Solar export from North Africa to Europe: no longer a mirage

The TuNur project in Tunisia is shaping up to become the first gigawatt-scale solar export project between Tunisia and Europe.

Dr. Till Stenzel and **Kevin Sara**

The European power mix is radically changing. Several countries have decided to phase out nuclear power (or not to introduce it), while tough European environmental legislation, coupled with local NIMBY (not in my backyard) protests makes it ever harder to build new conventional power plants.

At the same time, more and more intermittent renewable energy technologies such as photovoltaic (PV) and wind are added to the electricity mix, increasing the need for flexibility in the power system and making new interconnections ever more important.

The summer of 2012 showed that even the traditional periods of peak power demand no longer coincide with peak power pricing. In Germany on sunny days, about 20 GW of PV injected electricity into the network during the peak periods mid-day, depressing wholesale market pricing. Similar trends can now be witnessed in Italy and Spain.

Against this backdrop, electric utility companies and governments alike have increasingly evaluated the opportunity to introduce concentrating solar thermal power (CSP) supply into the European power mix.

What makes CSP technology so attractive is the fact that they can deliver dispatchable power, a feature that intermittent PV and wind cannot offer in the absence of economic large-scale electricity storage systems. CSP plants can either store heat captured during the day for release "on-demand" for additional power production when the sun is not shining or they can be co-fired with bio-fuels or fossil fuels to extend operating hours and smoothen the production profile during cloudy days.

However, there are few sites for large-scale installations of CSP in Europe due to the limited solar radiation potential and the lack of large-scale sites for >100 MW plants. Yet, ever since the development of the Desertec concept, it has become increasingly clear that that the abundance of high solar radiation coupled with the availability of vast areas of desert land makes CSP a viable option on the southern side of the Mediterranean in North Africa.

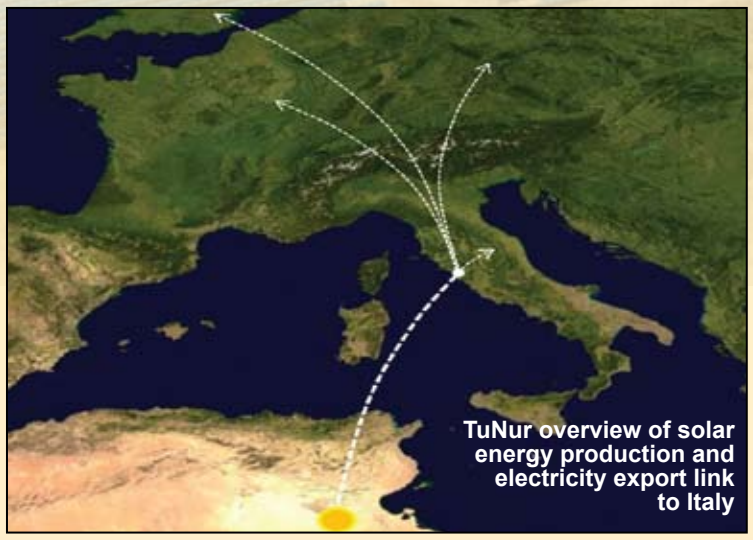
The potential is enormous, not just for regional electricity supply in the Maghreb region, but also for exports from North Africa to Europe. The numbers are simple: Just 0.3 per cent of the North African desert surface area could serve the entire Europe-Middle East- North Africa (EU-MENA) electricity demand. HVDC electricity transmission technology is mature and makes long-distance electricity transmission feasible at low losses (around 5 per cent over 1000 km).

First utility-scale projects are being realised. A 160 MW concentrating solar power (CSP) project, including three hours of thermal storage, has been fully approved and financed at the Ouazarzarte site in southwestern Morocco. The project leaders are ACWA Power of Saudi Arabia together with two Spanish engineering partners. A financing package from leading multilateral banks, including the European Investment Bank (EIB), the World Bank and the African Development Bank, has been secured alongside a 25-year PPA.

However, while Ouazarzarte aims at the domestic Moroccan market, the TuNur project in Tunisia is shaping up to become the first gigawatt-scale solar export project between Tunisia and Europe. TuNur takes advantage of several factors – rapidly falling costs of CSP technologies, a solar resource-rich site in the Tunisian desert, and a close link to the import-dependent Italian power market.

TuNur has already achieved several milestones. Technical planning began in 2009, and by 2010 a target site was identified and a solar-radiation measurement station installed to verify data from satellite-based solar resource data providers. Environmental impact studies and geotechnical studies were completed later that year and after the political change of the Arab spring, a full project proposal was submitted to the new Tunisian government in 2011. The Desertec Foundation has officially endorsed the project.

At the same time, a dedicated cable route between the project site and the Italian coast was identified with support by marine engineering specialists Intertek Metoc, and based on work by expert engineering consultants CESI in Italy, an interconnection point on the Tyrrhenian coast in Italy was chosen, and later approved by Terna S.p.A, the Italian grid operator. Hence, TuNur already has a grid connection solution provided by Terna, which can accept up to 2000 MW on the Italian network without the need for lengthy grid reinforcements or upgrades.



TuNur overview of solar energy production and electricity export link to Italy

TuNur is currently in detailed discussions with the Tunisian government over an investment framework agreement for the TuNur project in Tunisia. This will establish the legal, fiscal and environmental framework for the project implementation, thus providing the investment certainty required to realise the project.

Under the current timetable, project engineering and the project consortium will be ready in the second half of 2014, with project financial close scheduled for the first half of 2015.

Multilateral banks will be a cornerstone investor to the project, with the African Development Bank and the World Bank Group already actively engaged in the project's evaluation. Discussions have begun with commercial banks and selected strategic equity investors.

What are the benefits and costs of the electricity delivered to the Italian network?

CSP systems are now being built in the USA for power purchase agreements (PPAs) in the $0.15/kWh (about €0.11/kWh) range, and are expected to fall further once the first power plants have started operations and next generation designs are under way. NREL/Sandia Laboratories estimates that solar tower CSP technology can reach $0.078/kWh (including a 10 per cent tax credit) in the USA by 2020. Translated to the solar conditions of North Africa, and excluding the tax credit, this still leads to cost levels of around €0.08/kWh.

Furthermore, the flexibility of CSP technology means that for the same energy collected, CSP can produce electricity under various configurations to match different types of load. Thermal storage design of the plants is optimised so that the energy stored is released when it is the most economic and profitable to dispatch the power plant. Hence, CSP design is closely developed with future clients of the electricity output. This flexibility has a value, which has been estimated in a range between $16-$40/MWh (approximately €13-€32/MWh) in California.

Furthermore, a detailed study with Imperial College, London, and DNV Kema, the consultants, has shown that the advantageous production profile of CSP with storage, coupled with the strong interconnection point in Italy, delivers significant grid integration benefits from a system perspective. The capacity value of TuNur is calculated at 95 per cent – close to conventional power plants. Adding to that a strongly interconnected grid with >11 GW of capacity between Northern Italy and its neighbours, and it has been demonstrated that solar exports into Northern European countries can deliver savings in terms of reduced grid extension requirements due to offshore wind, and lower system operating costs.

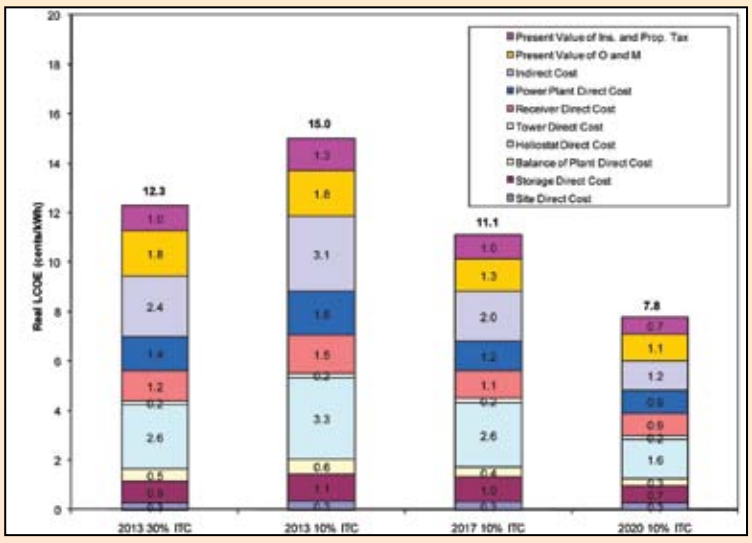
One scenario, showing a displacement of 3.4 GW of offshore wind in the UK and Germany by TuNur, yields savings from over 2.5 GW in reduced transmission extension requirements, as well as from lower system operating costs due to less demand for balancing and ancillary services on the grid.

Several EU governments are evaluating the option to strategically expand their renewable energy portfolios with imports. The EU's Renewable Energy Directive 2009/28/EC has already provided the framework for such imports, but it is down to individual member states to transpose these provisions into national law.

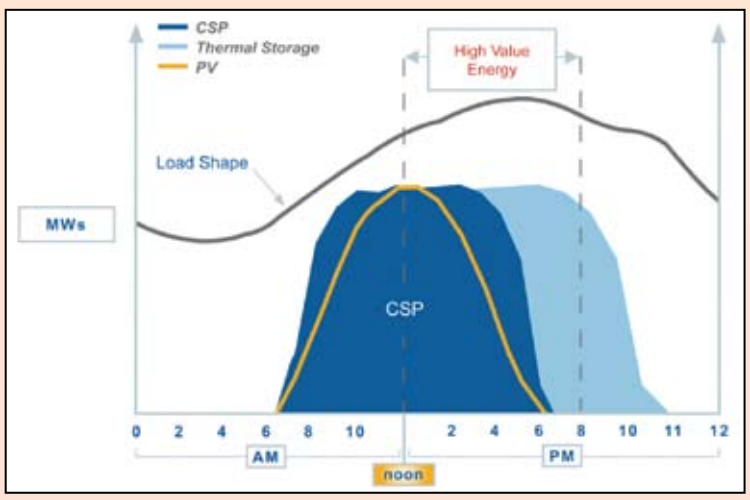
Already, the Secretary of State in Germany's Federal Ministry for Economics and Technology, Stefan Kapferer recently declared that Germany would support first solar export projects in order to demonstrate the feasibility of this approach and to act in partnership with other EU member states and the EU commission. And while Germany has already plenty of intermittent wind and PV installed at home, CSP is simply not an option in this Northern part of the hemisphere. While a first intergovernmental declaration for solar exports from Morocco was slowed down by the economic crisis in Spain, discussions, also including France and Italy, continue.

Although some regulatory and commercial issues remain, progress is rapidly being made on all fronts, and TuNur could represent the very first large-scale utility-scale solar export project. With the first tranche of 1000 MW of capacity targeted to go into construction in 2015, the Desertec vision is finally moving "from power point to power plant".

Dr. Till Stenzel and Kevin Sara are CEO and Chairman, respectively, of TuNur Ltd., a South-North partnership between a group of Tunisian investors led by TOP Group and Glory Clean Energy (50%) and UK-based Nur Energie (50%),



Expected LCOE of solar tower systems 2013-2020 (including investment tax credits (ITCs) of 30 per cent and 10 per cent respectively). *Source: Sandia Laboratories, 2011*



Matching CSP electricity production to peak pricing periods, due to the use of thermal storage