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NOOR OUARZAZATE I

Concentrated Solar Power Plant

March 2018

Noor Ouarzazate I, a 160 MW Concentrated Solar Power (CSP) plant, is a path-breaking large-scale CSP project, one of the first to be delivered in the Middle East and North Africa (MENA) region, taking advantage of the region's abundant solar resources.

PROJECT OVERVIEW

Noor Ouarzazate I is the first phase of a CSP complex exceeding 500 MW, also known as NOORo ("Noor" is Arabic for "light", the "o" stands for Ouarzazate).

The CSP facility is located 10km outside the town of Ouarzazate in Morocco and approximately 200km south of Marrakech. Ouarzazate was chosen as the location of the solar complex because of the city's excellent solar resources, the availability of water for cooling, its accessibility for heavy equipment, and the proximity to the power grid.

Noor Ouarzazate I was structured as a public-private partnership (PPP) on a Build, Own, Operate and Transfer (BOOT) basis, with the ACWA Power consortium announced as preferred proponent in September 2012. The PPP was supported by a Power Purchase Agreement (PPA) and a Power Sales Agreement (PSA), plus a significant amount of concessional finance provided by the Clean Technology Fund (CTF) and several International Financial Institutions (IFIs). The project would not have been a viable investment prospect without this concessional finance and the support of the Government of Morocco.

The PPA is a 25-year fixed term, fixed tariff agreement between the ACWA Power consortium and the Moroccan Agency for Sustainable Energy (MASEN). The tariff in this PPA was determined by the bidding process – i.e. the ACWA Power consortium was the bidder that proposed the lowest tariff. MASEN has also entered into a separate PSA with ONEE[1], the Office National de l'Electricité et de l'Eau Potable (National Office for Electricity and Potable Water), in which ONEE will buy all power from MASEN at a tariff approximately matching the grid price, and dispatch it from the plant. The difference between the tariff in the PPA and the price in the PSA will be covered by subsidies from the Government of Morocco and an operational support loan from the World Bank (via the International Bank for Reconstruction and Development (IBRD)).

The ACWA Power consortium is responsible for project implementation, including design, construction, and performance optimisation of the plant. The construction period was 30 months (including a test period), with 25 years of operation. The project uses parabolic trough CSP technology, the most widely deployed CSP technology, and the plant has capacity of 160MW, with three hours of thermal energy storage capacity to supply electricity at night or during peak demand. The plant commenced power production in December 2015 and the project was inaugurated by the King of Morocco in February 2016.

[1] *ONE, the Office National de l'Electricité, and ONEP, the Office National de l'Eau Potable, merged to become ONEE, Office National de l'Electricité et de l'Eau Potable (National Office of Electricity and Potable Water), in April 2012.*

PROJECT HIGHLIGHTS

The Government of Morocco is an early mover in implementing CSP technology on a large scale, and the project could have significant implications for the development of the technology, and the renewable energy mix, in the MENA region. Some of the project highlights are:

- Once completed, the 580MW NOORo complex, which includes Noor Ouarzazate I, will be one of the largest single solar complexes in the world.
- The scale of the project was able to trigger significant cost reductions through economies of scale, and close the competitiveness gap between CSP technology and other renewables.
- At USD 0.18 (equivalent to 1.62 MAD), the tariff offered by the winning bidder was the lowest ascribed at the time for CSP technology, and amongst the lowest tariffs for thermal solar power projects worldwide, due in large part to the innovative structuring of the project and the concessional finance provided.
- New technology risk was limited by the sponsors, who were asked to provide completion support through a complex and comprehensive risk mitigation scheme, to sufficiently de-risk the project in order to secure financing and project completion.
- The project had full support from the Government of Morocco and multiple IFIs to shift some risk away from the private developer and ensure funding sustainability during both the construction and operational stage.
- The creation of MASEN (and its unique and multiple roles in the project) demonstrates the Government of Morocco's complete political backing and its ability to protect the project company from conflicts of interest.
- The NOORo complex is expected to build up a local CSP supply industry, stimulate local economic development, and create thousands of job and training opportunities.
- Renewables, including CSP, are seen as an opportunity to reduce dependence on imports whilst also cutting greenhouse gas emissions, with the potential for future green electricity exports to Europe.
- The Noor Ouarzazate I plant is expected to avoid approximately 280,000 tonnes of CO^2 emissions per year on average.

THE MOROCCAN SOLAR PLAN

Morocco's energy needs far exceed its oil and gas production. In recent years, Morocco has imported 95% of its energy as fossil fuels, providing subsidies on these fuels at a cost in the range of USD 1-4 billion per year. Its demand for primary energy continues to grow, increasing by an average of at least 7.2% between 2002 and 2012. To meet economic growth and industrial development, this demand is expected to triple by 2030 and electricity consumption is expected to quadruple.

The Moroccan Solar Plan (MSP), launched in 2009, has a total estimated initial investment cost of USD 9 billion, and hopes to achieve emission reductions of 3.7 million tonnes of CO^2 per year. The Government of Morocco has set a goal of reaching 42% of installed capacity (equivalent to 6000 MW) from renewable energy by 2020, and a goal of reaching 52% of installed capacity from renewable energy by 2030. In 2016, Morocco reached 34% of the targeted installed capacity of renewable energy. To assist in reaching these targets, the Government of Morocco promulgated a law establishing MASEN in March 2010.

The MSP aims to take advantage of the region's abundant solar resources[2] and install a minimum of 2000 MW of solar capacity by 2020, contributing to approximately 14% of the energy mix in Morocco's electricity supply.

Further phases of the NOORo solar complex are under construction with commissioning expected in 2018. These include:

1) Two solar CSP plants:
   Noor Ouarzazate II with 200 MW capacity; and
   Noor Ouarzazate III with 150 MW capacity.
2) One solar PV plant (part of the NOOR PVI program):
   Noor Ouarzazate IV with 72 MW capacity.

[2] *Solar radiation intensity in Morocco is extraordinarily high, reaching more than 2500 kWh per m² per year.*

One of the key challenges of the Noor Ouarzazate I project was to reduce the gap between the tariff paid under the PPA and the tariff paid under the PSA, to the greatest extent possible. To that end, MASEN sought to optimise every aspect of the project. MASEN streamlined the overall procurement process and clearly defined the risk allocation reflected in the contractual documents, in addition to de-risking the project profile and hence reducing the risk premium embedded in the tariff. This gap is expected to continue to decrease in future projects under the MSP, as is already the case with the Noor Ouarzazate II and Noor Ouarzazate III projects.

It should also be noted that Noor Ouarzazate I and the other projects of the MSP are expected to create significant local and national industrial benefits. Noor Ouarzazate I, combined with its second and third phases, is expected to contribute substantially to local economic development by building up the local supply industries, and through the creation of jobs in construction, manufacturing, and operations and maintenance. For each project under the MSP, MASEN will encourage the use of local staff and materials, and is aiming for a minimum of 30% of the plant capital costs to include local content, in order to help stimulate the private sector and create jobs. The final decision to include local content in the NOORo projects was entirely voluntary and based on the selected bidder's proposal, at their full discretion.

PROJECT TIMELINE

Key dates in the Noor Ouarzazate I procurement timeline are shown below:

March 2010
Request for Expressions of Interest (EOIs) launched by MASEN

May 2011
Request for Proposals (RFPs) launched

August 2011
RFPs amended (further RFP amendment in February 2012).

September 2012
MASEN announces ACWA Power consortium as preferred bidder

November 2012
MASEN and ACWA Power consortium sign a PPA for the sale of the net electricity output of the Noor Ouarzazate I CSP IPP. MASEN and ONEE sign a PSA for the sale and dispatch of the power the same day.

April 2013
Engineering Procurement and Construction (EPC) contract awarded to Acciona Energy, SENER Ingeniería y Construcción (SENER) and TSK Energía y Plantas Industriales.

June 2013
Financial close

June 2013
Construction begins

March 2014
First parabolic mirrors installed on the solar field

December 2015
Commercial operations of Noor Ouarzazate I commence

CONTRACTUAL STRUCTURE

The diagram below illustrates the main contractual components of the project.

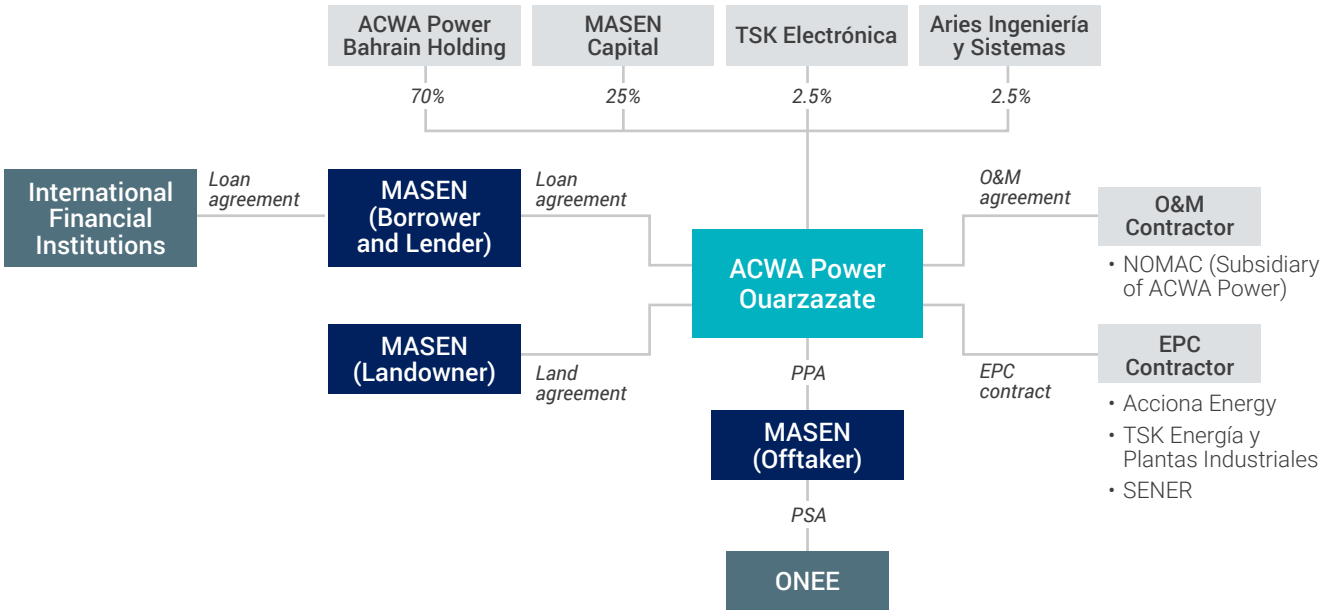

Diagram acknowledgement: Norton Rose Fulbright

FINANCING AND FUNDING

The sources of financing and funding were both critical to the viability of the project.

The total investment cost of the project was USD 846 million, which was financed through a combination of debt (80%) and equity (20%). MASEN also received grants from the European Commission (via the Neighbourhood Investment Facility) and Kreditanstalt für Wiederaufbau (KfW) to finance its equity stake in the project.

After the ACWA Power consortium was selected as the winning bidder, the final bid on project costs was 25% lower than the initial projections[3]. The final bid also revealed that less equity and debt were required to finance the project than had been anticipated, due to the risk mitigation scheme which includes: completion guarantees by the sponsor/EPC contractor, an equity sell-back option for MASEN, and an optimum risk allocation between public and private sectors, where the public sector assumes political, financial and commercial risks, while the private sector assumes construction and performance risks.

The debt portion of the financing was provided by Bilateral Development Financing Agencies (DFIs) and International Financial Institutions (IFIs). The DFIs and IFIs provided almost USD 670 million in debt financing to MASEN, with tenors ranging from 15 to 40 years, as well as necessary institutional and specialised technical support and some non-repayable grants. MASEN, in turn, on-lent the DFI/IFI loans through a facility agreement to the project company, with a tenor reflecting a blend of the terms and conditions of the DFI/IFI loans.

The European Investment Bank (EIB), African Development Bank (AfDB), Agence Française de Développement (AFD), KfW (on behalf of BMZ, the German Federal Ministry for Economic Cooperation and Development), and the Clean Technology Fund (via the AfDB and IBRD) provided loans to MASEN to finance the debt of the project.

Equity was provided on a pro rata basis by the winning bidder, the ACWA Power consortium, consisting of ACWA Power Bahrain Holding (70%), MASEN Capital (25%), TSK Electrónica Spain (2.5%) and Aries Ingeniería y Sistemas (2.5%).

[3] *This is due to the winning bidder's higher production estimates, lower capital costs and the bidder's early mover strategic behaviour (See Climate Policy Initiative "San Giorgio Group Case Study: Ouarzazate I CSP Update", Frisari and Falconer, May 2013).*

The financing sources for the project, including the debt financing, equity contributions and grants, are listed below.

FINANCE SOURCES	AMOUNT (USD MILLION)
Debt Financing	
European Investment Bank (EIB)	103
African Development Bank (AfDB)	133
Agence Française de Développement (AFD)	103
Kreditanstalt für Wiederaufbau (KfW) (on behalf of BMZ)	133
Clean Technology Fund (via AfDB)	100
Clean Technology Fund (via IBRD)	97
Total Debt Financing	**669**
Total Equity	**117**
Grants	
European Commission (via Neighbourhood Investment Facility)	40
KfW (on behalf of BMUB, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)	20
Total Grants	**60**
Total Financing	**846**

The primary source of funding for the project is the guaranteed tariff revenue stream provided to the ACWA Power consortium under its PPA with MASEN. The price subsidy from the Government of Morocco's State budget, and the World Bank (IBRD) low-interest rate loan designated as the Solar Incremental Cost Support (SICS), will be used to fund the viability gap i.e. the price differential between (i) the tariff that MASEN will pay to the project company, and (ii) the amounts that MASEN will receive from ONEE as the final off-taker. The difference in price is largely due to the amortisation of the high capital costs of CSP technology.

The funding subsidy sources for the project are listed below.

FUNDING SOURCES	AMOUNT (USD MILLION)
World Bank (IBRD) Low-Interest Rate Loan (SICS)[4]	**Up to 300**

The SICS loan will cover the additional generation cost of CSP when the Government of Morocco decides to resort to this financing instead of the State budget. The subsidies from the Government of Morocco will cover the expected 25-year lifetime of the project.

[4] The loan amount of USD 300 million will provide subsidy support for the entire NOORo Complex (encompassing Ouarzazate I, II and III projects).

CSP TECHNOLOGY

CSP technology is still not yet competitive with conventional generation alternatives, given its relatively high capital costs. Although it has the potential to become competitive in the short- to medium-term, it is currently more expensive than fossil fuel-based energy generation (even if fossil fuel subsidies are removed). At the time Noor Ouarzazate I was under procurement, the gap between CSP and less expensive carbon-intensive energy alternatives was particularly evident in markets, such as Morocco, where large fossil fuel subsidies heavily distort domestic energy prices. Thus, this project required a unique blend of public subsidy and risk mitigation instruments to attract private investors.

The project uses parabolic trough CSP technology, the most widely deployed CSP technology. Technology risks are lower than those for central tower CSP, while the latter has a larger thermal efficiency and potential for cost reductions. At the time MASEN made the decision to employ parabolic trough CSP technology, central tower CSP costs were higher than those of parabolic trough CSP. Photovoltaic (PV) technology was not considered adequate given the need for the project to cover the evening demand peak using storage technologies.

Parabolic trough technology involves the following elements:

1. Rows of parabolic trough mirrors concentrate direct solar radiation onto a steel pipeline that contains a heat transfer fluid (HTF). The mirrors are moveable to be able to automatically track the sun throughout the day;
2. The HTF is pumped to large solar collector fields where it is heated before passing to a steam generator, where it transfers its heat to vaporise water;
3. The steam produced is then used to drive a conventional steam turbine that in turn drives the energy-generating turbines;
4. The electricity is delivered to a transformer to be injected into the distribution grid.

The technology also has a three-hour molten salt thermal energy storage capacity, allowing it to operate at full capacity for three hours without sunlight (after sunset or during cloudy weather), and to supply electricity to the grid at night or during peak demand. Thus, the facility will help cover the demand for electricity at peak hours that occur in Morocco between 5pm and 10.30pm in winter, and 6pm and 11.30pm in summer.

GOVERNMENT SUPPORT

Along with the Government of Morocco's commitment to fund the substantial viability gap of the project, it also established a favourable regulatory and renewable policy framework to encourage private-sector engagement, in line with its clear and ambitious development targets for renewable energy sources.

The Government of Morocco established MASEN, the Moroccan Agency for Sustainable Energy, in 2010, with a mission to promote the widespread adoption of solar, wind and hydro resources. Through integrated and well-structured projects, MASEN aims to:

i) endow the country with a competitive industrial network to create added-value and employment;

ii) develop R&D capabilities to serve industrial companies;

iii) promote specialised training; and

iv) contribute to local development around the projects.

MASEN is a limited liability company, which is publicly-owned but governed by private law. It is owned by the Government of Morocco, ONEE, the Hassan II Fund for Economic and Social Development, and the Société d'Investissements Énergétiques (SIE), each with 25% stakes. MASEN is responsible for the feasibility assessment, design, development, and financing of solar projects in Morocco on a case-by-case basis, along with contributing to expertise and research in the solar industry.

In this project, MASEN plays the role of offtaker in the PPA, and of seller of the electricity generated in the PSA. The agreement between the Government and MASEN provides certainty that the viability gap will be covered, and the agreement between MASEN and ONEE guarantees connection to the grid and full dispatch of electricity. MASEN is also an equity partner in the project company along with the winning bidders, which is governed by a shareholder agreement. This includes a 'put option', allowing MASEN to sell back its share if the private partner defaults on specified construction or performance obligations. MASEN also acts as sole lender, mobilizing concessional financing provided by AFD, KfW, the Clean Technology Fund, the AfDB and the EIB, repackaging it and on-lending it through a single line of credit to the project company. During the construction phase, MASEN provided finance and managed the associated facilities (for water supply, grid connections and land). At the end of the PPA, MASEN will obtain full ownership of the CSP plant.

The following chart shows the multiple roles played by MASEN in the Noor Ouarzazate I project

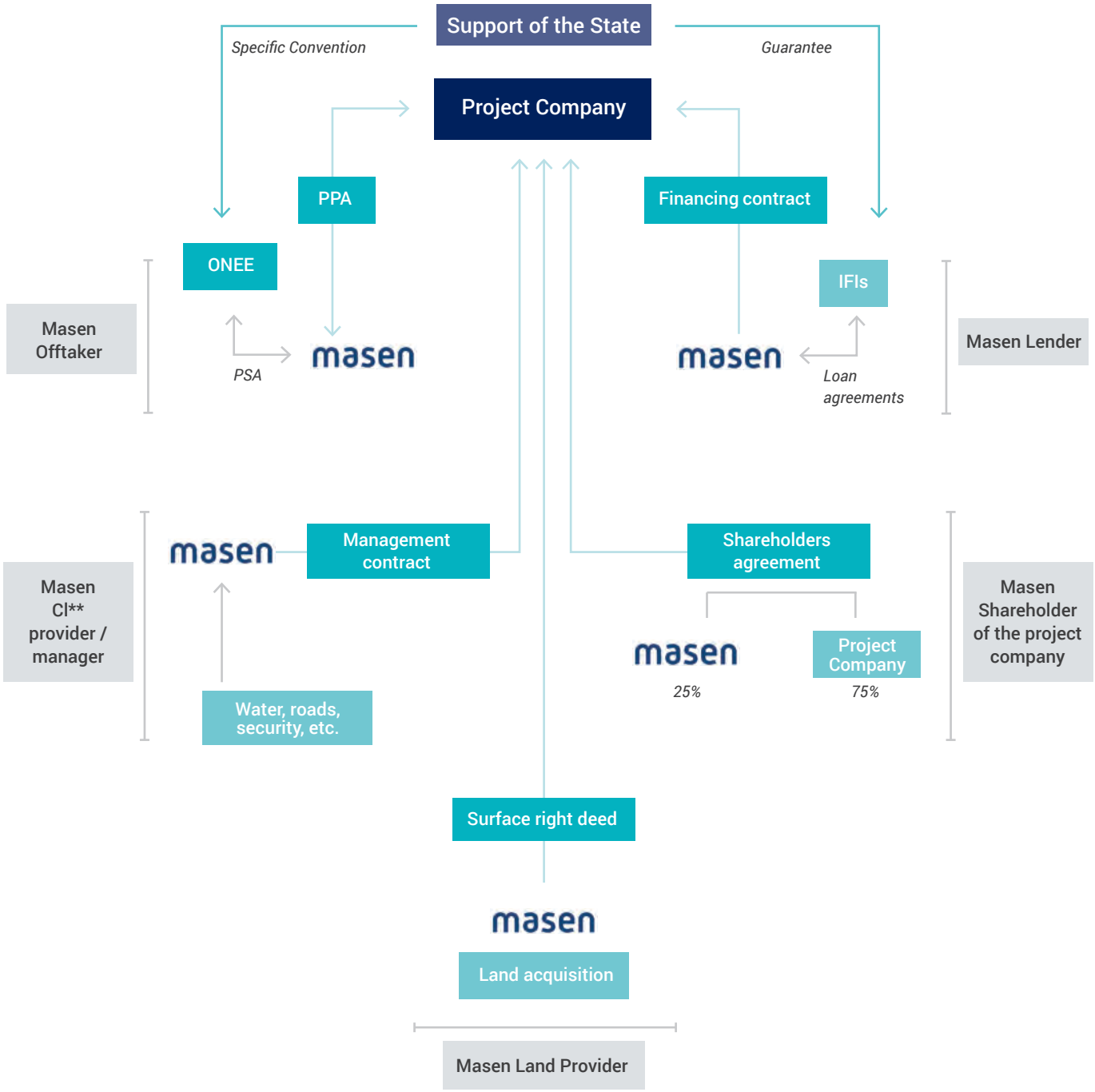

Diagram courtesy of MASEN

RISK ALLOCATION

Government of Morocco	• Electricity market risk, caused by low fossil-fuel prices driving wholesale electricity prices below the benchmark set in the PPA between MASEN and ONEE. • Budget shortfall risk, resulting in the Government being unable to provide the solar subsidy. The ability of the Government to provide the necessary subsidies depends on the value of the fossil-fuel subsidies displaced by the power that the CSP project generates, and has a significant impact on the government budget. • Reputational risk, if the Government is no longer able to fund the viability gap, forcing MASEN to default on the PPA commitment. • Storage technology failure risk, which would undermine the achievement of fossil-fuel subsidy savings. • Indirect risk of reduced solar irradiation levels, which would impact the amount of fossil fuels displaced.
Project Company Consortium	• Construction delay risk, resulting in financial penalties paid to MASEN. • Risk that MASEN will terminate the PPA and exercise the put-option in the Shareholder Agreement if the developers fail to deliver the project on time. • Risk of capital shortages during construction. • Exogenous risk, such as oil-price spikes, changes of government policy on fossil-fuel subsidies that would affect the electricity price on the national grid, and changes of government policy towards renewable energy. • Production risk, caused by reduced solar irradiation levels resulting in lower than projected production output.
IFIs	• Management of the likely coexistence of different interest charges, loan tenders and collateral guarantees across the loan portfolio. European donors avoided this complication by choosing not to syndicate their contributions, but rather to contribute through a joint financing package with synchronised loans
MASEN	• Budget shortfall risk, resulting in the Government failing to pay the solar subsidy to MASEN, and the agency being forced to default on the PPA commitment, making the project unviable. • Project management risk, increased by the loan conditions of the project and the IFIs' right to object to all significant decisions. • Financial risk, which is partially covered by the SICS loan.
EPC Contractor	• Construction and operational risk, including risk of equipment failure and associated reduced production and increased costs. • Storage technology failure risk, causing the plant to be unable to supply peak-load power, which is currently provided by expensive imported oil. • Cost overrun and delay risk, due to the size of the project and the decision to use a relatively new business model (PPP).

Additional details on the Ouarzazate I CSP Plant can be found at:
http://www.masen.ma/fr/projet/2/noor-ouarzazate-i-32/
https://climatepolicyinitiative.org/publication/san-giorgio-group-case-study-ouarzazate-i-csp/

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