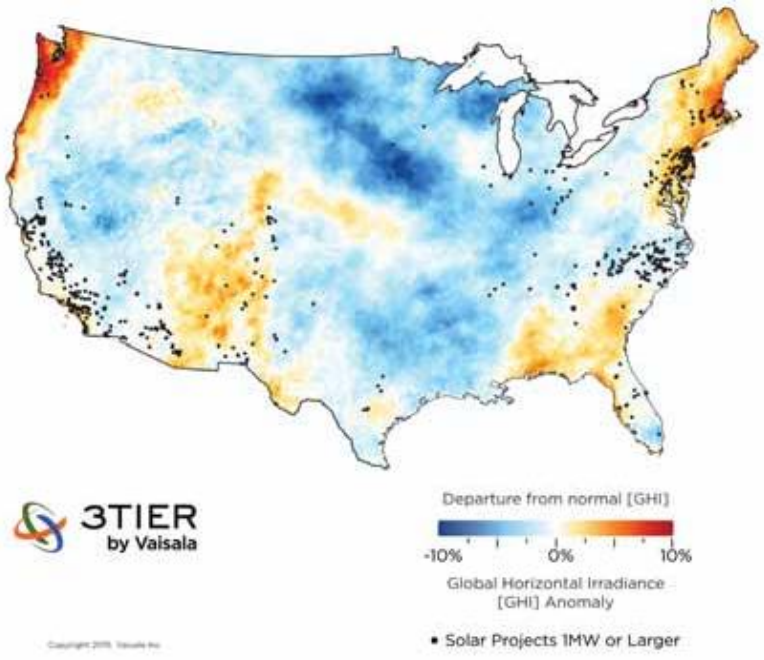
A model approach

Yield assessment | Evidence is emerging that data used in PV yield modelling, an essential element in optimising a plant's design and profitability, is leading to erroneous results. Ben Willis reports on the solar industry's data challenge and how it is responding



Source: Vaisala.

Solar performance in US over the summer months of 2014 varied relative to 18-year averages.

Late last summer researchers at the Fraunhofer Institute for Solar Energy revealed that a fleet of German PV power plants it had been monitoring were producing around 5% more power than had been predicted in their initial yield assessments. Using recent satellite data, the team linked the plants' relative over-performance to a phenomenon known as 'global dimming and brightening', whereby atmospheric changes over time cause average solar radiation conditions to fluctuate.

As the Fraunhofer team's findings revealed, the underestimation of the plants' likely performance was down to the initial data on which these estimates had been based. Previous assessments had assumed future radiation levels would not differ greatly from average values over the past 30 years; however analysis by the Fraunhofer team of recent satellite data from DWD, Germany's national meteorological service, revealed disparities between the two sets of figures.

"Relying on average radiation values from the past 30 years causes a systematic underestimation of actual PV system yields in Germany by around 5%," said the Fraunhofer ISE project leader, Björn Müller, at the time. "We expect that other regions experiencing the brightening effect are seeing similar underestimations."

The Fraunhofer study highlights what Müller and others believe is emerging as a crucial issue for the solar industry to get to grips with as it matures: the need for better data to improve the accuracy of PV power plant yield assessments. Speaking to *PV Tech Power*, Müller says the main conclusion from last year's study was the need for the industry to use up-to-date data for its modelling. "If you have long-term changes in irradiance, then you should use recent data, because that should be the best estimate for the future," he says.

And this is more than just a point of academic interest; it's a fact that could have big implications for the profitability or otherwise of PV power plants. PV yield – or energy – assessments form the basis of decisions by the financial community on whether or not to back a proposed project. Conservative forecasting can lead to lost investment dollars, while overly optimistic assessments will inevitably lead to questions for the solar industry when plants fail to deliver expected outputs.

Over-performance expected

Gwen Bender, an energy assessment product manager for forecasting firm, Vaisala, believes the solar industry is likely to see further instances of divergence between the predictions and actual performance of PV power plants. "There's going to be a ton of over-performance in the solar industry, quite honestly, because I think people have been too conservative," Bender says.

The basis for Bender's assertion is the fact that, as she explains, the general practice in the industry has been to rely on 'typical meteorological year' (TMY) data for assessments. This essentially distils a number of years' irradiance data into one 'typical' year, often combining that with ground measurements taken from pyranometers. These figures are then used to arrive at so-called P50 and P90 figures, which describe a probable level of generation that will be exceeded respectively 50% or 90% of the time.

When presented with a project proposal, an investor will consider both figures, with the spread between them giving an idea of the variability of the forecast resource at the site and therefore the risk attached to the project. The closer the P90 to the P50, the less the variability at the site and therefore the less risky a project; the greater the spread, the greater the variability at the site.

The problem with using TMY data for this exercise, says Bender, is that because it is based on only one year of data, it is unable to give a particularly nuanced picture of the likely climatic variability over a project's lifetime. That means a developer must "guess" at the distribution between the P50 and P90, leading them to err on the side of caution.

"Depending on how you assume the distribution [between the P50 and P90], there is a likelihood that you could over- or under-predict what that full range of variability might be," Bender explains. "And those have different consequences – like if you over-predict, if you say the distribution between your P50 and P90 is tighter than it turns out to be, you may end up underperforming.

"The other thing is that you under-predict – you say I think this spread is really wide, and you give yourself a P90 that's fairly low.

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In terms of industry perception that's probably ok, because then the plants are performing better than expected. But then in terms of you as a developer, you just dropped a ton of money with the bank, because you picked a number that was too conservative."

Bender says the PV industry's caution is partly a reaction to a spate of large over-predictions that hit the wind energy industry in around 2008 and led to plants underperforming relative to expectation. "A lot of people would have been using the same consultants to do their solar," she says. "So because of a reaction among the major consultants to be conservative, so as not to have the same under-performance problem, I suspect we're going to see an over-performance in solar, which, again, is good for industry perceptions, but means that a lot of investment dollars were left on the table."

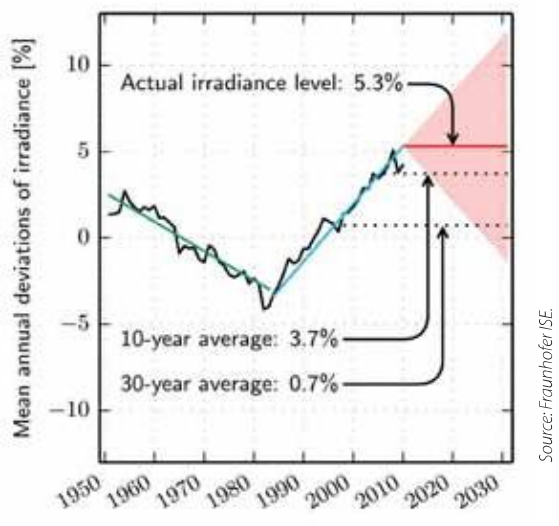
And that could be a lot of dollars. "It's extremely variable – depending on the tax situation, depending on how you finance your project and so on, a particular plant could be seeing that they left US$500,000 to US$1 million on the table every year, if you were overly conservative and you were over-performing," Bender says.

Better data

In an era when solar is increasingly moving into unsubsidised territory, where every kilowatt-hour generated by a plant will count, the trend of conservative estimates highlighted by Bender could cost developers dearly. "As we shift to a system where you are not paid for what's in the ground, but for what you produce, which is the world we're looking at in 2016 [when the US investment tax credit is due to run out], then all of a sudden you care a lot more about the variability of what you're going to produce," she says.

The message for developers and financiers is that the quality of the data that sits behind yield forecasting must improve at an industry-wide level. Bender's company, Vaisala, offers an assessment service that can produce a model based on 18 years of data, and she says she gets the sense that the industry is starting to realise the need to move towards more accurate modelling. "It's partly because there is enough installed now that my guess is people are not seeing the results they expected one way or another," she says, citing one unnamed client who came to her company because their plant was over-performing and "they needed a better number" to negotiate refinancing.

Fraunhofer ISE's Müller agrees that the industry needs to adop better modelling practices. "We had a lot of discussions last year about this, and it's starting, but it's not something that's already happening widely," he says. "TMYs are good, because they are quite cheap and they are available, but you need to use satellite time series, 10-year time series, so you can simulate a whole 10-year period and get from this the expected annual energy yield, but up to now satellite-derived irradiance time series have been quite expensive."



Source: Fraunhofer ISE.

Graph showing the annual deviations in solar radiation from the average value in Germany.

Others are more positive about the industry's awareness of the data issue. César Hidalgo, head of solar at the Barcelona office of renewables advisory DNV GL, agrees that some TMY data that has hitherto been available in the market, particularly for emerging markets in regions such as Latin America and South Africa, has not been particularly representative of the past 15 or 20 years. But that situation is now changing, Hidalgo believes: "People are more concerned about the quality of the data sets for solar resource assessments. Most lenders and developers are now well educated regarding the need for good solar resource data."

One important development says Hidalgo has been that the national meteorological offices in many countries, particularly emerging solar markets, have been concerned about the need to get good quality solar data. They have been installing masts at ground stations with pyranometers. Alongside this, Hidalgo believes that the quality of satellite data has generally improved. "There are a number of providers in the market that can provide very good quality data that a few years ago was very difficult to find," he says.

Hidalgo's colleague Ray Hudson, DNV GL's global solar service leader, agrees that the industry is becoming more sophisticated in its gathering and use of data. "Now that both the cost of the system components has come down and the margins have come down on what can be expected for the financial returns, this makes having a very accurate energy assessment much more important," he says.

But Hudson believes there is still room for improvement in some aspects of the energy assessment process, particularly around how data on component performance and actual field performance are incorporated. "There are areas to make the fundamental simulation tools for the conversion process in the modules better; there are opportunities to improve models to incorporate more of the parameters of the individual components," Hudson says. "As more solar is installed, incorporating lessons learned and actual performance, and feeding that back into the modeling, will be key. That's especially the case in areas like availability modelling and O&M."

Hudson says data on individual components such as modules and inverters has improved vastly, a fact that, combined with improved satellite data, is improving the precision of yield assessments. "Those combined have helped with accuracy," he says. "The state of the art is to actually do testing of components, especially modules, and in some cases doing project-specific model files for the energy estimate. Some of them have gone to that level of detail. And actually that's one of the services DNV GL provides through our test lab to support the increased accuracy of the assessments."

The advances described by Hudson as well as the adoption by the industry of more sophisticated resource and performance data will all undoubtedly be key steps for solar to take as it matures as a mainstream power source. The long-term performance of PV plants is still a relative unknown, but enough evidence is now beginning to emerge of plant over- and under-performance to suggest that smarter use of resource and actual performance should now become a priority for the industry.

Bender believes the industry is beginning to wake up to this. One piece of evidence she cites for this is the fact that when she gave a talk at last October's Solar Power International show in Las Vegas, although it was one she'd given many times before, this time she felt it finally began to hit home.

"I've been giving the same talk for five years, but it was the first year I feel like people heard it," Bender says. "So I think the industry is hearing the message, because they're seeing in the future they're going have to make the numbers work on production, not just building [power plants]. A project could be viable four out of five years, but you have to pay the bank five out of five years."