Taking PV design software to the next level

System design | As PV projects get bigger and more complex, plant design programs are rising to the challenge. Sara Verbruggen looks at how some of the latest innovations in design software are helping developers win the competitiveness game

Specialist software design tools for simulating PV plant layouts and yields can shorten design time significantly and resolve engineering challenges, helping to reduce soft costs.

But providers are also responding to the needs of the industry with software tools that simulate with greater accuracy super-sized ground-mount projects, half a gigawatt or more in size, as well as provide modelling that factors in the economic impact and value of connected systems and loads, like storage and electric vehicles (EVs).

Historically developers of large-scale solar PV plants have had two main tools at their disposal: the engineering tool AutoCAD, used in computer-aided design of anything from road infrastructure to furniture, and PVsyst, for the project's energy modelling.

But as the PV market has grown and the industry faces pressure to reduce costs in PV plant development, construction and operation, more software programs that can design PV plants and take into consideration impact of a wide range of influencing factors, from specific module or inverter types and models to shading, have arrived enabling developers to rapidly simulate PV plants.

New functions

An established provider of PV plant simulation and design tools is Germany's Valentin Software, which introduced its PV Sol tool in the late 1990s. Users of the software include developers, installers and also banks, for ensuring bankability of projects.

Recently the company has enhanced its offering by launching PV Sol Premium, which is able to model PV systems and projects in 3D by taking into consideration shading and the impact this has on the plant's output and yield.

The premium offering can produce designs with a maximum of 5,000 modules, equivalent to a 1MW plant. However, where a developer wants to design a bigger plant, to take into consideration shading, this can be done by using PV Sol to model several smaller plants and combine these, using PV Sol Premium for any shaded areas.

Credit Meteodyn

PV Sol is also able to produce designs not only of PV systems, such as commercial rooftop, but simulations that factor in a building's loads, or on-site EV charging, as well as battery storage for projects where self-consumption of PV-generated electricity needs to be optimised.

One client, a shipping/logistics business, operating throughout the night, is interested in installing a rooftop solar PV system at its premises. The firm operates a fleet of battery powered forklift trucks that can be recharged with electricity from the solar panels during the day. The software results provide economic modelling for the solar PV array down to how many kilowatt hours each forklift truck will use, supplied by the solar, versus the cost of these kilowatt-hours, from the grid.

To simulate PV projects and the yields and output of plants, PV Sol software imports climate data from Meteonorm, site data from Google Maps and has a database of different PV modules, inverters, battery storage systems, EV makes and tariffs.

PV design software is becoming more sophisticated, in step with the requirements of solar developers

The software produces an aggregate simulation based on the performance metrics of the modules and other system components fed into it, along with assumptions based on the actual electrical behaviour of the components, plus data on loads and grid connections, to produce a simulation that is closer to how the physical plant might actually perform. More recent developments include a battery simulation.

Most projects are run through PV Sol on its own or through a second software, usually PVsyst, for a "second opinion" assessment of bankability, according to Valentin Software's managing director Steffen Lindemann.

Credit Valentin

Innovations in PV design include being able to simulate the incorporation of batteries

Utility-scale design

Vertically integrated module and component producer, developer and asset manager SunPower has spent the last few years refining its approach to simplifying the building of large and utility-scale solar PV plants by standardising components that are constructed in modular blocks. The US company launched the latest version of its Oasis Power Plant in September 2016, with additional features to optimise the design of utility-scale PV plants.

The earliest stage of developing a large-scale PV project requires selecting the right site. Developers usually have to use available satellite images, and send people out to sites to photograph and survey them. But as PV plants have grown in size, sometimes to hundreds of megawatts in size, this approach becomes impractical.

"The other option is to hire a small plane and take images from above, which can cost around US$30,000 to hire," says Matt Campbell, vice president, power plant products, at SunPower.

SunPower's answer is to use drone imaging. High in the sky, drones scout potential locations, flying over hundreds of acres of land in a matter of hours to record images and assess topography.

"In 2016, when surveying sites for large-scale PV plants in Mexico, one guy with a drone was able to survey two sites a day, rather than the weeks it can take with conventional methods," says Campbell.

The images are fed into SunPower's proprietary software to create bird's eye view images of potential sites, containing more detail than satellite images are able to capture; for example picking out creeks, gullies, rocks, old buildings and other potential obstacles. Other important information can be fed into the company's software to build up a complete map of the site, including gradients of areas, to show where there are parts of the site that may be too steep for some types of trackers, as well as other constraints, such as transmission lines.

Once all the necessary information is inputted into the software for processing, it produces a range of site layouts with maximum output and best financial results, based on multiple parameters, all in a matter of hours. The parameters include DC to AC energy loss, clipping loss, lowest levelised cost of energy (LCOE), lowest engineering, procurement and construction (EPC) cost, as well as net present value (NPV). Big data and algorithms are used to crunch all of the data and information required to come up with suitable sites and designs.

"Traditionally when assessing sites, NPV has been the determinant metric, but as we move more and more to auction-based systems and lower power purchase agreement (PPA) prices, then LCOE is probably going to be the key metric when assessing sites to take forward for development," Campbell says.

The software enables the overhead image of the site to become the interface for the project through its entire duration and the resulting plant's operational lifetime. SunPower can make its software available to EPCs so they can also refer to the site's map and any updates.

To prepare for construction, roads can be added to the site map as well as the location of a substation, inverter cabinets and cabling. A drone can be flown over the site during regular intervals throughout the construction period, reducing on-site management time, monitoring the rate of construction process and updating inventories and delivery schedules.

According to Campbell solar plants should be thought of as factories. "A manufacturing plant's operations and output is optimised with management information software (MIS). Why shouldn't it be possible to optimise all stages of the solar plant's construction?" he says.

Once the PV plant is operational the map and the software updating it is still important, for example, to show which portions of the PV plant are more prone to soiling so the cleaning can be adjusted accordingly with the area most prone to soiling cleaned more regularly. As the site map is updated in terms of areas cleaned it, O&M costs can be more accurately calculated.

SunPower uses drones to speed up the surveying of potential PV sites and aid the design process

Credit: SunPower

Highest output at the lowest cost

Folsom Labs is a west coast US software developer that launched its solar PV simulation and design tool in 2014. At the time the aim behind HelioScope was to provide the industry with PV design software that was simpler and faster to use while ensuring the projects it simulates provide all-important bankability, aiming for the highest output at the lowest LCoE.

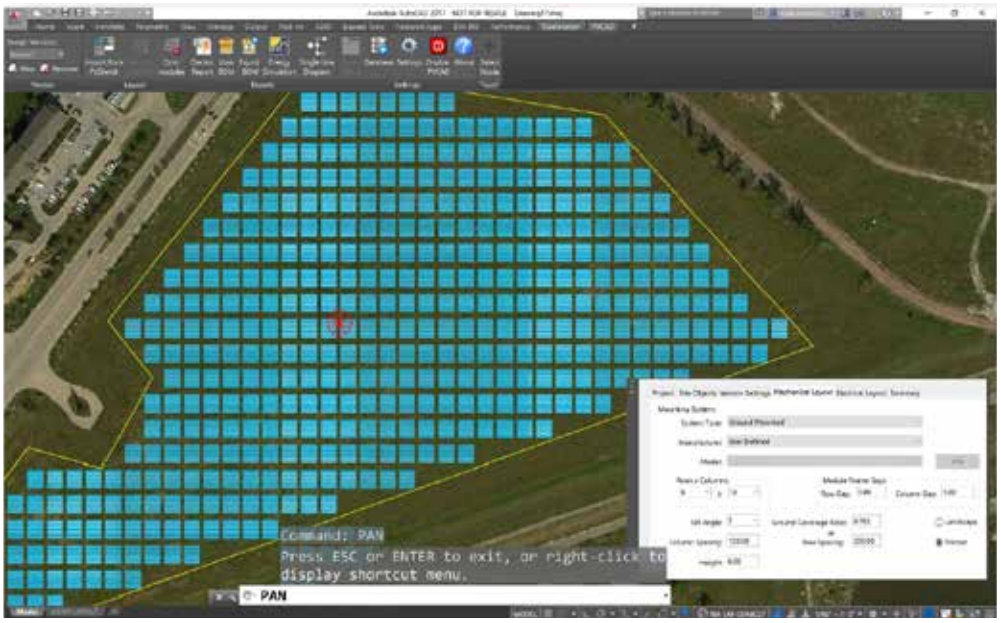
The user selects a suitable project site, such as through Google Maps, and produces a design based on inputs of different components, including modules, inverters, cabling and mounting. The software also combines with weather forecasts and runs simulations based on all the data in order to accurately predict the system's performance in terms of output.

This core design can then be adapted, with different components, to see the impact on results, including shade modelling and analysis.

"The incumbent PV design software took a module multiplied by however many and then applied a 'haircut' for the losses. When we launched, the value proposition for HelioScope was that it was a bankable granular component-level modelling software. But what we have found since then is the demand has been for a poor man's AutoCAD. By that I mean a solar PV-specific design tool for non-engineers," says Paul Grana, co-founder of Folsom Labs.

He cites a typical mid-sized solar firm, where there might be two or three engineers and a team of several sales representatives. "When one of the sales team sets up a meeting with an owner of five properties who wants to put solar on their roofs, the sales rep comes back and needs the engineer to produce five designs. HelioScope gives the sales team the ability to produce engineer-calibre results," says Grana.

With HelioScope a sales person can produce designs, meet with the client, and



Credit PVComplete

PVCAD combines the main attributes of AutoCAD design software with solar modelling capabilities

if the client wants to change something – removing trees from a site for example – to maximise the array area and increase output, then these types of changes can be made on the fly. "This fits in much more with the sales process, which tends to be very dynamic," says Grana.

The breakdown of projects using the software tool is about 40% commercial, 40% residential and 20% utility scale. But the highest traction is in commercial.

"A racking supplier on the east coast of the US said that of their 30 largest customers, there is 100% usage of HelioScope. That's a good indication that we are the market standard in commercial," according to Grana.

The company is prioritising adding new features for a residential version of HelioScope though some of the refinements will also feed into making the software more user-friendly for utility projects.

"One way we've modified the offering is to factor in the different building and safety codes that are different for residential buildings than for commercial. We've also tweaked features to allow individual modules to be clicked and dragged to move about in the layout, as required by this market."

The company has also customised a document aimed at homeowner customers. The reports HelioScope generates contain lots of detail, in terms of losses due to various factors, which is extremely useful for engineers but unnecessary for a sales pitch.

Grana says: "For homeowners we've streamlined the proposal to show cost, payback period, images and details such as what their typical bill might look like after installing solar. It's all backed up with underlying module-level physics."

One of Folsom Labs' main customers is Caterpillar which has gone public about plans to roll out solar internally and also supply dealer partners that are constructing solar PV projects and supply all the components necessary for building PV-hybrid microgrids.

Over 50 Caterpillar dealers globally are signed up to use HelioScope. "Caterpillar told us their dealers would also appreciate a similar proposal tool, based on a simple yet robust financial programme, a document that can be used in the sales process."

Getting a utility-type project such as a solar PV microgrid developed usually requires face-to- face meetings with different stakeholders, such as landowners, utilities and permitting departments. Each often has different questions, but crucially they all benefit from a simple, non-engineer level of document, according to Grana.

"It can change dynamically for the different stakeholders involved in the project, which can be very useful. For example a developer is facing a series of constraints: the utility will have a limit to the maximum power that the grid can take; the municipality will have restrictions on how the land can be used, such as setbacks from property boundaries and roads and line-of-sight restrictions, while the project owner may have budgetary constraints or financial return requirements.

"Plus, different technologies will be more or less effective at satisfying all of those requirements. Developers will use HelioScope to update their design and financial model on-the-fly, as they learn more information about new restrictions," says Grana.

Around 40% of Folsom Labs' customers are outside of North America, mainly in India, South Africa, Latin America, Australia and Turkey.

"We are seeing demand where new markets with growing demand are the norm. In these markets developers want to grow revenues aggressively but not necessarily grow their teams of staff."

The utility-scale proposal tool version, which includes features for solar trackers, is going to be launched later this year. Expanding the functionality of the software to include storage is also in the pipeline.

"We are very aggressive about API tie-ins , making sure that our software is compatible with other relevant software that investors and developers use. We have financing modelling, but HelioScope is compatible with the software used for financing calculations. Energy Tool Base is one such example

of compatibility. When we add storage capability, we will still support API tie-ins to storage design software tools. It's important they all play nicely together," Grana says.

New players, new solutions

Another west-coast software start-up, PVComplete, has created its PVCAD software design and modelling tool to be entirely compatible with AutoCAD by adapting the software for the specifics of the PV industry, through a royalty agreement with AutoDesk, AutoCAD's developer.

The advantage is that commercial and utility-scale PV plants of any size, with yields modelled, can be designed on one piece of software. "Almost anyone who is an engineer or is trained to draft will be familiar with AutoCAD from working with it as a student. In the cases of other PV design and modelling tools, there is an added step between exporting back and forth between two different types of software plus, you have to pay for each one. That's not the case with PVCAD," says Claudia Eyzaguirre, a co-founder of PVComplete.

PVCAD taps into databases of thousands of different modules, inverters and racking and mounting components. "Because the layout and geometry is influenced by the type of racking, in the past a developer would have had to go to the racking supplier first and requested a layout. If you were not a regular client you could be waiting for a couple of days. With this type of software it's instantaneous," says Eyzaguirre.

Such software removes the rule-of-thumb approach. "You can design a project using one type of module and calculate its energy yield, and then see instantly it changes when you input another type of module. You can see your optimal design based on different tilt angles. You can see immediately how energy production is impacted, whereas before engineers would have to do long calculations and build in contingencies," Eyzaguirre says.

From wind to solar

Another new player on the scene is the French firm Meteodyn, which having cut its teeth in the wind energy business, has now developed a software simulation tool for solar projects.

Meteodyn develops applied meteorology software and is a leading provider of wind software for resource assessment in complex terrains. The company's PV software offering spans solar resource assessment as well as modelling of utility-scale solar PV power plants.

Similar to other solar PV design tools Meteodyn PV will simulate projects based on geographical position, component-optimising parameters such as azimuth and inclination angles, and distances between arrays. But the software includes some new features, including topographic data the company has accumulated, as well as data based on wind speed at specific sites, to define the temperature of the module, which can affect output, especially in hot climates. Increasingly as developers in markets such as Australia and India, co-locate wind and solar PV generation, Meteodyn offers a compelling one-stop-shop for resource measurement and plant design.

"With the renewable market growing, lots of companies from the wind industry have started to work in solar PV, so it was easy for us to talk to them and share a vision on what they really need in a solar resource assessment software," says Cyrille Vezza, who is in charge of business development for Meteodyn's PV software. The tool will be launched at Intersolar Europe 2017. Its beta users have done some tests and comparisons but the company will not be releasing results for a few months yet, according to Vezza.

Global demand for solar PV continues to grow. But with new regions, more complex terrains and sites, plus intense pressure to deliver projects cost-effectively as incentives are removed, it is no surprise the software design field is drawing more providers to provide developers, banks and other parties with more options than were available even just a few years ago.

What's particularly good news is the number of third-party software programs that are coming onto the market. While SunPower has investigated significant sums in developing its software, it is proprietary. With third-party engineering firms becoming more prevalent in the US market, or where developers retain a core in-house team of engineers, but take to contracting out engineering support needed for large projects, reliance on user-friendly, third-party PV design and modelling software will increase. ■

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Optimising the Gala solar plant through design

SunPower used its combination of surveying and design technologies to good effect in the design of its 56MW Gala project in Oregon, US.

The project site is 480 acres, so it was surveyed in a half day using a drone. SunPower claims to be able to survey an average of 1,000 acres per day, depending variables such as the time of year and site conditions.

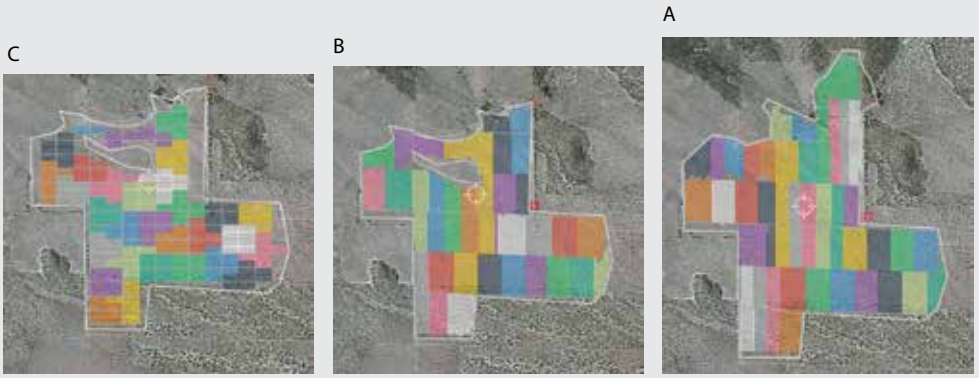
SunPower's proprietary software, GEO, allows users to input their preferred or target site parameters and then choose which unique design iteration is best suited to the specific project. They can adjust site boundaries, site density (GCR), and DC/AC ratio to optimise for specific outcomes such as highest DC capacity, target AC capacity, target year-one energy, highest yield, lowest levelised cost of electricity and highest net present value.

A given project may see anywhere from 10-100 user simulations, each of which results in a unique power plant design. But each power plant design is the result of billions of layout iterations processed by GEO's design algorithms. Depending upon the size of the project, it may take 20-30 minutes to run 10 simulations.

The 480-acre Gala site is oddly shaped and a portion of the site was going to be too steep to build on. With a generic linked tracker and standard efficiency modules (315W), SunPower would have been able to build 50MW (DC) on a reduced land area due to slope tolerance restrictions (image C).

With the new Oasis tracker and P-Series modules (345W), SunPower could build 65MW (DC) on the same reduced land area by taking better advantage of the oddly shaped land with a more configurable tracker and also the higher efficiency modules (image B).

With the new Oasis tracker and P-Series modules (345W), SunPower could build 81MW (DC) by taking advantage of the steeper land areas (image A).



Credit SunPower

SunPower was able to make best use of the 480-acre Gala project site in Oregon using its proprietary design technologies in conjunction with its tracking and module hardware