Best Practices in Operational Energy Yield Assessments

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Background

This poster provides an overview of the solar operational energy yield assessment (EYA) process. It compares pre-construction and operational methodologies, as well as report- and SCADA-based operational approaches. The poster also discusses when to conduct an operational assessment, the importance of operational reporting and long-term correction, and the key factors affecting assessment results.

When is an Operational EYA Recommended?

Operational EYAs are commonly performed during project acquisitions, refinancing activities, or when plant performance consistently deviates from the budget. For asset management, Wood recommends tracking the variation between the budget and actual production on a quarterly basis using a waterfall analysis that reconciles production with energy losses and solar resource correction. When a consistent trend appears (surplus or deficit), Wood recommends an operational EYA is conducted.

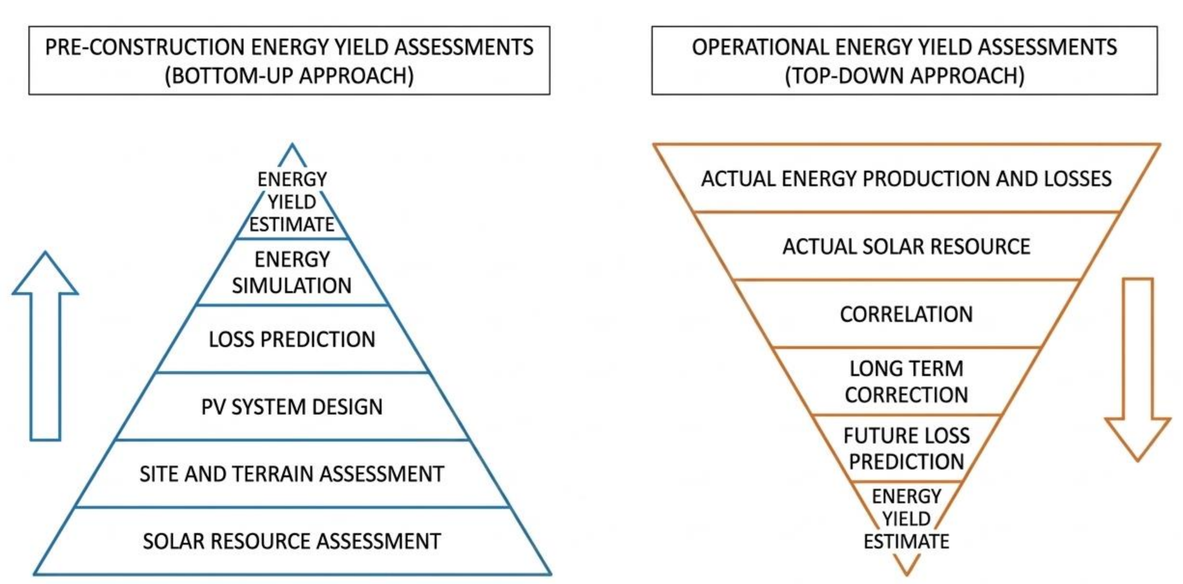
A minimum of 12 months of operational data is required to perform an operational EYA. As a result, Wood generally recommends conducting the assessment no earlier than 12 months after the commercial operational date (COD), with at least 18-24 months of data being preferred. This allows for a full year of representative operational data after initial "teething" issues have been resolved.

If a project acquisition is completed in the 6–12 months after COD, an operational energy yield can still provide useful indicative results alongside a pre-construction EYA.

Pre-Construction vs Operational EYA

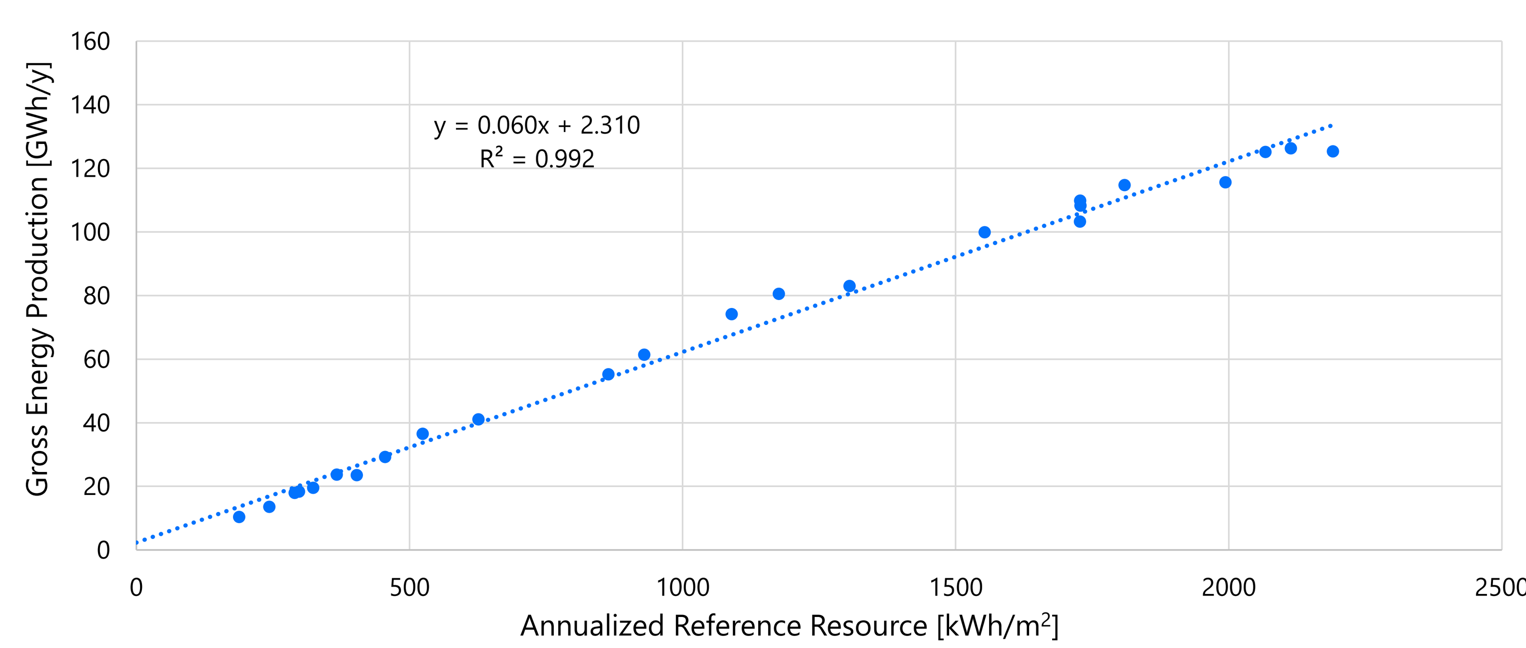
The operational EYA process is a top-down approach, whereas the pre-construction EYA process is a bottom-up approach. In a pre-construction EYA, the analysis begins with the solar resource incident on the PV modules, and losses are applied sequentially to estimate the net energy delivered to the grid. Conversely, in an operational EYA, you start with the energy delivered to the grid and work backwards by adding losses to determine the gross energy of the plant.

The top-down approach of the operational EYA is generally faster and more accurate, utilizing real data from the plant. The bottom-up pre-construction EYA approach is generally slower and less accurate, requiring sophisticated modelling of the terrain, configuration, shading model, etc.



Operational EYA Methodology

The operational EYA methodology involves developing a linear correlation between actual gross energy production (actual energy production + energy losses) and actual solar resource data, typically on a monthly level. Satellite-based solar resource data is typically used since a long-term dataset (15+ years) is required. Outlying data points are excluded where justified (i.e. low availability), however it is important a seasonally balanced dataset remains, with equal number of winter and summer months.



The long-term annual solar resource is then inputted into this linear relationship to estimate the gross P50 energy yield. Future loss predictions are than applied to formulate the net P50 energy yield.

Report vs SCADA Based Approach

The report-based approach relies on production and loss data from monthly operational reports prepared by the O&M provider or asset manager. As a result, the quality of the information in the reports determines the quality of the assessment. At a minimum, the reporting should include the monthly total inverter energy production and the average time-based inverter availability. Robust reporting will also include the monthly production from each inverter, the metered production at the point of interconnection (POI), and categorized energy losses for the various issues impacting the plant. Wood recommends operational reports include the following energy loss categories:

- inverter downtime by fault type
- inverter derating
- maintenance activates
- tracker outage or misalignment
- soiling
- snow
- wind/hail stow
- substation outage
- grid outage
- grid curtailment

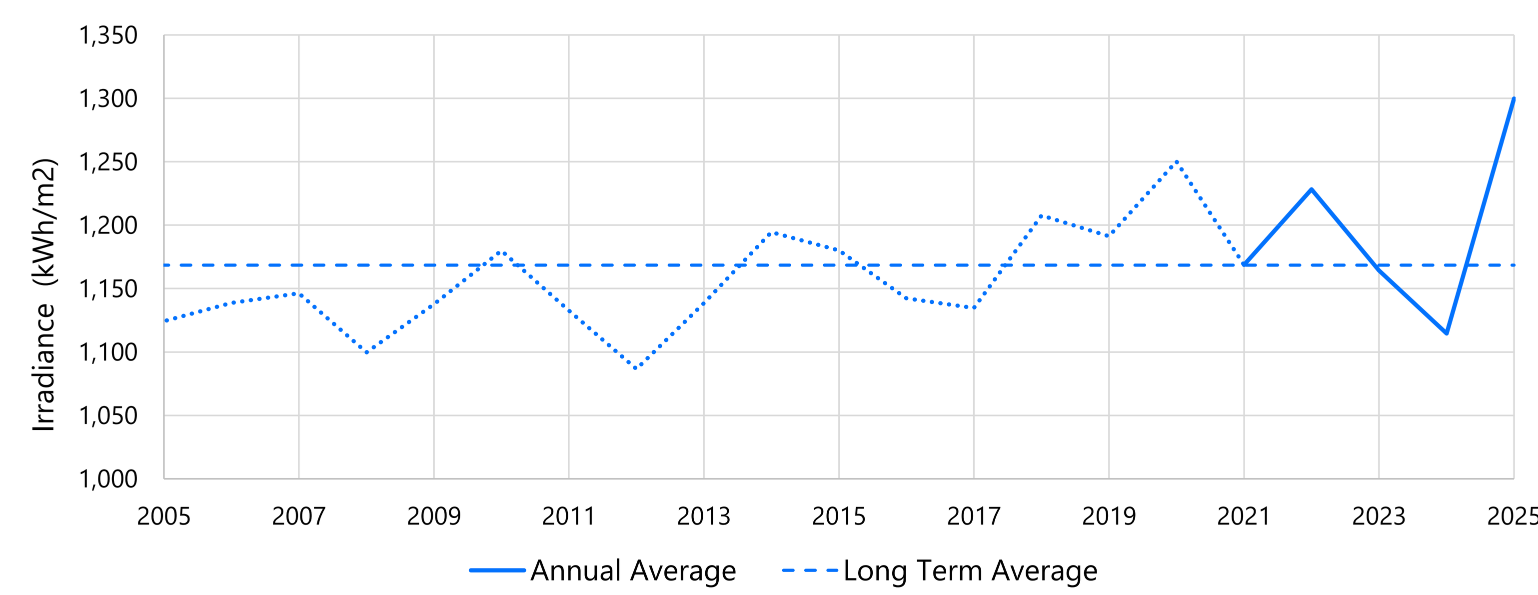
If operational reports are missing, the plant availability is often low (<95%), or a truly independent analysis is required, Wood recommends the SCADA-based approach, where production and losses are calculated directly from the plant's raw SCADA data.

A SCADA-based assessment enables energy-based loss calculations, which are more accurate than time-based methods. Although this approach can be more costly, it provides a more independent analysis, typically resulting in a more accurate P50 estimate and lower overall uncertainty.

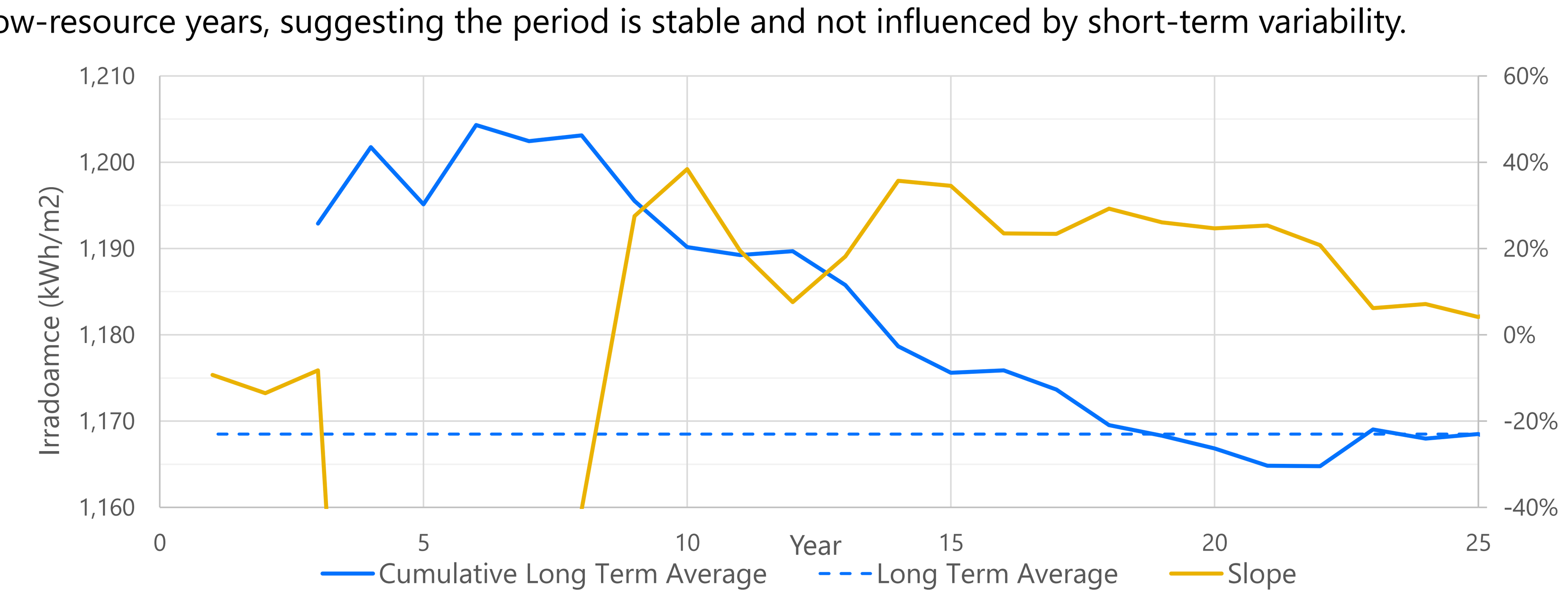
Long Term Correction

It is important that the short-term solar resource data, typically based on 1–3 years of operation, is adjusted to reflect the long-term average conditions over a period generally spanning 10–20+ years. This adjustment accounts for year-to-year variability in the solar resource, commonly referred to as interannual variability (IAV).

The figure below illustrates an example comparing short-term and long-term solar irradiance trends, where the short-term period exhibits irradiance levels approximately 3.5% higher than the long-term average. Long-term correction is performed by selecting a historical period that is considered representative of future solar resource conditions.



To determine the appropriate duration for the long-term analysis period, Wood evaluates the trend in the cumulative long-term average and the slope of that trend, as illustrated in the figure below. An appropriate long-term period is identified when the cumulative average stabilizes, and the trend slope approaches 0%. A slope near 0% indicates that the dataset contains a balanced distribution of high- and low-resource years, suggesting the period is stable and not influenced by short-term variability.



Wood also recognizes that climate change may influence the long-term irradiance or temperature trends at certain solar project locations. For these locations, Wood generally recommends the purchase of Climate Scale data which estimates future solar resource and temperature variations with various climate models and scenarios. Alternatively, Wood may select a slightly shorter historical period which places a slightly greater emphasis on more recent conditions.

Wood notes that long-term temperature correction can also be applied and is particularly important when the average temperature during the short-term period differs significantly from the long-term average.

Future Loss Prediction

Future loss prediction is primarily based on historic operating losses. However, if limited or inconsistent historic data is available, pre-construction predictions may be relied upon. Future loss predictions can be estimated for each energy loss category or in aggregate if easier. Typically, external losses (i.e. grid outage/curtailment) are separate categories.

It is common for solar PV plants to experience "teething" issues during the first year or two of operations, which may not be representative of long-term performance. In such cases, it is essential that operational reporting clearly captures and quantifies these losses so they can be excluded from future loss assumptions.

Uncertainty

The uncertainty associated with an operational EYA is typically in the range of 4–6%. SCADA-based assessments generally achieve 0.5-2% lower uncertainty than report-based approaches, depending on the quality of the operational reporting.

Wood notes that although pre-construction EYAs can exhibit uncertainty levels similar to operational assessments, they have historically tended to overpredict solar energy yields by approximately 4–5%.

Sources of uncertainty for an operational EYA typically include the following:

- Input Data
  - Power data (dependent on power transducer accuracy)
  - Solar Reference Data (dependent on data provider)
  - Loss data (dependent on time or energy-based availability)
- Model
  - Correlation (jackknife or bootstrap approach)
  - Short term period (function of period length)
  - Long term period (function of IAV)
  - Climate change (function of remaining project life)
- Future Prediction
  - Future availability (function of historic availability & amount of uplift)
  - Future degradation
- Interannual variability (IAV)

Key Factors Affecting the Yield

Wood recommends the following key factors are considered for an operational EYA:

- **Report or SCADA based approach** – the quality of the report-based approach is 100% dependent upon the quality of the operational reporting. SCADA-based approaches are independent and typically result in lower uncertainty.
- **Material changes** – changes in O&M provider or strategy, changes in reporting practices (i.e., energy loss categorization), shifts in environmental conditions (i.e. pollution, wildfire smoke), vegetation or forestry management or infrastructure (i.e. buildings) can have a significant impact on EYA results and should be carefully accounted for.
- **Solar resource data** – prior to selecting a solar resource provider, it is important to check the accuracy for your site location. This should include a review of third-party validation reports and a check of the accuracy of nearby validation sites.

Conclusions

Operational EYAs provide a fast and accurate method for re-evaluating a projects energy yield. They are particularly important to conduct for project acquisitions, project refinancing, or when the actual production (normalized by losses and resource variation) consistently deviates from the pre-construction budget. The SCADA-based approach offers a more independent assessment and typically results in lower uncertainty compared to the report-based methodology.