

Project briefing

MIDDLE EAST'S LARGEST PV PLANT LANDS IN JORDAN

Project name: Shams Ma'an

Location: Ma'an, Jordan

Capacity: 52.35MW

Huge solar parks with world-beating prices are under development in various parts of the Middle East, but no plant on a massive scale had been completed in the region until the last quarter of 2016. Settled in the desert conditions of southern Jordan, the Shams Ma'an solar PV plant was developed and constructed by US-based integrated PV firm First Solar. Standing at 52.35MW (AC), it is not only the largest solar plant in Jordan, but also the entire Middle East, and it will pave the way for future large-scale developments in this part of the world where irradiation is strong and land relatively plentiful compared to other regions.

A ground-breaking ceremony attended by the prime minister of Jordan, Hani Al-Mulki, took place in early October, 14 months after construction began. The plant is owned by a consortium of investors consisting of Diamond Generating Europe, Nebras Power Q.S.C. and the Kawar Group. After divesting its stake, First Solar was appointed the engineering, procurement and construction (EPC) contractor.

Local conditions

Both weather and soiling stations were put out to measure irradiance for as long as possible before getting deep into project development, says Raed Bkayrat, vice president of business development for Saudi Arabia and Middle East at First Solar. The land was not ideal for fixed installations so single-axis trackers were chosen to accommodate the shape of the land.

King Abdullah II bin Al Hussein set his sights on improving the infrastructure of southern Jordan with the creation of the Ma'an development area, an economic development zone that will feature new housing and amenities for locals, facilities for pilgrims on their way to the holy cities of Mecca and Medina, a major new industrial park and finally substantial new

volumes of solar power. Land owned by Ma'an development Authority (MDA) has been shared out between around eight solar developers for phase-one projects.

All the projects are co-located and connected to the same substation around 20 kilometres away; this can handle around 180MW capacity, which is the equivalent of the combined capacity of all the planned solar projects. While the plant that First Solar constructed stands at 52.35MW, others are between 10-20MW in size.

This fact may have provided some valuable lessons to the off-taker, Jordan's main utility National Electric Power Company (NEPCO), which has a signed 20-year power purchase agreement (PPA) for this solar energy. "Doing tendering on project sizes for projects of less than 50MW becomes a headache to the off-taker and the utility," says Bkayrat, "You really lose on economies of scale once you go below the 50MW mark so I think now all the utilities in the region consider 100MW and up in terms of project size."

The point is that engaging just one or two developers would be much more streamlined and efficient, but it is unlikely of course that smaller solar firms would feel the same way. "That's a big lesson learned that the bigger the better," adds Bkayrat. "You have to maximise your value and your benefit from economies of scale otherwise it's very hard to achieve the very low tariffs that we see in Dubai and Abu Dhabi."

"They see more and more solar coming online and the sky is not falling"

The southern part of Jordan is relatively poor so after obtaining the necessary permits with more or less no issues, First Solar assigned a CSR budget to focus on employment, training and job creation. The core team, the subcontract workers and labour, were all Jordanian. Meanwhile, construction workers were almost all locals from the Ma'an province or the Ma'an city.

The social impact of the PV project is one of its outstanding features, says Bkayrat.

That said, First Solar had to manage expectations within the local community over the number of jobs the project would create. There can be a sense in new markets that the solar industry will create thousands of jobs. At the peak of the project's construction, there were 600 workers on site, but with operations and maintenance (O&M) there will be 20-30 long-term jobs.

Access to the site was relatively simple. First Solar's manufacturing is primarily located in Kulim, northern Malaysia. The modules were then taken by ship from Penang, the closest port in Malaysia, and transported on to the port of Aqaba. From this point at the top of the Gulf of Aqaba in the Red Sea, it took only two hours to get to the site using trucks.

Grid connection

To progress with the first plus-50MW solar plant in Jordan, First Solar had to prove its advantages. "We had to convince NEPCO about the friendliness of utility-scale PV plants to the grid," explains Bkayrat. "NEPCO was a bit conservative in their assumptions and in their grid interconnection requirements. They've imposed standards for interconnection that went above and beyond what's customary in the US or Germany and so on. We had to abide by that."

In terms of transmission, First Solar also had to provide three 33kV medium voltage feeders from its plant to the substation, built by NEPCO. "Meeting the expectations; creating an impact for the community – that had to be handled carefully," adds Bkayrat. "Other than that it was smooth sailing in the sense of the execution, the technology and so on. This is all proven."

Explaining how the company went about convincing NEPCO about the plant, Bkayrat says there were a lot of discussions. NEPCO went ahead with revising its grid connection code and a second version was released after it had signed the PPAs, however, these were very conservative in terms of the demands on



By Tom Kenning



compensation and voltage ride through.

"Everybody agrees that it's a bit of an overkill but that's where they stand right now", adds Bkayrat. "I think in the future they see more and more solar coming online and the sky is not falling. I think they will be more inclined to relax some of these requirements a little bit."

Components

First Solar used its 110W Series 4 modules for the entire plant. "Obviously the value of thin-film technology in the desert is well proven from a temperature co-efficient standpoint and from a yield standpoint," says Bkayrat.

The single-axis trackers have an east-west design and each mechanical table of the trackers holds 60 modules: four high, 15 wide. "Each table has an actuator like a piston that moves and rotates it bearing east and west. It's a customary First Solar propriety design for trackers."

The Ma'an region enjoys good Global

Horizontal Irradiance (GHI) and Direct Normal Irradiance (DNI) at the same time, which means trackers are particularly suitable. The output of the plant shoots up from around 10% to its rated output of 52.35MW(ac) at 9am and then flattens out and stays flat as late as 4pm in the afternoon, before dropping again.

"It is quite significant and I haven't seen that before," says Bkayrat. "Literally you get a rectangular output. That is the value of the thin-film with the high DNI and the single-axis tracking."

The plant also uses 800KVa island inverters, switchgears and satcoms from major PV inverter manufacturer ABB.

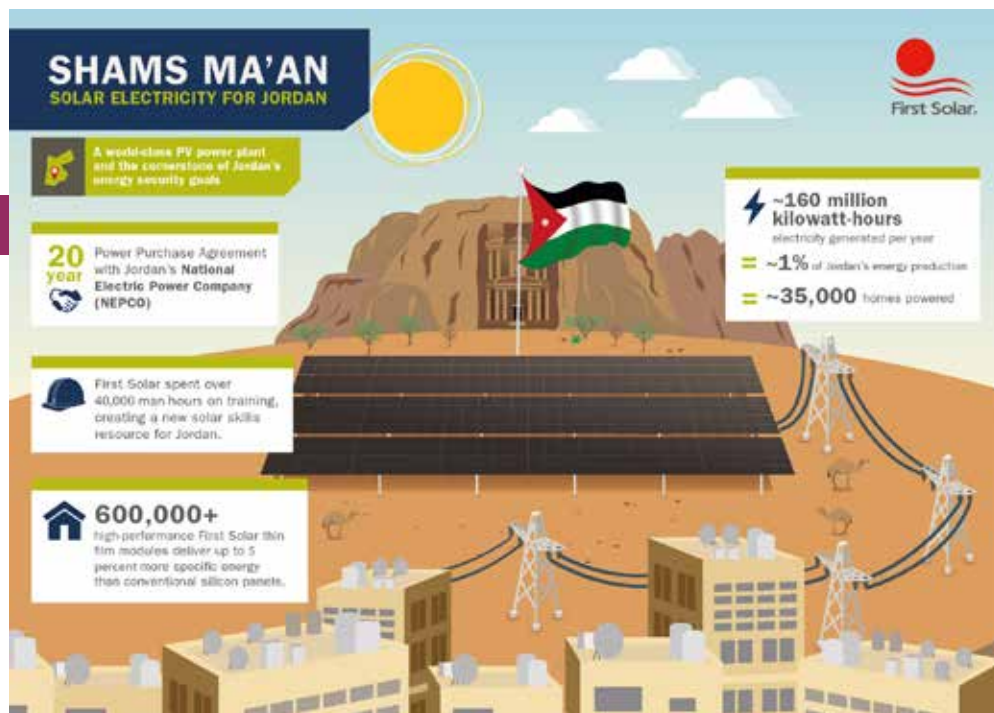
"We are very happy with the execution. The quality is what it needed to be. I think the performance of the plant is already turning heads as it is, and hopefully will continue to do so. We also have the O&M contract for the project so we are looking forward to publishing results at some point once we have enough data

to summarise the performance and the output."

O&M

While not as dusty as a sand dune desert environment, the site still needs regular cleaning. The company opted to use manual dry cleaning techniques without water or robots. It is likely that a group of 10-12 workers will clean in six-hour shifts every night from around 6-7pm. They clean a portion of the plant and within two weeks they can clean the whole plant and start again from the beginning. A special tool for this is still being tweaked. This is a trolley-based brush, which does not have any rotating parts or electric motors. It has stationary brushes and is simply dragged over the surface of the modules, as has been used by First Solar for almost three and a half years on its 13MW Dubai solar plant known as DEWA 13.

Only for a site well above 50MW would



Lessons for the Middle East

Raed Bkayrat, vice president of business development for Saudi Arabia and Middle East at First Solar, explains two lessons from the Shams Ma'an project.

"One learning for the Middle East at large is that utility-scale solar PV power plants can have a positive impact on the grid. Rather than negatively impacting performance such as destabilising the grid, on the contrary, it actually contributes to the stability of the grid. Once the utilities start commissioning and turning on these power plants and they engage them and connect them to their network operation centre, I think that value will be demonstrated.

"A second lesson is that utilities across the Middle East are new to solar and they keep comparing solar with dispatchable power plants. I think now they are beginning to appreciate the value of adding forecasting capability to help integrate solar PV. Even in Jordan, NEPCO is asking for forecasting functionalities out of the developers an hour ahead. They demand a certain level of accuracy, but so far it hasn't been contractual. In time they will realise that this information can help them plan their generation. I was hoping this lesson would be adopted or accepted faster, but I think they are still learning as they go and not using the optimal approach. PV can actually participate in the load generation planning."

the firm consider using robotics for cleaning.

Finance

The project is jointly financed by Mizuho Bank, Japan Bank for International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI) and Standard Chartered Bank (SCB).

"At the time, Shams Ma'an was the largest solar PV project to be financed in the Middle East and the only one to be financed by commercial bank lenders," says David Short, a director at Mizuho Bank. "This is a good example of how project finance can be effective in the region and shows how renewables transactions in the region are viable; and it shows that the economics of it are actually competitive with other forms of power available."

Across the Middle East, the next project to compete in size could come online

mid-2017, a single 200MW plant in the Mohammed bin Rashid Al Maktoum Solar Park in Dubai from developers TSK and Acwa Power, with modules supplied by First Solar. There will also be another 100MW plant in Jordan towards the end of 2017, developed by Spain's TSK and a partner in the UAE.

The government of Jordan recently announced the opening of its third round of competitive bidding for renewables tenders, with a further 200MW of solar on offer for the Ma'an area. The Public Security Directorate (PSD) also announced 60MW of 'autonomous' solar projects for its on-site facilities.

"We have already an extensive experience and local presence in Jordan so we don't mind being involved again, be it as a developer or an EPC or as an O&M provider," says Bkayrat. "I'm pretty sure we will be participating as well."

