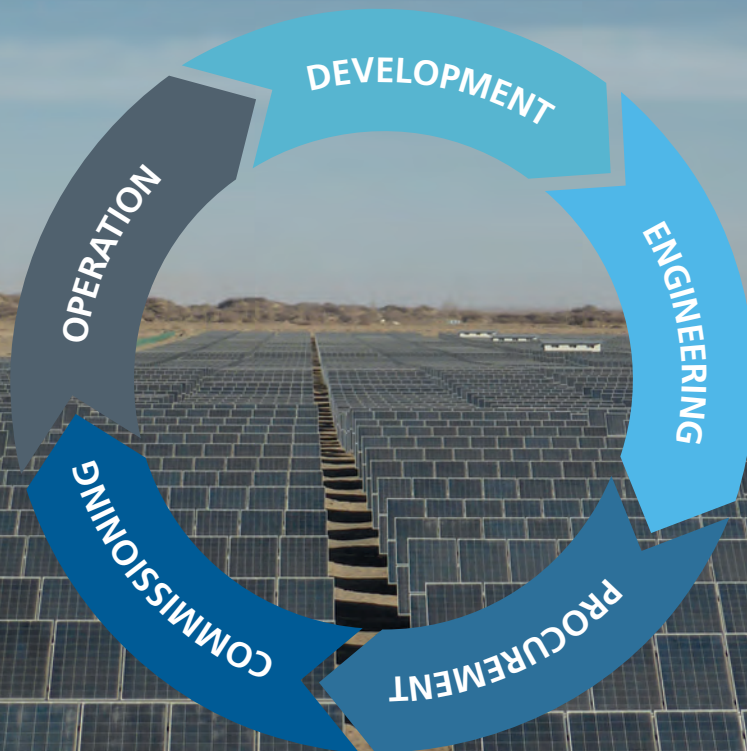


# QUALITY ASSURANCE AND YIELD OPTIMIZATION FOR PV POWER PLANTS



# HIGH PERFORMANCE AND OPTIMAL YIELD THROUGH COMPREHENSIVE QUALITY ASSURANCE

The professional quality assurance services of Fraunhofer ISE have been contributing to high performance and optimal yields of PV power plants over the last two decades. In every phase of a PV power plant project – from development up to long-term operation – our customers benefit from our longstanding experience. Our independent reports increase the confidence of all stakeholders of a PV power plant. International project developers, EPCs (Engineering, Procurement, Construction) as well as banks and investors trust in our services. Our experts look forward to supporting your projects.

## Development

A successful PV power plant project begins with the evaluation of potential project sites, the analysis of the environmental conditions and the estimation of the energy yield potential. We collect climatic data from various geographic information systems (GIS) and use high quality meteorological and solar irradiation data for the evaluation of specific sites, including temperature, humidity, soiling risk and local irradiation. These site specific input parameters are required for:

- detailed solar resource assessment reports
- evaluations of inter-annual variation and long-term trends of irradiation
- first plant design reviews and optimizations
- site specific reliability tests for components
- risk assessment and feasibility studies

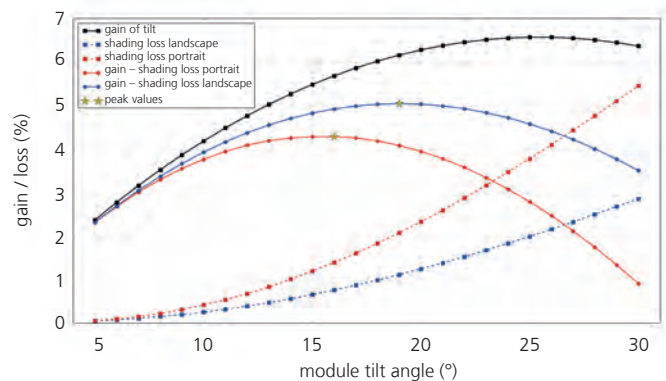
## Engineering

Which module and inverter technologies fit best to the specific project? How do these components interact within the system? What is the actual quality of the selected components? During the project engineering phase, we address these questions as part of our precise yield assessment and component quality benchmarking procedure.

For the **yield simulation** we generate a detailed model of the PV power plant based on design documents. The backside irradiation of bifacial PV modules as well as shading, reflection and the module angle are considered. Thus, the resulting yield

reports provide detailed information on all parameters that affect energy yield, as well as the associated uncertainties. We compare our yield predictions to results from our long-term monitoring portfolio on a regular basis and collaborate on international research projects. These activities help us to validate our yield assessments and continuously improve our methods and tools.

The **component benchmarking** procedure, optimized with respect to time and costs was developed with our customers to comparatively assess performance, reliability and workmanship. Module performance is measured at the accredited calibration lab CalLab PV Modules of Fraunhofer ISE. With an uncertainty down to 1.6 %, the laboratory provides worldwide leading measurement accuracy. A precise module energy rating in accordance with IEC 61853 standard delivers accurate input parameters for bankable yield assessments issued in this phase of the project. Additionally, module reliability and material checks as well as inverter efficiency can be verified by an independent and precise component characterization in Fraunhofer ISE Service Labs.



- 1 *Analysis of optimal design specification i. e. tilt angle and module orientation to achieve optimum yield.*
- 2 *Independent measurement equipment is used for performance evaluation.*



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### Procurement

An independent sample check of the delivered modules with respect to performance, reliability and workmanship is mandatory to ensure high quality in the procurement phase. Our designated **procurement check** procedures allow us to identify systematic underperformance or failure risks of PV modules and to assess their reliability. We select a representative sample based on a proven sampling method and perform power measurements with highest accuracy as well as tests for production process quality. The accredited TestLab PV Modules offers reliability checks for most relevant and critical failure modes. Our comprehensive results and reports are acknowledged by suppliers and off-takers worldwide.

### Commissioning

To ensure that power plants are built to the highest standards and that the expected performance can be reached, we offer our customers a comprehensive test program for PV systems. The range of services includes:

- visual plant inspections
- thermography and power measurement
- evaluation of the PV power plant performance

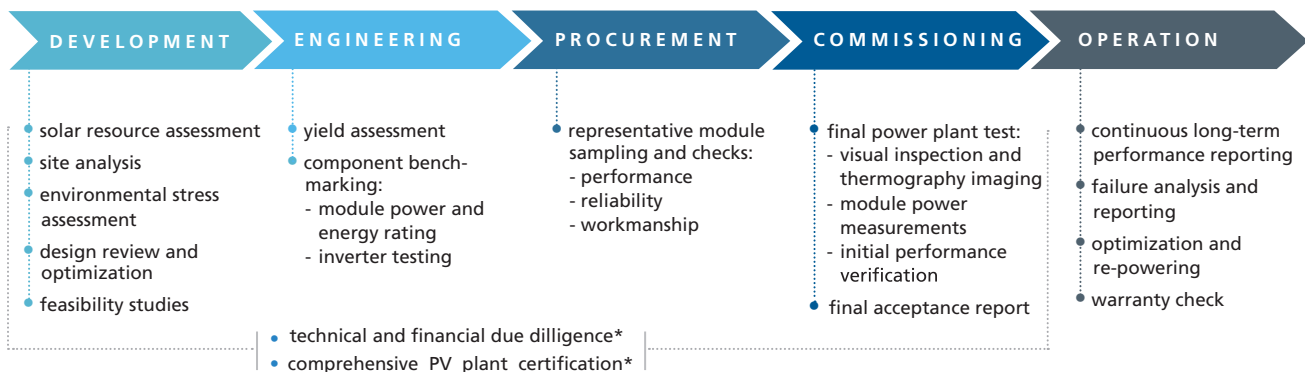
The inspections help to identify defects and deficiencies in the PV installation. Early fault detection allows operators to react quickly for needed repairs and potential warranty claims. Our tests are performed with approved state-of-the-art procedures.

With our partner VDE Testing and Certification Institute we offer supplementary services such as safety verification and PV power plant certification.

### Operation

Independent confirmation of the quality and performance of PV components and complete power plants is valuable to manufacturers, EPCs, banks and investors alike. We offer performance reports that are both reliable and accurate, for periods ranging from a few weeks to many years. The report includes benchmarking as well as an analysis of measured versus expected Performance Ratios, based on a yield assessment. The report supports bankability and can be used as track record and basis for further improvements of plant design and components. Amongst others they help to revise yield reports e. g. by reducing originally assumed uncertainties and re-evaluate the yield predictions results. Long-term reliability of PV modules is investigated through independent monitoring of reference systems worldwide and at our own outdoor test facilities. By collaborating with Fraunhofer ISE, large project developers have significantly increased the performance and asset value of their power plants.

Together with our strong partners, we provide integrated services as a one-stop-shop for bankability, investability and insurability, including technical and financial due diligence and PV power plant certification.



Please visit the following websites for further information and flyers on related activities:

**PV Modules and Power Plants**

[www.ise-module.de](http://www.ise-module.de)

**Module Technology**

[www.ise-module-tec.de](http://www.ise-module-tec.de)

**Module Characterization**

[www.ise-callab-modules.de](http://www.ise-callab-modules.de)

**Service Life of Modules and Materials**

[www.ise-service-life.de](http://www.ise-service-life.de)

**Module Testing**

[www.ise-tlpv.de](http://www.ise-tlpv.de)

**Photovoltaic Power Plants**

[www.ise-pv-powerplant.de](http://www.ise-pv-powerplant.de)

**Building Integrated Photovoltaics**

[www.ise-bipv.de](http://www.ise-bipv.de)

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*Cover page: Optimal yield has been assured for this 200 MW power plant in China through our quality assurance services.*