well as managing the ongoing obligations of the plant to ensure its longevity and profitability, as detailed in the previous chapters.

All different positions borne by the Asset Manager can benefit from new digital instruments, which allow for more efficient data management and ensure the best, most cost-effective power plant operation. These instruments include plant performance data management, O&M site activity supervision, contract management, administrative follow-up and optimisation. Ideally, an Asset Manager should make use of an Asset Management Platform that can undertake all of the digital aspects or can link to external specific digital tools to consolidate all relevant information. There is tendency in the industry to opt for solutions that integrate the functionalities of Monitoring Systems, Computerised Maintenance Management Systems (CMMS) and Enterprise Resource Planning Systems (ERP) in one software. Such integrated solutions allow Asset Managers (and O&M Contractors) to have analyse all parameters including plant technical data, maintenance activities related information and contractual data in one central platform. Such integrated solutions can be considered a recommendation.

Advanced data analysis comes in many forms, with the most sophisticated using special algorithms including machine learning for exploring big data. Service providers with PV experience and deep PV knowledge can combine this with digital analytics to transform data into intelligence. Hidden problematic areas of a PV asset can be identified and concrete actions for performance maximization provided. In addition, strategies for reducing operational & maintenance costs, based on comprehensive plant data, can be devised. Another aspect which is increasingly being offered to make operations more efficient is the automation of monitoring, also possible in combination with and as a side benefit of advanced data analysis. The latter also simplifies the overall reporting documentation side for Asset Managers. Many suppliers offer platforms or web-based dashboards to simplify integration and allow for autonomous results. The remote nature of the service also means that it can be integrated into Monitoring & Asset Management Systems and no hardware or software installations are necessary.

Additionally, the Asset Managers must have access to all data that the O&M service providers have at their disposal and the technical and operational data generated from the O&M service providers' activities. Asset Managers are further responsible for capturing all data related to their various

9 DATA MANAGEMENT AND HIGH-LEVEL MONITORING

/ CONTINUED

activities, such as financial data, commercial data, compliance data, contractual & regulatory data as well third-party data, necessary for the Asset Owners. Asset Managers are required to provide regular status reports to Asset Owners and require access to data provided by the O&M service provider relating to the monitoring of the plant, O&M service repair activities, and all data related to necessary compliance processes.

More specifically, Asset Managers should comply with the following guidelines regarding data and data management to ensure the most efficient operation of their power plants. To be able to achieve this, the Asset Managers should use an Asset Management Platform.

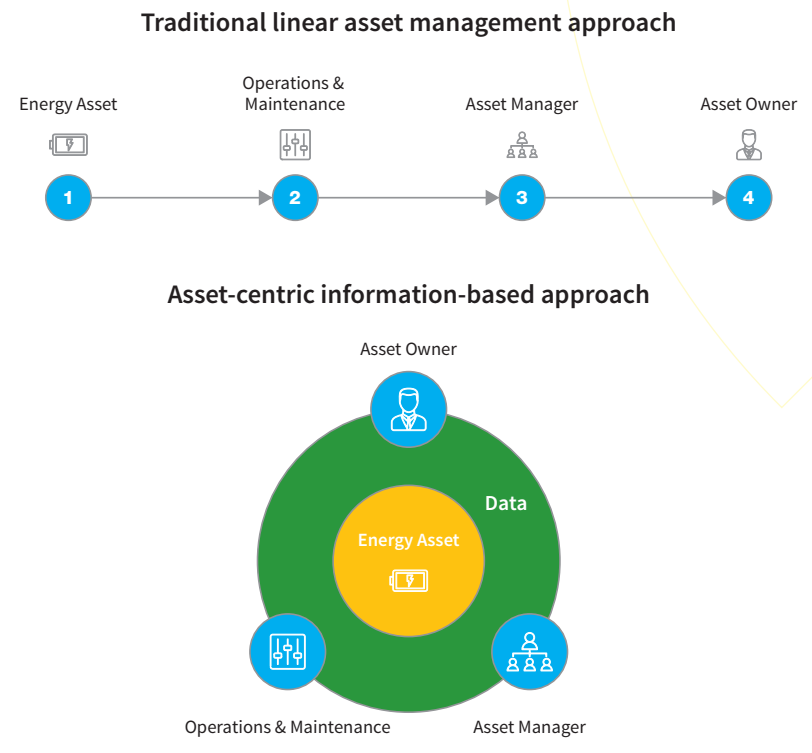
9.1. Asset Management Platform functionalities

An Asset Management Platform is a software package or suite of tools that is used by the Asset Manager to store and manage technical and non-technical data and information collected from and relating to the solar asset, portfolio or SPV. It combines the abilities of a Computerised Maintenance Management System (CMMS) and an Enterprise Resource Planning System (ERP).

It is the Asset Management Platform that makes it possible for the solar industry to transition to an asset-centric, information-based management approach, which addresses three key challenges: (1) loss of generation and income, (2) loss of time, and (3) lack of transparency. This is in contrast to the traditional linear Asset Management approach, where information flows from the asset through the O&M Contractor to the Asset Manager and ultimately to the Asset Owner. This linear approach means that the Asset Owner does not have direct access to data from the solar power plant and, rather, information is filtered before reaching the asset owner, creating a lack of transparency and mistrust between the three key stakeholders.

This section presents how Asset Management Platforms support the Asset Managers in their roles and responsibilities.

FIGURE 9 TRADITIONAL LINEAR ASSET MANAGEMENT APPROACH AND ASSET-CENTRIC INFORMATION-BASED APPROACH WITH THE THREE MAIN STAKEHOLDERS OF ASSET MANAGEMENT



Source: Greensolver.

9.1.1. Reporting

The Asset Manager should collect and share with their clients all key data/deadlines to demonstrate compliance with the expected deliverables set out in the Asset Management contracts. In some cases, based on a client's requests and SLA, delays or failures associated with the fulfilment of such obligations may result in the Asset Management company having to pay penalties (consider referring to the chapter on contractual framework).

The key data/deadlines should be identified based on the client's priorities and agreed scope of work. However, some typical areas are identified and summarised in the Table 8 below.

Once identified, these requirements and activities must be calendarised in the Asset Management Platform. Apart from simple calendar entries, the platform should also include escalation features, for example for overdue items, to ensure that important tasks are not neglected. Such escalation should ideally involve multiple team members, depending on their role and position in the hierarchy.

9.1.2. Site construction due diligence

The Asset Manager should perform due diligence on the knowledge and expertise of the EPC contractor. All documentation and certification should be digitalised in the Asset Management Platform's documentation management system (DMS). Re-certifications and training schedules should be calendarised.

9.1.3. Optimisation of energy production

Power plant KPIs and O&M Contractor KPIs, as defined in chapter *11. Key Performance Indicators of the O&M Best Practice Guidelines*, should be calculated automatically by the monitoring platforms and should be integrated in the Asset Management Platform and used as a reference for contract compliance. It is important that these KPI calculations take various contractual clauses (exclusions) into consideration, for example in periods of force majeure events.

9.1.4. Regular updates and software reliability

Asset managers should be involved and interested in further developing the capabilities of the Asset Management Platform they utilise. This can be done through typical feedback mechanisms with the chosen software vendors utilised, but this can also mean using broader parts of the Platform to further digitalise operations as the Asset Manager evolves with functionalities.

The implementation of an Asset Management Platform can often serve as a great opportunity to continuously review internal activities and processes to ensure that Asset Managers are focusing on value added activities rather than data entry.

The Asset Management Platform must be updated continuously and during every update performed, it must be able to continue collecting the technical data from the monitoring systems within which it is integrated.

TABLE 8 FREQUENCY OF KEY DATA PROVISION

DESCRIPTION	FREQUENCY
Date of delivery of AM reports	Based on client requirements (typically monthly)
Date of delivery of annual budget	Annually
Technical KPIs verified	Monthly
Revenue data	Monthly
Cash balance and reforecast	Monthly
Key contractual deadlines	Quarterly
Plant incidents (open, pending and closed)	Monthly
Financial reports (Balance Sheet, P&L, CASH FLOW), also on a consolidated basis	Quarterly
Reports for state or local agencies and authorities	Annually or as per country requirement

9 DATA MANAGEMENT AND HIGH-LEVEL MONITORING

/ CONTINUED

Asset Managers should also take steps to ensure the reliability and bankability of their software vendors as this may impact data continuity in their operations. See section *9.7. Data Portability, Backup and Disaster Recovery* below.

9.1.5. Lifecycle data collection

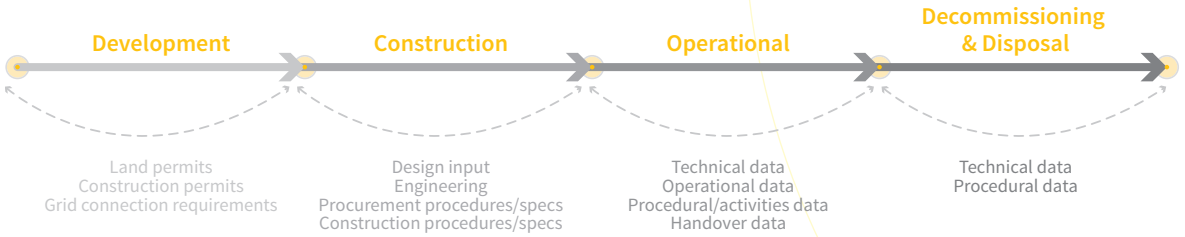
To ensure investment durability, it is recommended that the Asset Manager is involved in the project from the development and construction phases, collecting and managing all related data at each phase for easy and comprehensive reporting. This task can be streamlined through collaborations, incorporating advanced data analysis into the traditional AM structure – something that is increasing in popularity. Moreover, the AM should, as a best practice, utilise data and lessons learnt across project portfolios.

9.1.6. Operational risk management

The Asset Management Platform should collect and monitor relevant data in order to mitigate the major risks which may arise during the life of the assets, in particular:

- Keep track of serial numbers of components replaced to ensure the required communications to relevant authorities have been submitted (to avoid risks related to the authorisations in place)
- Monitor and record all relevant maintenance interventions conducted in order to ensure that the plants are kept in an efficient status
- Ensure key terms of insurance policies (e.g. deductibles, maximum reimbursable amounts) are consistent with the existing level of risks
- Calculate and monitor relevant covenants (D/E, DSCR, LCCR) related to the financing in place (if any).

FIGURE 10 TYPES OF DATA COLLECTED ALONG THE LIFECYCLE OF THE PROJECT



9.1.7. Procurement process management

The Asset Management Platform should enable the activities explained in chapter 7. Procurement by collecting relevant data to properly manage the procurement process in relation to key suppliers (i.e. number of plants with similar features to benefit from scale effects, contractual deadlines, warranty termination dates).

9.1.8. Deadlines management

In order to be fully compliant with regulatory requirements, an Asset Management Platform should support the Asset Manager in tracking and keeping under control the relevant deadlines for the required communications and collect the information that needs to be provided (e.g. annual production data requested by municipalities).

9.1.9. Health & safety records

The Asset Manager must ensure that adequate records are kept in the Asset Management Platform to ensure and demonstrate that relevant H&S standards and requirement are set and maintained. It is expected that a set of metrics will be agreed between parties to allow the reporting of events on site and encourage and judge adherence to standards and incremental improvements to the systems and associated standards.

9.1.10. Incidents records

To manage incidents and dysfunctions, the Asset Manager needs to record and have access to all data related to the solar asset, portfolio or SPV. Such data includes technical, operational, financial and market data.

9.2. Types of data collected through the Asset Management Platform

To ensure a full picture of the performance of a project, Asset Managers rely on several sources of data or information. For each source, it is important what data the Asset Managers are collecting, at what frequency and when. Beyond this, it is also important to understand the necessity and relevance of collecting and aggregating such data. Data is analysed and collected to enable good decision-making. To do so consistently requires good quality and reliable data. Data reliability can be enhanced through a data cleansing and data quality checking process via external data analysis services, should this not be possible or covered in the O&M scope.

It is important that the Asset Management Platform can generate consolidated reports with much of the data listed below. There are reports, for example technical reports, that are needed on Plant level, but some high-level reports, like financial statements, are needed both on Plant as well as Portfolio level.

Here are some key types of data that an Asset Management Platform should have access to:

9.2.1. Technical Data

Refers mostly to PV power plant data as referenced in chapter 11. Key Performance Indicators of the O&M Best Practice Guidelines:

1. Raw data measurements: data obtained directly from the PV plant and used for performance calculation.
2. PV power plant KPIs using the raw data from the PV plant to give a more balanced overview of the operation of the PV plant.

9.2.2. Operational data

Operational data goes beyond the technical data to encompass other relevant interpretations of the technical data as well as activities performed or logged by the O&M contractor:

1. Alerts driven or identified by the monitoring systems.
2. Decisions made by Technical Asset Managers based on alerts or technical data, including the overall timeliness of such decision or response.
3. “On or Offsite” actions taken by the O&M contractor, including:
    a. The overall timeliness of such decision or response (see 11.2. O&M Contractor KPIs of the O&M Best Practice Guidelines).
    b. Warranty & Insurance information (if needed).
    c. Spare parts used.
4. Updated forecasts or performance projections.
5. Records of maintenance, repairs and updates to the system.
6. Compliance with technical permits or agreements (interconnection, water, environmental).

9.2.3. Financial & commercial data

Also, financial and commercial data should be integrated into the Asset Management Platform and seen holistically should include, at the very least, budgeted and actual figures on:

- Revenue (including any incentive programs)
  - Billings, payments & collections
- Expenses (including financing costs, with a focus on planned vs. unplanned expenses)
- Financing information and expectations (debt, equity, etc.)
- Financial statements (balance sheet, profit & loss, and cash flow statements)
- SPV administration (signatories, authorisations, structures, requirements)
- Tax status, filing timings, etc.
- Insurance (status, conditions, claims, etc.)
- Documentation (requirements, key documents, etc.)
- Compliance records

9.2.4. Contractual & regulatory data

Solar projects are usually constrained by several agreements and regulations. Asset Managers need to have all relevant information at their fingertips to be effective and efficient, as they are often responsible for the contractual administration and regulatory compliance of their projects.

Data related to contract management:

- Amendments
- Updates
- Renewals

This goes beyond simple contract administration and management to include:

- Legal compliance
- PPA administration with all that they entail (calculations, frequency, escalators, terms & conditions, etc.)
- Power Generation License
- Building & environmental permits
- Stakeholder engagement requirements
- And any other contractual requirements

9.2.5. Third-party data

Asset Managers not only need to understand and aggregate data that come from their projects and their operations, but also, more and more Asset Managers need to understand how to deal with and manage data and information coming from third parties.

Market data

With more and more solar projects starting to have exposure to market conditions and trading opportunities, electricity market information is becoming increasingly important. This can include nodal prices, spot prices, future prices, price forecasts, etc. Ultimately, the structure of the agreement surrounding the market dispositions of a project will clearly dictate what to monitor, log and watch. This can be grid measurements, rates, schedules, etc.

Weather data

This is often lumped in with technical data through an on-site pyranometer or weather station, but more and more third parties offer reliable data feeds that can be incorporated into an Asset Manager's overview or simply as a validation point for on-site equipment.

Other data

Additional types of data sources can be accessed. The important point is to understand why these sources matter and the business objective behind them.

9.3. Aggregating data

Often the information gleaned from any one of these sources of data is of relevance at the individual asset level; however, it can increase in value across multiple projects. At an aggregate level, looking at trends or precursors, we can see the compounding effect of variances and quantify/identify systematic risks that would not be as visible on a single project. A definitive best practice is the ability to view and interact with different types of data at the portfolio and asset level. Third-party data analysis providers are being

increasingly integrated into the traditional Asset Manager/O&M structure for exactly this purpose in the case of larger portfolios with disparate O&M providers.

Often enough different data types will have different taxonomies, definitions and formats. And in a similar fashion they may "live" in different systems. Thereby the best practice of aggregating this information is in a primary Asset Management system.

9.4. Data format

The data format of the recorded data files must respect standards such as IEC 61724 and must be clearly documented. Data loggers should collect all inverter alarms in accordance with the original manufacturer's format, to ensure all available information is obtained.

9.5. Interoperability

As a best practice, the system should ensure open data accessibility, to enable an easy transition to Asset Management Platforms. The table below shows some examples of data integration options. Due to the lack of unifying standards, this is normally not the case and every Monitoring System provider has their own method to store and retrieve data. Best practice systems have the possibility to retrieve data by using open APIs such as RESTfull, providing interoperability between different systems.

9.6. Cybersecurity

In order to enhance cybersecurity, the Asset Manager typically performs also periodic audits on the main suppliers (the O&M contractors in particular) who have access to relevant data and connectivity of the plants. The audit mainly aimed at ensuring that the personnel is properly trained in relation to procedures for data protection (e.g. policies related to passwords, protection of access to relevant devices) and can detect and avoid possible cyber-attacks.

In addition (as clarified in chapter *6. Procurement*), as part of the risk mitigation activity, the asset managers support plant owners in identifying and activating

TABLE 9 EXAMPLES OF DATA INTEGRATION OPTIONS

METHOD	ADVANTAGES	DISADVANTAGES

FTP Push or FTP Pull	• Easy to implement
	• No need for additional hardware
		• Not secure (unless proper VPN is set up).
		  ◦ proper VPN is set up,
		  ◦ using sFTP or FTPs encryption method,
		  ◦ FTP access control methods implemented.
		• Limited control of data flow to the FTP server.

Modbus/TCP (with additional logger on site)	• Reliable and secure • Best control of data flow	• Additional cost for additional hardware. • More time-consuming implementation. • Relies on the existing monitoring system hardware, hence two hardware vendors involved.
API (or similar) in the cloud	• Fast and easy to implement • No need for additional hardware • Reliable depending on providers' conditions and communication conditions	• Small time lag from data collection to final destination (data pull technology requires automated back-filling technology in case of data gaps or communications issues). • Relies on the existing monitoring system vendor, double fees for monitoring. • (No control over data) • API may face data quality issues and limits – data granularity, data depth, availability, correctness, currentness, completeness – depending on the provider's terms conditions (SLAs) and technical abilities.

insurance policies that also cover the risks of indirect damages (i.e. missed productions) deriving from cyber-attacks. Since such attacks, in some extreme circumstances, can even determine plant outages that may require a long period of time before being solved, an insurance coverage is particularly relevant to avoid the exposure to significant revenues losses.

Ultimately the role of the Asset Manager is often to raise awareness about the importance of cybersecurity as it relates to the management of the plants.

Since PV plants will at least include inverters and power plant controllers (and monitoring systems) and these are expected to be accessible from (i.e. connected to) the internet to enable surveillance and remote instructions by operators, they have significant exposure to cybersecurity risks.

Cybersecurity comprises technologies, processes and controls that are designed to protect systems, networks and data from cyber-attacks. Effective cyber security reduces the risk of cyber-attacks and protects organisations and individuals from the unauthorised exploitation of systems, networks and technologies.[6]

Cybersecurity is a vast area and multiple measures are imaginable. The following hints may help as a starting point:

- Keep it simple: If possible, the number of network devices should be reduced to a minimum.
- As a recommendation, traffic of the network devices may be monitored in order to detect abnormally high use of bandwidth.
- Physical access to the network devices should be secured and a secure password policy should be implemented. The use of standard passwords should be especially avoided, and all factory setting passwords should be changed.
- Access from the Internet should be controlled via strict firewall rules:
    - Port forwarding should not be used because this is a big security gap. Only router ports that are necessary should be opened.
    - Remote access should be limited to the necessary use cases.
    - The use of VPNs (Virtual Private Networks – a secure connection built up from the inside of the private network) is necessary.
    - VPN access to the site from outside is a minimum requirement.
    - A VPN server or VPN service which works without requiring a public IP on-site should be preferred.
    - Each PV plant should have different passwords.
    - Documentation should be kept up to date to be sure that no device was forgotten.
    - Different roles should be used to the extent possible (e.g. read only user, administration access).
    - Professional (industrial grade) hardware should be used; only such hardware provides the security and administration functions plants need to be secure.
- Vulnerability management should be implemented (i.e. identifying and remediating or mitigating vulnerabilities, especially in software and firmware) by:
    - Improving insecure software configurations.
    - Keeping the firmware and software of devices up to date.
    - Using anti-virus software if possible and keeping it up to date.
    - Avoiding wireless access if it is not necessary.
    - Auditing the network with the help of external experts (penetration tests).
- Keeping companies safe:
    - Passwords should not be stored in plain text format, password managers should be used (e.g. 1Password, Keepass etc).
    - Employees should be trained on IT security awareness.
    - Not all employees should have access to all plants. Only those should have access who need it. This way damage can be prevented in case one employee is hacked.
    - Management of leaving and moving employees: in case a plant overseeing employees changes positions or leaves the company, the respective plants' passwords should be changed.

It is therefore best practice that installations undertake a cyber security analysis, starting from a risk assessment

6 Definition: https://www.itgovernance.co.uk/what-is-cybersecurity.

(including analysis at the level of the system architecture) and implement a cybersecurity management system (CSMS) that incorporates a plan-do-check-act cycle. The CSMS should start from a cybersecurity policy, and definition of formal cybersecurity roles and responsibilities, and proceed to map this onto the system architecture in terms of detailed countermeasures applied at identified points (e.g. via analysis of the system in terms of zones and conduits). These detailed countermeasures will include the use of technical countermeasures such as firewalls, encrypted interfaces, authorisation and access controls, and audit/detection tools. But they will also include physical and procedural controls, for example, to restrict access to system components and to maintain awareness of new vulnerabilities affecting the system components.

As minimum requirements, loggers should not be accessible directly from the internet or should at least be protected via a firewall. Secure and restrictive connection to the data server is also important.

The manufacturer of the datalogger and the monitoring platform should provide information on penetration tests for their servers, any command protocol activation channels and security audits for their products. Command functions should be sent using a secure VPN connection to the control device (best practice). Double authentication would be an even more secure option.

For further information, beyond the scope of this document, please look at the EU Cybersecurity Act (EC, 2019) and the European Parliament's study "Cyber Security Strategy for the Energy Sector" (EP, 2016).

9.7. Data portability, backup and disaster recovery

The data from the Asset Management Platform, or component systems, should always be legally owned by, and be accessible to, the Asset Owner (SPV). Stakeholders such as the O&M Contractor, the Asset Manager or auditors, during due diligence phases, that need the data to perform their duties should be able to be granted access.

Depending on whether you rely on an in-house built platform or rely on external vendors, these specific considerations should be key requirements that are passed on and included as part of the scope of the Asset Management Platform.

Consideration should be given to how the data contained within the Monitoring Systems, Asset Management Platform, and that is generally collected by the Asset Manager, is protected to ensure the long-term availability in the case of change of provider either through:

- Managed change of Asset Manager, O&M provider or Monitoring System/Asset Management Platform
- Unexpected change of Asset Manager, O&M provider or Platform (e.g. insolvency)
- Transfer of ownership of the SPV.

Key to the above is a full understanding of the data being collected at all levels and having agreements in place to make it accessible and ensure it is continuously backed up.

An important consideration in these matters is to understand what underlying system is the "system of record" for any given type of information as it will inform

TABLE 10 DATA BACKUP MINIMUM REQUIREMENTS AND BEST PRACTICES

CATEGORY	MINIMUM STANDARD	BEST PRACTICE
Technical data	Plant production monitoring with data collected at least once every 24 hours	Plant monitoring data collected in 15-minute intervals
Financial & commercial data	Yearly presentation of balance sheet, profit & loss, and cash flow statements	Monthly presentation of balance sheet, profit & loss, and cash flow statements
Contractual data	Yearly extension/renewal of contractual data and reporting	Yearly extension/renewal of contractual data and monthly reporting on all contractual related activities i.e. O&M service provider's activities
Legal data	Yearly extension/renewal of legal responsibilities	Monthly reporting on legal responsibilities

the backup strategy required for each initial "source" of data. It is recommended that the Asset Management Platform should keep a copy and log of all data saved if other systems feeding information into the Platform encounter problems.

The Asset Manager should endeavour to make sure that all data contained within the Asset Management Platform is correct and up to date, to the extent possible. The Asset Manager's ability to properly maintain the Platform should be evaluated regularly. It is expected that the Asset Manager's staff and any other users of the Platform should be appropriately trained in how to use it.

As a best practice, software vendors should be able to offer a variety of failsafe and backup options to Asset Managers. They should have as per the Information Systems Audit and Control Association (ISACA):

1. Developed a comprehensive backup plan – How and at what frequency are backups done and what are the possibilities for rollback and data recovery?
2. Perform effective backup management – Are they hosting their own servers or relying on cloud service providers?
3. Perform periodic databases restore testing – Have they performed restores of their backups?
4. Have backup and recovery Service Level Agreements (SLAs) drafted and communicated to all stakeholders – What are the severity levels, what are the guarantees, what are their remedies? What business interruption clauses exist?
5. Have the disaster recovery plan (DRP) database portion drafted and documented. Has this all been documented by the vendor?

Asset Managers, as customers of these software companies, can further increase their security by asking for:

1. Specific SLAs that refer to their own backup strategy
2. Dedicated instances of the application
3. Code Escrow agreements to secure against bankruptcy.

Ultimately, data portability, security and recovery are everyone's prerogatives and should be discussed with all technology providers.

They should also test the ease of data export/API connectors of their software vendors for more commercial reasons.

9.8. Handover of data and documents

For detailed information on the handover of data and documents, please refer to chapter *4. Handover of solar assets.*

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10 KEY PERFORMANCE INDICATORS

The baseline of the Asset Manager's work is confidence. The Asset Owner trusts the Asset Manager to manage their asset, assuring the best operational performance and financial optimisation. For that, the Asset Manager should outline effective, rigorous and well-defined processes and procedures according to each geography's needs. This will ensure that the Asset Manager complies with the best guidelines and working practices for daily customer-oriented work.

Close monitoring of Asset Management procedures is required to ensure the effectiveness and efficiency of AM service provision. This can be achieved through the definition of clear and objective KPIs which need to be continuously assessed.

The benefit of using solid and high-standard KPIs to assess performance is assuring the quality and stability of the Asset Manager work. This enables the Asset Manager to monitor their work and learn through experience in order to evolve continuously, which translates into providing a high-quality service for the Asset Owner.

The following sections present the most important KPIs to measure the performance of Asset Managers. (Note that the KPIs used by the Asset Manager to evaluate suppliers are presented in chapter *7. Procurement*.)

10.1. Asset Manager experience

The Asset Manager's track record and experience can be very important to enable the identification of critical subjects or situations lacking intervention – which translates into work efficiency, based on organising and prioritising the most urgent subjects. Additionally, the return of experience has an important role in the creation and/or redefinition of Asset Management procedures. The Asset Manager's experience can be quantified by indicators such as the number of tender processes managed, OPEX reduction achieved and historical KPI of the key suppliers.

10.2. Quality of Service based on periodic Asset Owner surveys

It is important to obtain Asset Owner's feedback to understand if the Asset Manager's work is aligned with the Asset Owner's needs. This can be achieved through the elaboration of periodic surveys. This helps the Asset Manager to identify critical areas of the Asset Management's process and to define different operating strategies, in accordance with market trends or technological innovations, to be more effective.

10.3. Reports Compliance Rate (RCR)

This KPI is intended to measure the capability of delivering the periodic reports to the Asset Owner on time. Periodic reporting is the most important responsibility of the Asset Manager's work, because it is the most comprehensive way to deliver the operational and financial position of the PV Plant or Portfolio to the Asset Owner on time.

Therefore, it is imperative to monitor this indicator closely and continuously.

Reports Compliance Rate:

$$RCR = \frac{\sum \text{number of reports delivered on time}}{\sum \text{all reports delivered}}$$

Frequency: Monthly (Continuous)

10.4. Invoicing Compliance Rate (ICR)

This KPI is intended to measure the capability of issuing the invoices to the Asset Owner on time.

Invoicing Compliance Rate:

$$ICR = \frac{\sum \text{number of invoices issued on time}}{\sum \text{all invoices issued}}$$

Frequency: Monthly (Continuous)

10.5. Contracts Optimisation Rate (COR)

This indicator is relevant to assess the Asset Management work of optimising the asset's cost structure and quality of service. COR KPI measures contracts' optimisations.

However, this indicator should be analysed carefully depending on the assumptions considered by the Asset Manager. This means that it is necessary to understand the computation of this indicator in order to make assertive/valid conclusions.

There are contracts that cannot be renegotiated by the Asset Manager either because they are locked by project finance requirements or they are initially negotiated for long periods based on an annual fixed fee and indexed to annual CPI. Usually, these contracts represent about 70 – 80% of the OPEX costs – predicted in the KPI's denominator. For example, Land Lease, Asset Management and O&M.

Although the number of renegotiable contracts has a residual weight in the OPEX structure, they should be reviewed annually to achieve global contract optimisation.

Nevertheless, from the Asset Owner's perspective, the most important thing is to achieve a COR > 0%, meaning that the Asset Manager was able to optimise one or more contracts (which is always positive) no matter how small the saving(s) was(were).

Contracts Optimisation Rate:

$$COR = \frac{\sum \text{number of contracts renogotiated successfullly}}{\sum \text{all contracts in force (excl. non-renegotiable contracts)}}$$

Frequency: Annual

10.6. Requests Treated

RT indicator is intended to assess the Asset Manager's efficiency during a specific period.

This KPI is to assess Asset Manager performance level, based on the number of replied requests. Additionally, it allows the Asset Manager to identify which requests were not followed-up.

Requests Treated:

$$RT = \frac{\sum \text{number of requests treated}}{\sum \text{all requests received}}$$

Frequency: Annual

10.7. Timely Response Rate (TRR)

Response Time is useful to monitor the compliance of contractual deadlines. As mentioned above, periodic reporting is one of the most important deliverables under the scope of the AM contract.

This indicator is useful to identify weaknesses and strengths in the Asset Management procedures.

Timely Response Rate:

$$TRR = \frac{\sum \text{number of requests responded on time}}{\sum \text{all requests}}$$

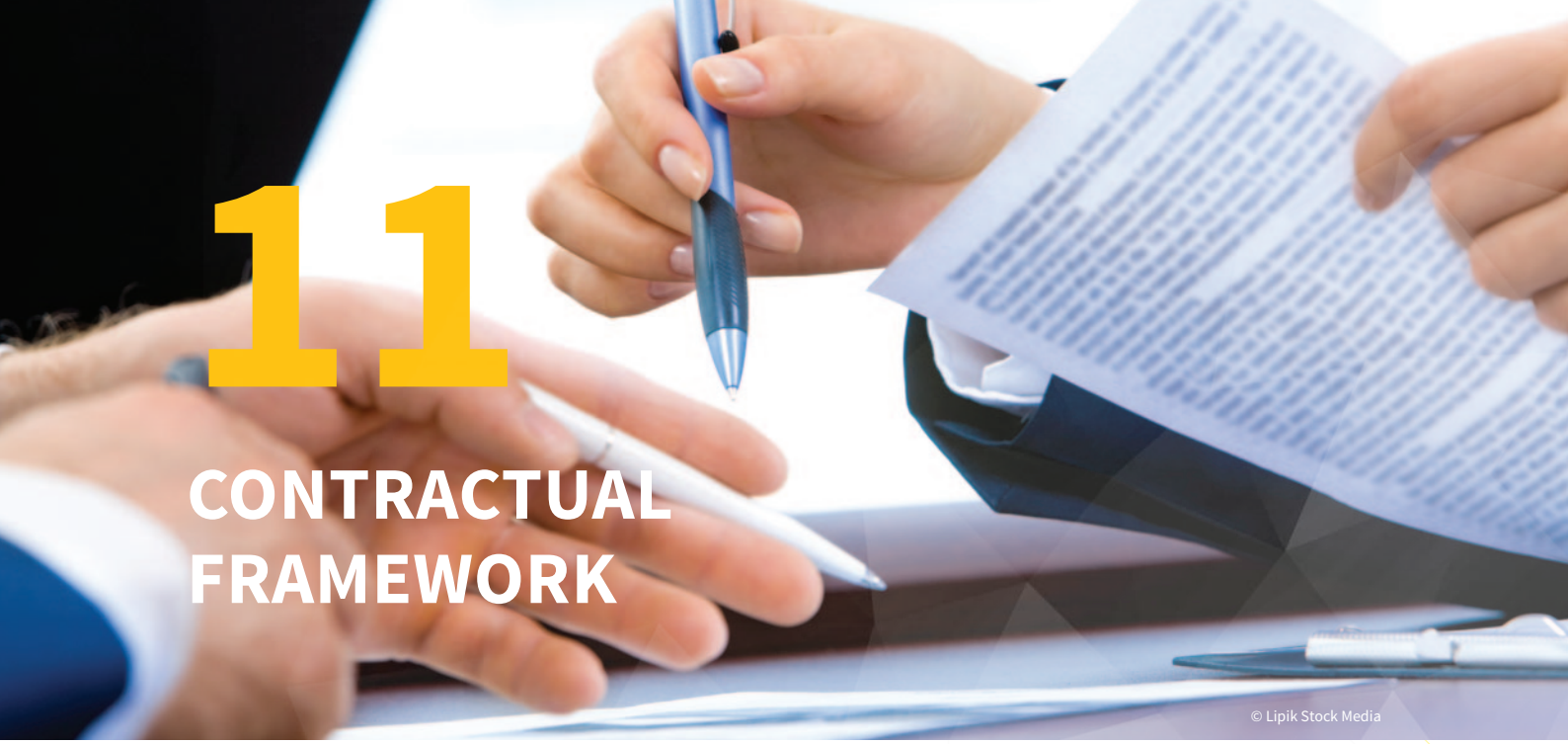
Frequency: Annual

10.8. Quality of the tender process

The quality of the tender process is a KPI related to the procurement capabilities of the Asset Manager, which is reflected in the clarity and comprehensiveness of the requests of proposals, as well as in the number of potential suppliers invited to the organisation of the data-room/Q&A process with the potential buyers.

10.9. O&M contractor compliance

The extent to which O&M Contractors managed by the Asset Manager comply with their contractual obligations is also a KPI that measures AM service quality.



11 CONTRACTUAL FRAMEWORK

This section contains a set of considerations for the contractual framework of AM services to be executed in respect to systems above 1 MW. As a complement to the technical specifications detailed in the previous chapters, the contractual framework described in this chapter is considered as a best practice.

11.1. Scope of the Asset Management contract

The services provided by an Asset Manager will include the tasks shown in Figure 11 and detailed in this document.

11.2. Asset Management contract fee

As a best practice, AM services should be provided on a fixed annual fee. The Asset Management fees could also be calculated according to a formula which takes into account the capacity of the power plant:

Asset Management contract fee:

Fee = Lumpsum x MW

Where:
Fee = Euro [to be agreed]

In addition to the annual fees, the Asset Manager may usually charge the client any out-of-pocket expenses within the annual maximum amount agreed between the parties.

Moreover, the parties may agree upon additional services to be executed at a predetermined price indicated under the contract.

11.3. Contractual guarantees

No contractual guarantees are generally provided under AM agreements.

11.4. Service standards

The Asset Manager will provide the services in accordance with all laws, authorisations, good industry practice and current market standard.

The services to be performed under the AM agreement and the action of the Manager shall be conducted honestly, in good faith, and in the best interest of the client.

With respect to the accounting services, the Asset Manager will keep the books and the relevant records in a proper manner and in conformity with all the required accounting principles and the applicable laws.

FIGURE 11 SCOPE OF THE ASSET MANAGEMENT CONTRACT

Reference to compliance with other project contracts' obligations may be negotiated separately and agreed between the parties to ensure that the SPV/Asset Owner is not in breach of any other relevant obligations undertaken under major contracts.

11.5. Limitation on authority

The Asset Manager shall not be entitled to sell, lease, pledge, mortgage, encumber any client's asset or grant any right or licence over the client's assets.

The Asset Manager shall perform the services in compliance with the annual business plan provided by the client.

In addition to the above, the parties may agree that the Asset Manager will not be entitled to enter into any contract having a value higher than the maximum amount identified in the AM agreement.

Moreover, with respect to any litigation that may arise between the SPV/Asset Owner and any third party, the Asset Manager will not have the power to settle any such claim or to submit to a court or an arbitration panel any such dispute.

11.6. Responsibility and accountability

The Asset Manager shall be liable towards the Asset Owner for every contractual breach or violation of any specific obligation set out under the Asset Management Agreement, including the confidentiality undertakings.

Parties may agree on a maximum liability threshold for the Asset Manager, which is usually equal to the payable annual fee.

11.7. Subcontracting

The Asset Manager could be authorised to subcontract part of the activities to be carried out under the Asset Management Agreement, provided that the subcontractor is a reputable and experienced entity or person capable of fulfilling all the subcontracted obligations and will comply with all the standards and requirements set out under the AM agreement. It is advisable to have a joint liability between the Asset Manager and the subcontractor so that the Asset Manager will remain liable for the subcontracted activities.

11.8. Reporting

Reporting should be done periodically if contractually agreed between the Asset Manager, the O&M Contractor and the Asset Owner. Should the client execute commercial agreements that require daily management and reporting, the AM agreement will also include such specifics. Please note that such activity is generally an additional service.

11.9. Continuity of operation and termination

In the event of termination or withdrawal from the AM agreement, the Asset Manager shall, if required by the client, continue to operate the assets for a specified period (i.e. 60 days) until the replacement of the manager. In such a period, the Asset Manager shall continue to act in accordance with all the provisions set forth under the AM agreement as if the agreement had not been terminated.

Termination is usually provided for general breaches of contract and obligations. Specific breaches leading to immediate termination are generally not included under this type of contract. Grounds for termination may vary a lot. They could go from a minimum of 15 days to a maximum of 90 days.

Termination for convenience may be negotiated between the parties as well as a relevant termination fee.

11.10. Force Majeure

In case of force majeure, the Asset Manager should mitigate the impact of the force majeure event on the performance of the services to be carried out under the AM agreement. The Asset Manager's obligation also includes minimising the timeframe of a suspension of services, understanding that the services must be restarted in the shortest possible time. During the suspension of services, the Asset Owner (or the lender, if a direct agreement has been executed) may have the right to step in in order to cure any default. Whether the suspension of services is forecastable or not, the Asset Manager should do its best to minimise to the extent possible the damage to the Asset Owner. The Asset Manager also has to inform the Asset Owner of the forecastable restart and the measures to be adopted for minimising the suspension. As a general remark, it should be underlined that in case of a breach of the Asset Manager's duty of care, the Asset Owner may have the right to request full compensation for the damages suffered; to this extent, compensation for indirect losses is generally excluded. Regarding the services suspension regime, it is market standard that the Asset Manager is relieved from the performance of such services as long as the force majeure event lasts. Therefore, each party may have the right to withdraw from the AM agreement upon the expiration of an agreed term or in case the force majeure event jeopardises the entire execution of the Asset Management Agreement.

11.11. Direct agreement

Should the PV plants be financed on a project finance basis, the Asset Manager, the Asset Owner and the lenders may execute a direct agreement in order to regulate lenders' step-in right in case of any default in the Asset Manager's obligation occurs.

Moreover, regarding lenders' security, lenders may require the Asset Manager to deliver any form of agreed collateral guarantee in order to secure the performance of the AM services under the AM agreement.

11.12. Personnel

The Asset Manager should engage and deploy an adequate number of competent, suitably qualified and experienced personnel in order to perform their obligations under the AM agreement. The personnel allocated for the performance of the services should remain allocated to such activities for the entire term of the AM agreement. In case of misconduct or any other incapability in the performance of the services, the Asset Manager should remove and replace the affected personnel with a suitable and qualified replacement. The same provision should also apply to the subcontractor.

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