

### **CSP Emerging Markets – Solar Development in North Africa**

**Daniele Tabacco** 

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- CSP Potential of MENA Region
- Nur Energie's Solar Export Project in North Africa
- Case Study: CSP Development in Greece



### **CSP: MENA Energy Potential**



Source: Breyer & Knies, 2009



### **CSP: MENA Energy Potential**



#### MENA region has amongst the best physical conditions for solar power in the world

- •CSP is of particular interest to utilities due to scalability and dispatch-ability
- •Growing strategic importance of renewable energy in the Mediterranean and Gulf region
- •Good potential for enhancing local content through technology transfer
- •Possibility of "green" stimulus packages that create employment through investment in transmission, generation, and equipment manufacturing
- Possibility of export of renewable energy into Europe



#### **Cost of CSP Power Generation by Location**

Source: African Development Bank, 2010



# Renewable Energy Targets in MENA Region

Algeria	<ul> <li>2017: 5 % power generation based on renewable energy</li> <li>2025: 10 % power generation based on renewable energy</li> <li>250 MW CSP planned based on feed-in tariffs (300 % bonus-system)</li> <li>450 MW cogeneration</li> </ul>	
Egypt	<ul> <li>2010: 3 % electricity demand from renewable energy</li> <li>2020: 20 % of the electricity from renewable energy, of which 12 % from wind</li> <li>Planned feed-in tariff for smaller plants (wind, solar)</li> </ul>	
Morocco	<ul> <li>2020 : 42 % contribution of renewable energy to electricity generation</li> <li>Renewable law approved by Council of Ministers- now due for</li> <li>Parliamentary approval</li> <li>Target for CSP: 2000 MW by 2020</li> </ul>	
Tunisia	<ul> <li>2012: 4 % contribution of renewable energy</li> <li>Investment incentives for renewable</li> <li>Feed-in tariffs and self-generation policy for renewables expected</li> </ul>	Source: African Develop Bank, 20



### **CSP for Solar Export Projects: DESERTEC**

The **DESERTEC INDUSTRIAL INITIATIVE (D.I.I.)** was founded to the pave the way for establishment of a framework for investments to supply the MENA region and Europe with power produced using solar and wind energy sources. The long-term goal is to satisfy a substantial part of the energy needs of the MENA countries and meet as much as 15% of Europe's electricity demand by 2050.



Source: D.I.I., 2009



# Nur Energie is an international solar developer and utility



Nur Energie is a truly international multi-technology solar power plant developer with activities in Greece, Italy, France and Africa.

**IN FRANCE**, Nur Energie aims to become a major solar power generator using PV technology with a specific focus on BIPV and landfill projects. Currently Nur has 91 MW under development, mostly in the south of France and is developing a 14 MW rooftop BIPV on the Port of Marseille.

**IN ITALY**, Nur Energie has a focus on "Greenfield" PV mainly in the regions of Puglia, Lazio and Sicily. Nur Energie has 8 MW of projects ready to build within H1 2011 and a pipeline of 45 MW for 2012. Nur Energie is also working on arrangements for the import of solar power from North Africa, including landing rights for a HVDC merchant cable, grid integration, and off-take agreements.

**IN GREECE**, Nur Energie is developing its first commercial CSP power tower, building its execution and operational experience. In Crete Nur Energie won a critical municipal auction for land to build a 35 MW CSP plant against major Spanish CSP competitor. In Rhodes, Nur Energie has applied to build a second CSP project (50 MW).

**IN NORTH AFRICA**, Nur Energie is active in Tunisia and Morocco, and is considering entering markets in the remaining North African countries. **Nur Energie is Associated Partner of DESERTEC.** 

**ELSEWHERE**, Nur Energie is looking to develop projects in the GCC region as part of its long term strategy.



#### **Solar Export Project**

NUR Energie will construct **2000 MW CSP solar power tower** projects, generating clean energy in the desert. First plants will be ready for construction in 2012-2013.

**High Voltage Direct Current** (HVDC) cables will transport electricity to Italy and from there electricity will be transported to the rest of Europe.

#### **De-risking the project**

Electricity generated by CSP is competitive with regard to the clean energy price spectrum in Italy.

Environmental certificates will be awarded in respect of European objectives for the production of energy from renewable sources.

HVDC cables have proven to be very profitable in recent installations



#### Submarine cable transporting clean energy to Europe



10 CSP plants of 200 MW (2GW total) producing clean energy in the desert



#### Milestones achieved to date

#### Development

- Site identified in central Tunisia
- Technical and soil analysis of site performed
- Pre-feasibility analysis for cable route completed
- Pre-feasibility study on cable landing points completed
- Installation of solar measurement station (July 2010)

### Political

- MoU with Tunisian state under negotiation
- Discussions with Italian political institutions started
- Discussions with Terna for cable interconnection undergoing

### Financial/Economic

- Detailed business plan and financial modelling completed
- Fund raising with multilateral institutions and commercial banks started











### Nur's development approach in Tunisia

#### Strict methodology for site to pass selection criteria

 Environmental screening, desertification risk, solar radiation, water rights, large size for 2GW, proximity to gas and electricity transmission

#### **Building local support**

- Water Cooling for large solar thermal plants not feasible and not desirable in deserts focus on dry cooling technologies
- Analysis of potential for local value add

#### Study on techno-economic feasibility of cable connection through the Mediterranean

 Work with Statnett Engineering, experienced sub-marine HVDC engineering consultancy, previous work included engineering for 560km/700MW sub-marine HVDC cable between Holland and Norway



CFSI

#### Study on grid integration into the Italian electricity network

• Work with CESI, Italian electricity research bureau part-owned by Terna, the Italian grid operator, analysing 6 possible inter-connection points, identified 4 that can take up to 2000MW of electricity imports



Technical and socio-economic assessment of 2000MW plant

#### **Technical Analysis of the Site**

Together with Comete Engineering, significant studies and assessment have been carried out

- Analysis of desert environment and unstable soil conditions
- Analysis of water availability and use in the area
- Availability of local infrastructure such as roads and telecommunications
- Proximity to existing electricity and gas infrastructure

### Socio-Economic Impact Assessment

- Employment creation of at least 1500 jobs during construction period
- Direct employment of at least 500 skilled and trained workers during operation
- Indirect employment benefit through new industry development of ca. 20000 jobs
- Value-add to Tunisian economy of up to TND 3bn for full 2000MW plant
- Electricity production to meet increasing local consumption and decrease fossil fuel dependency









# Legislation: Policy for solar exports into Europe is already implemented, and various mechanisms in operation

#### **EU Policy**

EU Renewable Energy Directive 2009/28/EC sets mandatory target of 20% renewable energy by 2020. It allows EU member states to meet the target by importing renewable energy from non-EU member states and extend national support programmes such as feed-in tariffs to them.

#### Art 9 Imports

Article 9 of Directive 2009/28/EC allows "virtual" accounting of renewable energy imports even before the operation of export cables, if cable projects are already implemented and foreseeable to be connected within defined time frame; this disconnects the construction schedule of CSP plants from the construction schedule of new HVDC electricity cables.

#### **Green Certificates**

Italy already operates a tradable green certificate scheme that has been extended to other countries (Switzerland, Albania) for the export of renewable energy into Italy.

#### Mediterranean Solar Plan (MSP)

The MSP has been agreed as a corner-stone policy of the Mediterranean Union, with a target to develop 20GW of renewable energy around the Mediterranean Basin by 2020.





Purpose Build CSP development experience in a FIT supported market in Europe

Why Greece Late for Spain, CSP in Greece was untapped in early 2008

StrongEstablished 50-50 JV with Motor Oil Hellas, major Greek independent energy companyPartnersto jointly develop the projectEPC to be provided by METKA, the leading EPC company in Greece

**Complete** 

### Stage 1: Land Identification

- Land survey
- Land inspection
- Land scoring/ranking
- Site-specific modelling
- Solar radiation assessment
- Assessment of authorisation and grid connection issues

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16													located in the area		
	9		35.01282	25.7803		4km East of lerapetra		1	square		50-100		South facing, some olive trees plantations + 4-5	в	
17													greenhouses, close to the sea / expensive?		
	10		35.03165	25.75416		General ierapetra area		>10			20-100		densely cultivated / greenhouses. Close inspection	Ð	
8													advised		
9	11		35.05302	25.73313		5km north of lerapetra centre		1	square		130-180		some olive oil plantations, relatively dry.	B	
	12		35.14116	25.70206		5km South of A. Nikolaos		1.6	square		80-120		Looks green but not cultivated (only 2-3 small plots).	A	
													Likely expensive area though		
	1.0		35.12678	25.57269		7km WSW of Kritsa		2	square		1150-		High plateau ("Katharo Plateau") grid connection likely	C	
21											1190		problematic. High mountain area		
	14		35.21403	25.48795		9km south of Malia		2	square		930-980		high plateau. Grid connection likely problematic. Barren	0	
22													landscape (possible archaeological site)		
23	16		35.18193	25.46518		Agios Georgios		20	square		815		Lasithi Plateau. Very flat, fully cultivated	в	
24	16		35.0485	26.39954		1km SVV of Viannos		4	square		470-500		Cultivated plateau + trees	0	
20	12		35.16946	25.30718		Kastelli Area		>20	square		320-350		Cultivated area, trees + greenhouses.	в	
<u>.</u>	18		35.07046	25.27308		1km west of Lagouta		15	square		190-250		Cultivated area, trees + greenhouses.	в	
	19		35.22130	26.20396		14km SSE of Iraklion		1.6	square		240-290		Cultivated area	C	
53	20		35.02228	26.11776		Charakas region		30	rectangular (10x3)		220-260		Cultivated area & river	в	
84	~ 1		35.12531	25.00606		1km East of Ag. Varvara		4	Square		640-680		Cultivated & wind farm at south side	в	
84	22		35.09466	25.00176		4km South of Ag. Varvara		1.00	square		330-360		olive plantation, South of wind farm	C	
1	23		35.037	26.00764		North of Vagionia region		> 30	square		150-300		cultivated area		
24	24		35.31065	24.90405		Skm north of Anogela		1.6	rectangular (2 x 0.75)		800-840		semi - cuivated, small valley	1 S	
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6 A						Anogena							late afternoon		
10	27		35.0378	24.8622		Moirer plaip		>20	rectangular (5x4)		40-70		cultivated plateau + (excilages (some large opes)	B	
84 I	20		05.00550	04.35400		EL EL C		-20	reetangular (oka)		100.100		contrated platead + less shages (solite large offes).		

Bottom-up approach: 37 sites screened!





Stage 2: Securing the Best Site

### SITE CHARACTERISTICS

- South eastern tip
- Highest Direct Solar Radiation in Greece, possibly Europe (DNI in excess of 2100kWh/m<sup>2</sup>/y)
- Gentle south slope
- Adjacent to the island's major conventional power station (300MW)
- Adjacent to grid connection, HV lines through property
- 2km from port

### PATHWAY TO SECURING THE SITE

- JV with Motor Oil Hellas gives Nur Energie a strong Greek partner, recognised by all
- On the ground presence, constant interaction with local stakeholders
- Participation in municipality tender for 170 hectares of land (100hectares usable for CSP)
- Highest quality techno-economical documents and feasibility studies including detailed layouts, grid integration impact, environmental benefits etc
- Use of best CSP technology (BrightSource Energy) allows Nur Energie to outbid major Spanish CSP company

Complete





### Stage 3: Solar Radiation Assessment

- State of the art meteorological station
- Global Horizontal Irradiation (GHI), Direct Normal Irradiation (DNI), Wind, Temperature etc
- Measurements since November 2008, per minute measurement frequency

 In-house data assessment, including correlation with real time satellite DNI data to generate TMY data (Typical Meteorological Year)

DNI VERIFIED TO BE IN EXCESS OF 2100kWh/m²/y (5.7kWh/m²/day)

[e.g. Andasol is 2136kWh/m<sup>2</sup>/y, PS10/PS20 are 2012kWh/m<sup>2</sup>/y]









- Crete electricity network is very unique:
  - Autonomous grid
  - Oil based
  - Large daily and seasonal variability
  - >20% wind energy
  - · Wind/hydro hybrids expected
- Benefit of the CSP plant to grid stability has been demonstrated by Nur Energie
- Co-firing is a better solution than storage for intermittency control and the provision of guaranteed capacity during the high demand summer months
- · Solar field layout and tower location optimised
- Power block components designed









Power Block





NOT TO BE USED FOR CONSTRUCTION

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Ongoing





### Stage 5: Complete Permission Process

• Application dossier submitted (February 2009), currently being reviewed for the granting of an Electricity Generation Licence [expected in H2 2010]

• Lease agreed with local municipality which owns the land after winning the tender process in September 2009

• Forestry department has verified that the land is suitable for use (i.e. not forest land or other restrictions)

- Full authorization expected in 2011.
- Local stakeholders are very positive towards the CSP project

Site of CSP plant, next to conventional power plant and port

Ongoing



