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NewEnergyUpdate

Analysis for the renewable energy community

Noor Energy 1: A watershed project for CSP?

Section 1: Financing

This first instalment in this series zooms in on the financing arrangements at Noor Energy 1. The second instalment in this series considers the technological journey to-date at the facility.

Interviewees:

- **Paddy Padmanathan**, CEO and President, **ACWA Power**
- **Jeroen Van Schijndel**, Chief Sales & Marketing Officer, **Rioglass**
- **Svante Bundgaard**, CEO, **Aalborg CSP**
- **Ana Cristina Gonzalez de Una**, Director of Business Development, Energy, **Abengoa**.
- **Xavier Lara**, Independent Senior Consultant, **Empressarios Agrupado**
- **Tom Wray**, Vice President Business Development, **BrightSource Energy**
- **Laura Wolak**, CSP Global Lead, **The Dow Chemical Company**

Executive Summary

The 950MW Noor Energy 1 CSP-PV project currently being constructed under the fourth phase of development at the Mohammed Bin Rashid Al Maktoum Solar Park (MBRAMSP) in Dubai, UAE, has achieved, or is poised to achieve, no less than ten global records for utility-scale solar power before it has even connected to the grid.

Noor Energy 1 Global Records:

- The **tallest CSP solar tower** commissioned to-date standing at 260m
- The **largest capacity integrated solar project** globally at 950MW of CSP+PV
- At a cost of USD4.4 billion (AED 15.78 billion), this is the **largest single-site investment project** for any renewable project (not including hydro projects)
- **World's lowest LCOE tariff received for CSP** at USD7.3 cents/kWh
- **World's lowest LCOE tariff received for PV** at USD2.4 cents/kWh
- **Largest area of land used by a single CSP+PV project** at 44 square kilometres
- **Largest volume of molten salt** used in a single CSP project at 550,000 tons
- **Biggest number of wireless heliostats** deployed in a project at 70,000
- **World's largest parabolic trough aperture** deployed commercially to-date at 8.2 meters
- **First site globally to configure three solar technologies** – PV, parabolic trough and solar power –to deliver power to the grid as a wholly integrated plant or as individual modules dependent upon off-taker requirements.

Bolstering these feats at the facility which spans three identical 200 MW parabolic trough CSP systems, a 100 MW CSP tower plant, 250 MW of PV capacity and 15 hours of molten salt CSP storage capacity, is Sheikh Mohammed bin Rashid al-Maktoum's UAE Energy Plan 2050. Under the Plan, which signifies the country's first unified national energy strategy to extend beyond 2030, $163 billion of investment has been allocated to renewable energy projects up to 2050, with the ambition that 44% of the nation's energy will be generated from renewable sources by then.

Municipal targets for Dubai and Abu Dhabi are already in place, which if met will see a quicker and sharper recourse to renewables than the national targets. Abu Dhabi has a target of generating 7% of electricity from renewables by 2020 while Dubai aims to generate 25% from solar energy specifically by 2030.

In March 2019, the project off-taker and majority stakeholder Dubai Electricity and Water Authority (DEWA) alongside investment partners Saudi Arabia's ACWA Power and Silk Road Fund, announced financial closure of the project.

The project which broke ground in March 2018 is exceeding the original scheduling plan.

"Since the beginning of our partnership with the Dubai Water and Electricity Authority, the Noor Energy 1 project has grown in both scale and in its ability to revolutionise the global energy landscape," said Mohammad Abunayyan, ACWA Power's Chairman. "The successful closure of the project with renowned international players corroborates the potential of Noor Energy 1 and also maintains our reputation as a partner of choice, delivering projects that contribute to the growth and development of vibrant economies such as that of Dubai."

In many ways, Noor Energy 1 symbolises the culmination of a decade of concerted CSP development, housing the world's most advanced CSP technologies, executing innovative business practices, novel financing arrangements and enhanced systems and components.

"From winning the project at the lowest international tariff to the robust capabilities of hybrid Concentrated Solar and Photovoltaic plant, Noor Energy 1 will inevitably see the highest standards of creativity in design, and efficiency in operations," Abunayyan added.

Located approximately 50km south of the city, deep within Dubai's desert interior,this is truly an international effort, attracting industry stalwarts from around the world and enticing new players to the ecosystem. Indeed, the projects lead-EPC, Shanghai Electric Group has no previous experience with CSP projects, although their conventional energy portfolio is vast.

The scale, developments costs, record-low LCOE tariff and record-long PPA of Noor Energy 1 make it an atypical project, but these very characteristics have also intensified the criticality in addressing industry-wide financing, technological and operational pain points. In this sense, the gains made at Noor Energy 1 will be up-for-grabs at successive CSP projects globally regardless of profile.

In this series New Energy Update speaks with project stakeholders at Noor Energy 1 and broader industry experts to examine how the project is providing a platform from which some of CSP's most enduring challenges are being reconciled, game-changing innovations are being unlocked and a new frontier of opportunities are being propagated from to position CSP as a reliable, flexible and investible power generation source ready to meet the complex demand profiles of global cities like Dubai.

Concurrently, we delve into which pain points are likely to remain for the industry and which new challenges have arisen and forced to the foreground by the project.

Finally, the analysis considers what the CSP landscape might look like post-Noor Energy 1 and whether we will look back at it as a watershed project within the industry's development.

Section 1: Financing

High financing costs

CSP technologies have historically incurred high financing costs relative to other power generation technologies of a comparable maturity level, namely wind and PV plants. The unfavourable lending climate derives from the high capital expenditure (CAPEX) costs of CSP plants, high production costs and high-risk profile connected to its limited deployment track-record.

An increase in the proportion of CSP projects integrating cutting-edge thermal energy storage (TES) systems and the scaling-up of solar fields has elevated average installation costs in the MENA region, overriding cost reduction gains realized through advancements in project development learning. The installed costs of CSP projects in the region increased by 12% to reach USD 7 048/kW in 2016-2017 (IRENA, *Renewable Power Generation Costs in 2017, 2018*). Some 0.5 GW of new CSP plants commissioned in 2018, showed installed costs ranging between $3,400/kW and $7,000/kW, depending on project location and storage duration, IRENA said in an updated 2019 report.

The weighted average cost of capital (WACC) or cost of capital accounts for between 45-50% of a parabolic trough project's levelized cost of electricity (LCOE), Xavier Lara, Independent Senior Consultant at engineering group Empressarios Agrupado, told New Energy Update.

The associated costs for the more nascent solar tower technology is even higher. "You probably need to increase the percentage of financial cost in the LCOE breakdown for solar towers by an additional 3.4%," explained Lara. For some solar tower projects, it is conceivable therefore that WACC accounts for over half of the LCOE.

"There is currently a higher financing risk margin for tower plants compared to trough plants. This will fade away as more solar tower projects become operational," Michael Geyer, managing director of Abengoa Solar, told New Energy Update in 2017.

The drive for reducing cost of financing

Reducing the costs of financing across CSP technologies will not only have an immediate and significant impact on the industry's cost-competitiveness against PV and onshore wind, it will also free up developer capital to invest more vigorously in technological innovations and speed up the path to grid-parity.

Now that global average costs of electricity from PV and onshore wind generation fall within the range of fossil-fuelled sources, CSP will need to continue to push the boundaries of cost reduction even in the face of record-project tariff rates being achieved.

If cost-effective and reliable battery energy storage systems (BESS) for PV and wind configurations are realized, CSP's cost profile will become a greater driving force within deployment selection compared to today's situation whereby the dispatchability of CSP-generated power frequently elevates its attractiveness.

According to IRENA, the global weighted average cost of electricity for PV plants in 2017 was c.USD 0.10/kWh and c.USD 0.06/kWh for onshore wind, compared to an average of c.USD 0.22/kWh for CSP (IRENA, 2017).

We know from the tariff levels achieved across auctions since 2016 that CSP costs are falling steeply and are expected to continue to do so. For example, ACWA Power's tariff of USD 73/MWh awarded by the Dubai Electricity and Water Authority (DEWA) in 2017 comes in at under half the USD 163/MWh rate the developer agreed with off-taker MASEN in 2015 at their 150MW Noor III tower plant in Morocco. The average LCOE of new CSP plants fell by 26% in $2018 to $185/MWh as developers implemented the latest technology and installation learnings, IRENA said in a 2019 report .

But the cost of CSP generated power remains higher than average wholesale market prices, and so structural arrangements integrating public policies and financial investments are still required to facilitate rollout.

Mitigating risk perception

To secure the most attractive terms within these arrangements the key is to mitigate risk or risk perception for investors.

Risk perception is embedded within the industry's development trajectory, regularly shaping developer's project plans on the ground or outright preventing build-out.

DEWA's original project tender for the Noor Energy 1 project launched in 2017 called for twin parabolic trough-tower designs, but ACWA Power's winning project included a far larger portion of parabolic trough capacity compared to the tower unit. Representatives from the developer confirmed to the delegation at New Energy Update's CSP Madrid 2018, that the allocation of capacity was driven by investor bankability preference and suitability to the local climate conditions.

The technology distribution helped lower the project's financing costs, Rajit Nanda, Chief Investment Officer at ACWA Power said. "The moment trough was brought in as a larger part of the overall hybrid, it brought about a completely different level of comfort", he explained.

The parabolic section will produce 74% of total power volume, while the tower will produce 14% and the PV component 12%, Nanda said. In terms of revenues, 80% will be generated by the parabolic trough plant, 15% from the tower and 5% from the PV plant, he said.

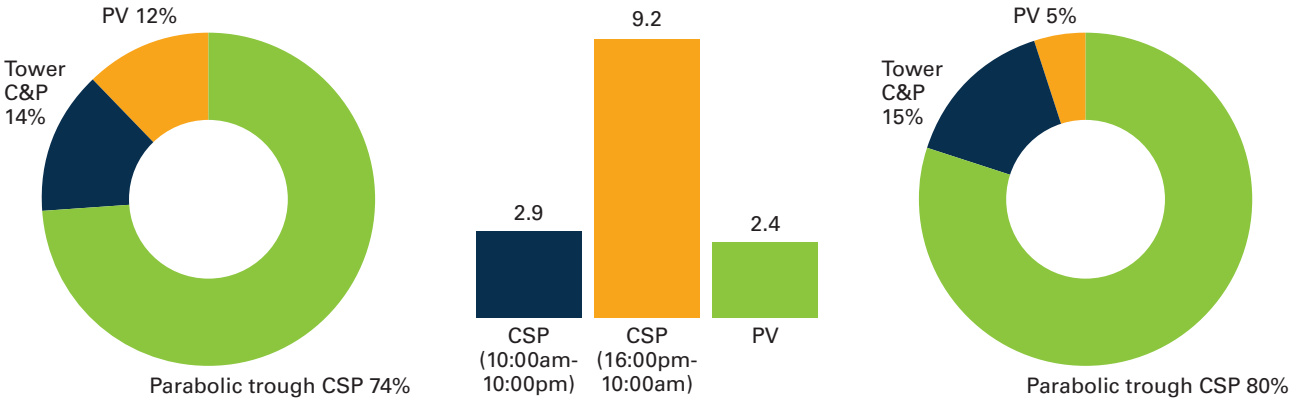
In April 2019, SolarReserve shelved its $650 million 150MW Aurora CSP Project in South Australia after failing to secure financing despite a 20-year PPA with the South Australian government in place and $110 million of taxpayer funding already allocated. The US-based developer is proposing selling the project to a third party who can continue their conception of the project, or an alternative proposal, at the site.

To add to the situation, technical hiccups and structural inefficiencies during earlier waves of projects have fed back into risk perception levels.

"Reliability is a key factor within the financing cost, because more risk perception means higher interest from lenders which in terms inflates the LCOE value," Lara said.

Technical challenges and below par production outputs at the world's first utility-scale tower with molten salt storage facility, SolarReserve's 110MW Crescent Dunes located in the US's Nevada desert, have exacerbated investor concerns.

Most competitive price – USD 7.3 cents/kWh



Source: Shanghai Electric Group

"Up until a few months ago, there was just one utility-scale tower with molten salts receiver technology completed globally, and as everybody is very aware it was not working as expected," Lara continued.

CSP projects undergo a uniquely risky phase during their earliest stage of operations known as the ramp-up period. Lengthy ramping periods and subsequent missed production targets have clouded investor confidence, with some projects taking longer than the factored three or four years to reach full capacity. For example, NRG Energy's 377MW Ivanapah tower facility in California fell short of production targets in the first two-years of operation due to issues with raising the temperature of the water in the boilers each morning and positioning of the heliostats to track the sun.

At Crescent Dunes, there were issues with a leak in the molten salt storage system which forced the plant to shut down for repairs over an eight-month period between October 2016-July 2017, only a year after it connected to the grid. The upshot has been a very long ramping-up period, with figures for 2018 showing an average annual capacity factor of 20.3% compared to its planned 51.9% level (US Energy Information Administration).

Other challenges have included underestimations in the parasitic load and the design of piping in towers, Ranjan Moulik, Global Head of Power and Renewables at investment bank Natixis told New Energy Update.

"None of the CSP projects we've financed have been perfect. There were always bad surprises; these need to be forecasted and mitigated long in advance," Moulik said. "What can be done is to learn from experience and what went wrong in other CSP projects; trying not to repeat the same mistakes. It's the way renewable energy has been since its birth. There's no shortcut. The more you do it, the better you become."

The installed base for tower technology currently stands just north of 1GW, about 16% of total CSP operational power globally, according to New Energy Update's CSP Global Tracker. But the technological landscape is shifting, with China, the world's fastest-growing market, showing a preference for tower projects.

"If we are talking about a trend, most of the projects announced under the Chinese Commercial Demonstration Programme were solar towers not parabolic troughs," said Lara.

On 27 December 2018, the 100MW Shouhang Dunhuang – Phase II tower project with 11 hours molten salt storage connected to the grid, closely followed on 31 December by the 50MW Supcon Delingha tower project with 7 hours of molten salt storage.

Financial close at the delayed 100MW Redstone project in South Africa is likely to be announced soon, Lara revealed.

"I think that Noor III has been the tipping point whereby investors going forward will finance tower projects against the same risk benchmark as parabolic trough projects," concluded Lara.

Financial closure at Noor Energy 1

On March 24, DEWA, ACWA Power and China's Silk Road Fund announced they had reached financial closure on the $4.4 billion project. The project is bolstered by a 70% debt-to-equity ratio with c. $2.9 billion of debt and $1.5 billion of equity.

DEWA is to provide $750 million, half of the project equity. Of the remaining half, ACWA Power will provide 51% and China's government-backed Silk Road Fund 49%.

Interestingly, over 70% of the project debt will come from Chinese banks, with the remainder supplied by international and local lenders. No less than 19 lenders have been publicly linked to the project illustrating the scale and complexities involved in structuring the debt.

Lenders include, the Agricultural Bank of China, Bank of China, China Everbright Bank, China Minsheng Bank, Commercial Bank of Dubai, Commercial Bank International, Industrial and Commercial Bank of China, Natixis, Standard Chartered Bank and Union National Bank, Emirates NBD Bank, First Abu Dhabi Bank and Mashreq Bank.

No public information is available on investment requirements per CSP technology or unit costs, but we do know that an additional $490 million was made available when the project was extended from the 700MW of CSP to include the 250MW of PV, which places the CSP investment at around $3.8 billion or c.86% of the project cost.

The level of debt secured against Noor Energy 1 far surpasses that at the UAE's inaugural utility-scale CSP facility, the 100MW Shams 1, which has a $612 million loan against it. Importantly, the debt-to-equity ratio has improved between the two projects, with Shams 1 operating at an 80% debt-to-equity ratio.

To-date the GCC region has been spurred by lending from local banks, but Noor Energy 1 has seen the successful pooling of international financiers alongside domestic stakeholders, a pattern which is expected to be replicated across the region as project scale increases and investment levels rise.

"Currently, DEWA has over 4,000MW of IPP projects underway, in partnership with the private sector at a total investment of AED30 billion. This model has attracted external investments totalling AED 26 billion, enabling us to invest our own funds on other infrastructure projects," HE Saeed Mohammed Al Tayer, MD & CEO of DEWA said at the press conference marking the project's financial closure.

For example, Phase II of the Mohammed bin Rashid Al Maktoum Solar PV required financing of about USD 300 million, which was delivered by a consortium of local banks. Phase III of 800 MW PV and Phase IV of 950 MW CSP and PV, and 1 177 MW Noor Abu Dhabi PV are much larger projects (USD 940 million, USD 4 360 million and USD 870 million, respectively) requiring syndicates consisting of local and foreign banks, often with the significant contributions of lenders from developers' home countries (Apostoleris et al., 2018).

The presence of local banks provides international investors with a level of comfort and reassurance, with experts calling for this approach to be replicated across the region where local financiers have previously been absent (particularly in the broader MENA region outside the GCC) and in slower to emerge markets like Saudi Arabia.

"Given the magnitude of financing that was required for this mammoth project, there is absolutely no way we could have achieved anything without Chinese financing involvement as they are the only banks in the world today who can make available this level of liquidity for the tenors needed," Paddy Padmanathan, CEO and President at ACWA Power told NEU.

Chinese financing will likely be a required feature at CSP projects of this scale going forward, Padmanathan projects.

"CSP by definition with storage is many times more capital intensive on a kw basis compared to PV and wind, and is not far behind nuclear power plant cost and as such will need significant capital in each instance of deployment at scale and thus Chinese sources will remain the key to getting these projects deployed."

Breaking down cost barriers

"The project is an iconic project. The new cost barrier broken by the ACWA Power proposal renders the technology competitive with conventional generation, if the full value of the plant is taken into account," Gilein Steensma, Regional Director EMEA – New Energy at Advisian (WorleyParsons Group), the appointed Owner's Engineer at the project told NEU in 2018.

Indeed, if the plant perform as the bids promise and these levels can be realized at future projects, Noor Energy 1 could mark a turning point for CSP.

ACWA Power confirmed that at this tariff CSP generation is cheaper than what DEWA can buy natural gas for. "At least in fuel importing countries, the price at which this energy is being sold is able to compete on a like for like basis with combined cycle gas power generation," Padmanathan said.

But how is Noor Energy 1 able to achieve such a significantly low LCOE, particularly given the location's less than optimum DNI level?

As examined in Section 2, technological innovations, business practice optimizations and scaling gains will feed into the PPA rate at Noor Energy 1, but recent modelling has shown that these factors alone would not get anywhere close to the level achieved.

Johan Lilliestam and Robert Pitz-Paal's examination of how Noor Energy 1 and the now-shelved Aurora project in Australia might have realized their record-low tariffs, surmises that progressive financing structures and favourable lending conditions are the driving forces here.

"In sum, we find that DEWA IV has low technology cost, compensating for the comparatively weak solar resource. We believe that there are two additional reasons that enable the low PPA of the DEWA IV project: an extraordinarily long PPA duration of 35 years, and very good financing conditions and production guarantee conditions," (Lilliestam and Pitz-Paal, "Concentrating solar power for less than USD 0.07 per kWh: finally the breakthrough?", Renewable Energy Focus, September 2018).

NEU contends that sharper financing structuring and reduced interest repayments in the project's early years which have been harnessed and/or aggressively sought out by the project partners should be added to the drivers behind the record-low LCOE tariff.

A favourable financing climate

While feed-in-tariffs have historically been the main policy tool to promote CSP, policy makers are now slowly shifting to competitive tenders or reverse auctioning, with the expectation that these instruments will more effectively drive down costs.

Auctions have underpinned renewables rollout within the MENA region, creating competition which allows falling technology costs to be more fully reflected in bid prices (IRENA, 2017). The mechanism attracts companies with established project track records, healthy balance sheets and the resources required to drive mega-scale projects forward. Prequalification rounds ensure that only companies with the aforementioned facets progress to the final bidding stage, and these types of companies typically pose minimal risk in terms of mobilizing finance.

GCC countries are cultivating development climates akin to what we have seen in Morocco, whereby a "plug and play" framework has shifted much of the financial and development risks to a government-supported private organization. In the case of Morocco, the Moroccan Agency for Sustainable Energy (MASEN) acts as an off-taker selling the power on to the Moroccan state, whilst providing lending resources and minority shareholder equity to the projects.

DEWA have adopted a similar position at Noor Energy 1. The project's financiers have no doubt been reassured by the 51% majority ownership stake that off-taker DEWA has in the project. This translates into reduced risk perception and thus cost of financing rates as on-time repayments are guaranteed by the public entity.

In addition, as has been the case in Morocco, renewable projects in Saudi Arabian and UAE auctions have seen the respective government assume risks and costs associated with pre-qualification requirements including obtaining environmental licenses, resource assessments, grid-access permits and land acquisition.

In order to avoid underbidding resulting from reverse auctions and ultimate project shelving from parties who cannot honour the winning tariff rate, stringent technical and financial expectations bidders must meet to qualify are put in place.

Large-scale solar projects in the GCC region enjoy some of the most favourable lending conditions globally. Interest rates for these projects have been in a competitive range of 120 to 200 basis points above Libor, while loan tenors are often over 20 years (IRENA, Renewable Energy Analysis: GCC 2019). This is combining with historically low global interest rates to generate an optimum financing climate and low-risk profile.

These conditions have cultivated the new frontier of project costs seen at recent CSP facilities, of which Noor Energy 1 has been the epitome of to-date.

“The Moroccan, UAE and South African projects have been instrumental in progressively reducing the tariffs and increasing the likelihood of a meaningful role for CSP in the future energy mix,” Padmanathan said. “It was the Noor I project that resuscitated the CSP technology and brought it back from the oblivion state it was headed towards at the insupportably high tariffs of the past. The steady stream of projects, albeit only one or two at a time and thus not enough to attract as much innovation and competitive tension as is needed, have nevertheless attracted enough to keep reducing tariff.”

The PPA effect

Financial investors always scrutinize the PPA stipulations to determine a project’s risk profile. They look at who the agreement has been signed with, risk appropriation in the event of transmission constraints, whether there is an out clause, a force majeure, essentially anything which could prevent them getting their money back.

In 2017, the ACWA Power and Shanghai Electric consortium forged an innovative PPA structure which saw the world’s first 35-year CSP PPA. Until this sign-off, the average length of PPAs for active CSP projects had been 23.8 years, with 25-year terms representing the upper echelon (New Energy Update Global CSP Tracker, 2019).

The PPA signed with off-taker Dubai Electricity & Water Authority (DEWA) at Noor Energy 1 pertains to power generated between 4 pm – 10 am, which means an additional revenue stream could be open to the developers via the sale of daytime generation on the wholesale electricity market if the technological capabilities of the plant permit.

The duration of the PPA has fed into ACWA Power’s ability to offer their record-low levelized tariff and provided a more attractive financing proposition for the project’s partners.

“On the back of the longer tenor of PPA we were able to attract a longer than otherwise tenor of debt which of course positively impacted on tariff,” Padmanathan confirmed.

A 2018 study by Johan Lilliestam, Professor of Renewable Energy Policy at ETH Zurich and Robert Pitz-Paal, Co-Director of the Institute of Solar Research at the German Aerospace Centre (DLR), has calculated the likely correlation between PPA length and LCOE reduction at the project.

“With a more standard 20-year PPA, the LCOE would be USD O.106 per kWh, which is about the same as declared by many Chinese stations under construction. The long PPA duration thus directly reduces the LCOE by some 2 cents per kWh.” (Lilliestam and Pitz-Paal, “Concentrating solar power for less than USD 0.07 per kWh: finally the breakthrough?”, Renewable Energy Focus, September 2018).

The structuring of the contract will enable the project’s equity partners DEWA, ACWA Power and China’s Silk Road Fund who are fronting $1.5 billion, to absorb the initial permitting and development costs over a longer period concurrent to generating revenues.

For the debtors set to lend $2.9 billion the extended contract helps to de-risk the project by providing a long-term financing perspective, something fossil fuel-based power has not been able to offer because of the pricing volatility experienced in the past five-years.

Speaking to New Energy Update in 2018, Abengoa's VP of Business Development Michael Geyer explained how the 35-year PPA is one of the most critical levers for cost reduction as it "reduces the annual cost of paying back the initial investment."

Another takeaway for financiers coming out of the project should be reassurances over CSP plants' operational lifespans, which far surpass the PPA durations we have seen typically envelop projects to-date.

"The lifespan of the plant has been predicated on the experience seen at the Solar Energy Generating Systems plants in California, the oldest of which was built in 1984, Geyer said.

Making sure future project PPAs are more aligned with operational lifecycles, as has been the case at Noor Energy 1, presents a mechanism for unlocking better energy prices for end-users, Jeroen Van Schijndel, Chief Sales & Marketing Officer at Rioglass, explained.

"I remember a comment from an operations manager at a plant in Spain who said that when the 20-year PPA period - which they were limited to back then in the Spanish program - has ended, I know that I maybe have to reinvest something like 3% of my components and overall CAPEX but then I will be able to operate the plant for another 20 years."

"The point is that this clearly demonstrates the lifetime capabilities of these plants and how failing to tie financial arrangements accordingly prevents CSP from getting the best prices for energy customers."

But 35-years is still a conservative duration based upon operational potential, ACWA Power explained.

"A CSP plant with storage is essentially a combination of a chemical and steam power plant. Just as steam turbines, chemical plant vessels have a technical life of 50+ years, CSP also has a technical life well in excess of the term of this PPA even though here it is a 35-year PPA," said Padmanathan.

Financing structures at Noor Energy 1

The WACC at Noor Energy 1 has not been disclosed, but Padmanathan revealed that the "WACC is no different to that for a PV or a wind or a combined cycle gas fired power plant if it were to be developed in the same country for the same off-taker on the same terms and conditions."

Claims have circulated that ACWA Power is able to access cheaper capital than competitors from Saudi state money and similarly EPC SECG is a recipient of preferential financial conditions from the Chinese state. These claims are unsubstantiated but what is clear is that project partners were for the first time able to access fully private lending for tower technology without premium.

"This project changes the landscape of financing CSP technology in that the debt tranche of the total investment cost is structured on a conventional limited recourse project finance basis from entirely commercial financing sources for the first time for a CSP plant with tower technology." Padmanathan explained. "Equally importantly, the leverage, terms and conditions of financing and the risk margin pricing are all on a normal reasonable basis."

The developer's project development portfolio and reliability achievements strengthened financier confidence, bringing down the cost of financing at the facility and likely to benefit all CSP projects going forward.

"With an impeccable track record of having brought online four very significant CSP projects without any significant ramp up issues, we were able to confidently convince our project partners (co-investors and Lenders) with our experience," Padmanathan said. "This in turn secured a favourably risk premium at Noor Energy 1 and

will continue to positively influence risk premiums on future CSP projects all which will continue to help reduce tariff further."

Noor Energy 1 has incorporated an innovative loan mechanism in the form of a soft mini-perm loan which we have also seen rolled out at Phase III of the MBRAMSP (800MW PV project) and the Noor Abu Dhabi 1177MW PV project.

Soft mini-perm loans are long-term loans with an escalating interest rate built in and activated after a stipulated period. For borrowers this means a reduction in interest rate payments during the early years of investment, freeing up liquidity and translating into lower tariff bids. For lenders, the project's risk profile is altered, with the borrowing party assuming the refinancing risk.

With developers motivated to refinance, it is expected that a dynamic refinancing segment will emerge, spurring commercial banks enthusiasm for solar projects by essentially shifting away from these projects being long-term illiquid products. In turn, the ability for banks to lend more should increase and the terms of lending becoming more favourable.

The legacy of Noor Energy 1 and next steps

Noor Energy 1 is set to be a gamechanger because of both the nature of the financial arrangement in which multiple and diverse lenders have successfully been syndicated to facilitate the build-out of the project and the sheer scale of investment required to get it off the ground.

That message is certain to reverberate across investment institutions globally.

Indeed, financing success is deemed to be far more conducive to the future deployment of CSP than any technical innovation unlocked at the project. The sentiment from stakeholders, including technology contractors themselves, is that the units at Noor Energy 1 are based upon proven, commercialised technologies. While there are technological optimizations, practice improvements here and there, these are outstripped by what has been achieved in the financing arrangement.

"What is different here is how the project has been financed, that is where the big difference is," Van Schijndel said.

"This is a huge step for financing. This has always been one of the big restrictions blocking CSP from further growth simply because we are talking about installations that do not compete with PV. So, the project signals a broader discussion between the CSP industry and the financing world to prove that CSP is able to compete."

A recent study from IRENA projects that we are likely to see CSP projects rollout off the back of the success at the region's UAE hub. "Although the bulk of investments to date are concentrated in the UAE, as deployment picks up, investment flows will likely be distributed more evenly among the countries in the region," (IRENA, 2019).

To optimize regional deployment in the face of increasingly costly projects, IRENA advocates the development of innovative loan structures, including the replication of soft mini-perm loans like we have seen at Noor Energy 1. Developers should also consider the utilization of green bonds to access long-term non-bank capital, potentially at a lower cost. "In the GCC region, the green bonds market is in the beginning stages, but has already seen a large green bond issuance. The [First Abu Dhabi Bank] has issued the first green bond in the Middle East valued at $587 million in 2017," IRENA said.

ACWA Power agrees that financing breakthroughs will translate into optimized rollout via the achievement of lower costs of generating energy.

"Bringing down the cost by reducing financing cost will substantially help," said Padmanathan. "The mechanisms and instruments we need here are no different to what infrastructure financing in general is in

desperate need of. Access to broader sources and wider pool of liquidity and more certainty around the availability of such liquidity. For example, increased levels of confidence in access to bond financing once a project is generating a steady revenue stream will enable projects to get built using only construction financing or mini perm structures which will result in not only lowering WACC but also in accessing an even wider pool of liquidity. Structures such a bridge to Bond, revenue securitization and equity bridges will all help to reduce the total funding cost which in turn will reduce the cost of energy produced."

The achievements at Noor Energy 1 are all the more impressive given the relatively poor solar resource levels in Dubai. That opens up new development prospects in locations where CSP has previously been deemed an incompatible technology. Moreover, it poses exciting possibilities about just how low tariffs can go in markets with significantly superior DNI levels.

"Other countries, like Chile or South Africa, have up to 40% higher insolation, which could allow for even lower PPAs, if the financial risk can be handled to give good conditions," Lilliestam and Pitz-Paal noted.

"How far exactly the costs will decrease is difficult to establish, but ACWA Power already foresees another drop from the $7.3c/kWh at Noor Energy 1," Steensma said in 2018.