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Solar Power from North Africa

Frameworks and Prospects

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The vision of generating solar electricity in the Sahara Desert and exporting it to Europe is by no means new. But it only came to broad public attention in July 2008, when the newly founded Union for the Mediterranean made the Mediterranean Solar Plan (MSP) one of its six declared priorities. The idea received another huge media and political boost just a year later, in July 2009, when a private business consortium launched the Desertec Industrial Initiative (DII).

The objective of the Solar Plan is to create 20 gigawatts (GW) of renewable generating capacity in the Mediterranean region by 2020. The Desertec Initiative aims to provide 15 percent of European electricity consumption as well as a significant proportion of domestic demand in North Africa by 2050. Both initiatives concentrate on solar power and both plan to export part of their green electricity to Europe. Funding for specific projects is expected to come from various European development banks and the private sector, as well as the governments of the EU member states and the southern Mediterranean countries.

The idea is captivating – both from the perspective of climate, energy and foreign policy and with an eye to Europe's goal of intensifying cooperation with its southern neighbours through the Union for the Mediterranean and the European Neighbourhood Policy. But if these highly ambitious projects are to become reality, a proper financial, political, legal and regulatory framework will need to be put in place. Enormous scientific progress means that technical feasibility is no longer a major issue.

This study consequently focuses on the interests of the different parties and the framework and conditions that would be required for implementing the initiatives, examining both Europe (especially Germany, France, Spain and Italy) and North Africa – the target region for implementation of the plans.

Our analysis identifies structural and political obstacles at three levels: national, regional (within the EU and the southern Mediterranean region) and interregional (between the EU and the states of North Africa). At the level of nation-states, continuing nationalism and structural conservatism in energy policy impede the introduction and dissemination of new technologies and preserve barriers to market entry,

both of which keep costs high. At the EU level this makes it harder to formulate a common energy policy. The big question here is whether the political will exists to create a common green electricity market. Another problem for the Solar Plan is the political make-up of the Union for the Mediterranean: because it encompasses the whole Mediterranean region, the Middle East conflict has severely impaired its activities and the process of establishing its structures. Last but not least, he who pays the piper calls the tune: an unattractive investment environment in the partner states also stands in the way of rapid implementation.

Given that generating solar electricity in the deserts is one of the few logical concepts for a sustainable energy supply, it is certainly worth pursuing the solar initiatives. In view of the many obstacles this will require staying power. But that should not be taken to mean that decisions can be postponed. On the contrary, time is of the essence.

Much of Europe's generating capacity is coming to the end of its working life, and the transmission networks are due for modernisation. Investment cycles in the energy sector last thirty or forty years. Once made, a particular investment rules out alternative options for decades because of the high costs involved. If the self-imposed climate targets for 2020 and above all 2050 are to be achieved, a break is needed in the technology paths in order to initiate the conversion of the conventional energy system. The time is right from another perspective, too: the southern Mediterranean states need to develop new energy sources to meet rapidly growing demand for electricity. A quick decision for solar energy also serves Europe's security interests, because the countries in the region are seriously thinking about acquiring nuclear power.

If the solar initiatives are to be successfully implemented, it is of fundamental importance that a start be made with concrete flagship projects (constructing pilot power stations) with a clear perspective of consolidating the project as a whole. In the initial phase that means setting to one side the idea of physical export of electricity, and generating electricity just for the North African market. In order to encourage investment in the absence of the option of immediate export, virtual trading tools such as "green certificates" need to be considered. EU member states and their businesses could purchase such certificates to meet their obligations for emission reduction and expansion of renewables. Swap deals where natural gas is exported to Europe in place of electricity are also conceivable. Such arrangements would benefit all involved: European states, the southern Mediterranean countries and commercial partners seeking to make their technologies commercially viable. Favouring North African businesses and workers would offer partner states additional incentives and help to generate the political will that is needed to improve security of investment.

Even if an initial phase proceeds with specific projects on the basis of regulation by contract, a fundamental political and legal framework will need to be created eventually. Within the EU progress needs to be made with developing a cross-border green electricity market and modernising the European transmission networks. A stable legal framework is also imperative for establishing Euro-Mediterranean electricity trading. The political and regulatory groundwork could be prepared within existing forums, for example in the scope of the European Neighbourhood Policy and the Energy Charter process, with a small coalition of states north and south of the Mediterranean initiating the negotiating processes. The second phase would be to realise the export components of the solar initiatives. Their central precondition is to set up and expand undersea transmission lines across the Mediterranean and a transmission ring encircling it.

The time is ripe for large-scale solar energy but the window of opportunity is small. Ambitious plans for comprehensive regional cooperation in the framework of the Union for the Mediterranean must be put on the back burner for the moment in order to develop the initiatives pragmatically and effectively.

The Idea

The Origins of the Desert Solar Projects

The central idea behind the solar initiatives is both simple and captivating. The energy the earth receives every year from the sun is 1.6 billion terawatt-hours (TWh), or ten thousand times the world's entire energy needs.[1] And the sun will remain a source of abundant and easily available energy for millions of years to come. Solar energy produces very low emissions and has by far the greatest potential of all renewable energy sources. It is the obvious choice for supplying global energy demand.

The Mediterranean Solar Plan (MSP) and the Desertec Industrial Initiative (DII) have both been in the pipeline for quite some time. And both initiatives have strong German connections. The MSP, which the German government brought into the Union for the Mediterranean in 2008, seeks to develop the enormous potential of renewable energy available all the way round the Mediterranean for the benefit of all involved. By adopting the plan the European Union and its partners in the southern Mediterranean sent two simultaneous signals: the project for exploiting solar energy should be pursued, firstly, multilaterally and secondly, as a North-South partnership.[2] However, the regional Euro-Mediterranean context of the Solar Plan has so far turned out to be problematic, with the Arab-Israeli conflict largely paralysing the Union for the Mediterranean.

The Mediterranean Solar Plan (MSP) proposes constructing solar thermal power stations (see "Concentrated Solar Power (CSP)", p. 15) and wind turbines above all in North Africa (specifically Morocco, Algeria, Tunisia and Egypt) and Jordan, building 20 GW of generating capacity by 2020 and expanding transmission networks in the partner countries. As well as these infrastructure measures, the EU would also like to draw the region closer to the European energy market, seeking a convergence of energy policies and legal and regulatory harmonisation. The plan encompasses measures for saving energy and increasing energy efficiency, as well as energy policy and regulatory reforms based on the Community acquis. Germany, France, Spain and Italy have taken the lead. In summer 2009 the solar thermal industry, represented by the European Solar Thermal Electricity Association (ESTELA), also intervened with proposals for implementing the Solar Plan.[3]

The Desertec Initiative originates in plans drawn up by the Trans-Mediterranean Renewable Energy Cooperation (TREC) which was set up by the Hamburger Klimaschutzfonds together with think tanks and energy agencies north and south of the Mediterranean and the Club of Rome. At the beginning of 2009 the Desertec Initiative brought forth the Desertec Foundation, whose plans are based on technical studies prepared by the German Aerospace Centre.[4] A consortium comprising twelve German and international companies and the Desertec Foundation brought together by Munich-based reinsurer Munich Re presented the Desertec Industrial Initiative (DII) on 13 July 2009. In October 2009, these parties founded a planning firm with the legal status of a limited-liability company. By spring 2010 half a dozen new investors – among them a French, an Italian, and a Moroccan company – had joined the project. It is planned to further expand the consortium to about twenty-five companies, not least in order to shake off the German predominance by recruiting members from other European and southern Mediterranean states. The target for 2012 is first of all to work out a road map for implementation.

1 Daniel Schäfer, "Solarthermie: Physik und Technik der Solarthermie in Afrika", *Spiegel der Forschung* 2, no. 25 (December 2008): 11–15 (12), http://geb.uni-giessen.de/geb/volltexte/2009/6731/pdf/SdF_2008-02-11-15.pdf.

2 One of the main concerns of the Union for the Mediterranean is to strengthen co-ownership of the ongoing cooperation process among the partners in the southern Mediterranean, among other things by creating a rotating North-South co-presidency.

3 ESTELA, *Solar Power from the Sun Belt: The Solar Thermal Electricity Industry's Proposal for the Mediterranean Solar Plan: A Programme of the Union for the Mediterranean* (Brussels, June 2009).

4 German Aerospace Centre, *Concentrating Solar Power for the Mediterranean Region, Final Report* (Stuttgart, 2005); German Aerospace Centre, *Trans-Mediterranean Interconnection for Concentrating Solar Power, Final Report* (Stuttgart, 2006); German Aerospace Centre, *Concentrating Solar Power for Seawater Desalination, Final Report* (Stuttgart, 2007).

The private sector, more than politics, is the driving force behind the DII. As well as banks, equipment manufacturers (e.g. Siemens) and power plant builders, the electricity companies E.ON and RWE also hold stakes in the planning firm. That means that the central actors required for realisation of this major project are on board. The initiative brings together powerful corporations to drive the project forward at all levels and develop "system solutions" that cover not just plant construction, but also project financing and the transport, distribution and marketing of the generated electricity. In the guise of Cevital of Algeria and Nareva of Morocco important private-sector companies in potential exporting states are taking part (although only Nareva has experience in the field of renewables), and with Abengoa the consortium includes a Spanish firm that already has experience operating solar thermal power stations. A good deal more ambitious than the Solar Plan of the Union for the Mediterranean, Desertec aims to cover at least 15 percent of Europe's and a significant share of North Africa's electricity needs by 2050. The estimated total investment amounts to €400 billion.

So within just one year, both politics and business have taken important steps. The DII focuses above all on the technical side of the project and the interests of the energy sector. The Solar Plan involves the EU level in advancing the process of creating a regulatory framework, and more strongly than hitherto includes the partner countries and takes their interests into account. In this way the idea of importing electricity from the desert receives important political, regulatory and institutional backing for the first time. This is crucial for realisation of the projects.

Motivation and Benefits

The broad interest of the European public, businesses and politics in the solar initiatives is easily explained. Successful implementation would accomplish positive effects in several policy fields at the same time: energy, development, climate policy, as well as foreign and security policy.

Because both initiatives propose exporting energy to Europe as well as supplying and expanding domestic electricity markets in North Africa, this is potentially a win-win situation for the EU, its individual member states and its North African partners. But at the same time, the interests of the different parties are very differently structured. Although there is a fundamental interest in renewable energy in the southern Mediterranean states, parts of the elite hold historically conditioned (i.e. ex-colonial) reservations towards the desert solar initiatives because of their European background.

Energy and climate policy

European Union. Just like Germany, the European Commission hopes that implementation would have a positive impact on security of supply, economic efficiency and climate compatibility, the strategic triangle of energy policy. The climate protection angle is obvious, although because of the long timeframe the initiatives will contribute little to achieving the EU's 20-20-20 targets.[5] The project could play a weightier role in achieving the climate targets agreed by the European Council: an 80 percent reduction in greenhouse gases by 2050. That objective is based on the realisation that global greenhouse gas emissions will have to be cut by at least 50 percent by 2050 – and by at least 80 to 95 percent in industrialised countries – if we are to have any hope of restricting global warming to two degrees Celsius. Making the Desertec vision reality would cut emissions by an amount corresponding to the German total for six years at the current annual rate.

An interest in climate protection is also behind the involvement of Munich Re: global warming has tripled the level of climate-related insurance claims since 1970. Globally, the cumulative total loss of recent years is estimated at €200 billion. Because the anthropogenic factor is the driving force of climate change and energy consumption in turn is responsible for two thirds of emissions, Munich Re has an overriding interest in the project, as well as the obvious narrower investment interest of a reinsurer, and the image gain linked to engagement in the field of renewables.

A second important plus point of the desert solar initiatives is their contribution to diversification of both the electricity mix and the geographical spread of supply. With a prudent mix of renewable energy sources and the application of new technologies helping to save fossil fuels, CSP technology supplies an important building block for a future sustainable

5 The EU has set itself the target date of 2020 for reducing greenhouse gas emissions by 20 percent, increasing the proportion of renewable energy to 20 percent and improving energy efficiency by 20 percent. While the first two are legally binding, the last is a non-binding declaration of intent.

energy system. If we consider the future possibilities of storage, electro-mobility and hydrogen, all of which should receive a boost, the sky is the limit.

Politics and the energy industry hope for positive spin-off from a cheap long-term energy supply. Of course, during the launch phase, accelerated development of renewable energy sources will incur higher capital and investment costs than would be the case building conventional power stations, and the same applies to the construction of the required high voltage direct current (HVDC) transmission lines. But from a certain point economies of scale and learning effects will bring down the costs of plant construction, and the transmission grids will need to be expanded and modernised either way. It should not be forgotten, either, that today many of the costs associated with the use of fossil fuels (coal, gas and oil) and nuclear power – such as pollution and permanent waste storage – are inadequately priced in or completely externalised and thus offloaded on to the general public and future generations. Furthermore, as demand grows the prices of fossil fuels will rise and fluctuate. Such price volatility is cost-intensive for economies. Given that the fuel costs of solar thermal are practically zero, developing this technology is a means to keep the cost of energy calculable.

Southern Mediterranean. These states are especially severely affected by the consequences of climate change. Desertification and above all an escalating water shortage – increasingly being tackled through energy-intensive desalination – make the responsible decision-makers (and the affected populations) acutely aware of the close nexus between climate problems and energy policy.[6] But these nations, already lagging behind economically, see no reason why they should share the burden of meeting Europe's climate targets. Pointing – not without justification – to the "polluter pays" principle, they insist that the West is largely responsible for climate change and should consequently bear the costs. This popular line of argument in developing countries was prominent at the UN Climate Summit in Copenhagen at the end of 2009.

The main concern of the North African states is worsening electricity shortages. All the relevant studies suggest that energy consumption there will increase strongly; annual growth is currently between 4 and 8 percent depending on the country. So far only oil- and gas-poor Morocco imports electricity on any larger scale (15 percent of consumption, at great expense).[7] In a situation of strong energy import dependency, Morocco has seen electricity imports from Spain increase by a factor of more than twenty-five over the past decade,[8] and is expecting electricity demand to quadruple by 2030.[9] Even Algeria with its wealth of fossil fuels has experienced repeated electricity shortages and blackouts in large parts of the country. With growing populations and corresponding economic growth, annual electricity demand in the Middle East and North Africa could be on a par with the European level of 3,500 terawatt-hours by 2050.[10] Last not least, the growing practice of seawater desalination also increases electricity consumption. The North African states are planning to expand desalination capacity three- or fourfold by 2015. In future desalination plants could be coupled with CSP power stations.[11] The idea of pushing CSP projects on a grand scale is broadly welcomed in North Africa. Any doubts that exist come about because the initiatives – especially the DII in its start-up phase – have emphasised the export angle more strongly than production for the domestic North African market and because the partnership aspect is still felt to be too weak.

6 Water deficits in North Africa (the difference between demand for drinking water and reliable supply) will increase by about 30 percent between 2010 and 2020; German Aerospace Centre, *Concentrating Solar Power for Seawater Desalination* (see note 4), 84–88.

7 Household electricity prices in Morocco are almost three times higher than in Algeria, primarily because Algeria as a natural gas producer can generate electricity more cheaply and electricity prices there are highly subsidised. Demand for photovoltaic in Moroccan households has been accordingly strong for years.

8 Union for the Coordination of the Transmission of Electricity (UCTE), *Statistical Yearbook 2007* (Brussels, 2007), 39, www. entsoe.eu/fileadmin/user_upload/_library/publications/ce/Statistical_Yearbook_2007.pdf (accessed 5 January 2010); Siegfried Breuer, "Marokko muss in die Stromwirtschaft investieren: Angebot kann nicht Schritt halten", *Germany Trade & Invest*, 31 July 2008, www.gtai.de/DE/Content/bfai-online-news/2008/14/medien/Ticker2Marokko.html (accessed 5 January 2010).

9 European Commission, *Rapport de Suivi Maroc*, Brussels, 23 April 2009, SEC (2009) 520/2, 16, http://ec.europa.eu/world/enp/pdf/progress2009/sec09_520_fr.pdf (accessed 2 December 2009).

10 Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power: Global Outlook 2009: Why Renewable Energy Is Hot* (Amsterdam, Tabernas and Brussels, 2009), 69, www.greenpeace.org/raw/content/international/press/reports/concentrating-solar-power-2009.pdf (accessed 5 January 2010).

11 German Aerospace Centre, *Concentrating Solar Power for Seawater Desalination* (see note 4), 103.

Economic and development policy

Both from the German and European perspective and from the point of view of the partner states there are numerous economic and development arguments for the desert solar initiatives. In Germany, politicians and private-sector participants are interested in creating a political consensus behind a balanced electricity mix capable of meeting the challenges to come, where importing electricity generated from renewable sources is but one component. At a point in time where there are question marks over many generation projects (like "clean" coal-fired power stations with CCS technology or extending the operating life of nuclear reactors),[12] this is an important motivation, especially for the big energy companies.

The economic interests of politics and the private sector are obvious: both increasingly recognise CSP as a technology of the future with great export potential. German and Spanish companies are already among the market leaders. German competence resides above all in collector arrays, in the conventional generating plant, and in high voltage direct current (HVDC) transmission. All three are key areas when it comes to the expansion of green technologies and global competition for market share. Establishing CSP worldwide offers significant opportunities for German businesses.[13] But in order to advance the technology German businesses need buyers in the global sun belt. In Europe itself locations are restricted to Spain, Portugal, Italy, Greece and Cyprus. If the technology is to achieve a global breakthrough cooperation will have to be sought with "pilot regions" that possess both the solar radiation and the required expanses of land. The option of export to Europe – where electricity prices are generally many times higher than in North Africa – is decisive in terms of funding the projects.

For European politics it is central that the desert solar initiatives take account of what has to date been one of the main concerns of the EU's Mediterranean policy: ensuring greater prosperity in the southern Mediterranean by developing infrastructure and creating jobs. At this point the interests and assessments of the EU largely coincide with those of the North African governments (or at least of the more progressive section of their elites). Both hope that a geographical and sectoral diversification will bring about a sustainable strengthening of the economies.

Opinions diverge about the potential effects on economic growth and the labour market in the southern Mediterranean. Pessimists claim the impact will be very small and see European businesses as the main winners.[14] But such predictions are not generally based on solid studies. More optimistic forecasts come – unsurprisingly – from the solar industry, but are also confirmed by independent studies.[15] If the 20 GW of capacity proposed in the Solar Plan of the Union for the Mediterranean were to be installed this could be expected to create a total of 235,280 jobs: 80,000 in manufacturing (half on site, half in Europe), 120,000 in construction and 33,280 in ongoing operation and servicing.[16] Because the CSP sites will lie in largely unindustrialised regions outside the conurbations, plant construction will

12 See Frank Dohmen, "Wir brauchen Klarheit", *Der Spiegel*, 2009, no. 49, 110f.

13 One study suggests that German companies could complete 33 percent of the work required for realising the reference power station (Wuppertal Institut für Klima, Umwelt, Energie GmbH, *Ökonomische Chancen für die deutsche Industrie resultierend aus einer weltweiten Verbreitung von CSP (Concentrated Solar Power)– Technologien*, project report, 24 June 2009, 59, www.wupperinst.org/uploads/tx_wiprojekt/Chancen_Verbreitung_CSP.pdf (accessed 5 January 2010).

14 Sören Scholvin, *Desertec: Wirtschaftliche Dynamik und politische Stabilität durch Solarkraft?* GIGA Focus Nahost 11 (Hamburg: German Institute of Global and Area Studies, 2009).

15 See for example Kevin Ummel and David Wheeler, *Desert Power: The Economics of Solar Thermal Electricity for Europe, North Africa and the Middle East*, Working Paper 156 (Washington, D.C.: Center for Global Development, December 2008). The development yield is potentially so large that voices from the development community are already predicting a growing gulf between North and Sub-Saharan Africa and calling for a – currently utopian – expansion of the initiatives to cover the whole of Africa. On this see Frank Schüssler, "Ein 'Meer aus Spiegeln' – aber wo? Trägt die Solarenergiepartnerschaft zwischen Afrika und Europa zur Verschärfung regionaler Disparitäten in Afrika bei?" *Spiegel der Forschung* 25, no. 2 (December 2008): 28–33 (31), http://geb.uni-giessen.de/geb/volltexte/2009/6734/pdf/SdF_2008-02-28-33.pdf; Winfried Speitkamp and Daniel Stange, "Energiepolitik in Afrika – Energiepartnerschaft mit Afrika: Historische Belastungen und aktuelle Perspektiven", *Spiegel der Forschung* 25, no. 2 (December 2008): 40–47, http://geb.uni-giessen.de/geb/volltexte/2009/6736/pdf/SdF_2008-02-40-47.pdf.

16 According to the solar thermal industry, each 100 MW of installed capacity creates four hundred jobs (man years) in manufacturing, six hundred in construction and installation and sixty in the field of operation and servicing; ESTELA, *Solar Power from the Sun Belt* (see note 3), 7–8. Jobs would also be created in Germany: in a moderate scenario 36,000 to 146,000 and in an ambitious scenario 58,000 to 238,600; Wuppertal Institut, *Ökonomische Chancen für die deutsche Industrie* (see note 13), 67.

probably be associated with a general enhancement of infrastructure, especially transport.[17]

Interest in the initiatives is greatest in the states with little in the way of fossil fuel resources: Morocco and Tunisia (and to a lesser extent Egypt). They see solar and wind power as an opportunity to create a new, sustainable and in the long term lucrative export branch and to grow from electricity importers into exporters. The gas resources of Algeria and Libya leave them under less short-term pressure to open up new energy sources. But here too – as in Egypt – the idea of covering more of the domestic electricity demand from solar and in return being able to export more gas is gaining in political popularity.[18] In the medium term exporting solar electricity could reduce vulnerability to gas price volatility. In Algeria in 2009, for example, about 97 percent of export revenues came from the oil and gas sector. In the long term solar electricity offers these nations the perspective of retaining their status as energy exporters into the post-oil era.

What is certain is that the initiatives will need to come with financial transfers and that the start-up funding represents a problem (greater detail under "Financial and Commercial Hurdles", pp. 24ff). Only the oil and gas exporting states of Algeria and Libya possess the independent means to at least partly self-finance CSP power stations. It is as yet unclear to what extent the initiatives will also involve a transfer of know-how and technology. Here interests diverge north and south of the Mediterranean: EU member states like Germany and Spain want to strengthen their export industries, while the North African countries hope for assistance in establishing a solar energy sector of their own.[19] Regardless of whether the latter comes to pass, there is every reason to believe that all the North African states would profit from a move into large-scale production of solar and/or wind power. This assessment is also gaining traction among North African energy ministers and is increasingly reflected in official documents.

Foreign and security policy

A glance at the EU's foreign and security interests quickly makes it clear why the Solar Plan was declared one of the six key projects of the Union for the Mediterranean. Firstly, successful implementation and – in the ideal case – successive expansion of the Solar Plan would lend a new quality to Euro-Mediterranean cooperation which to date has been largely lacking in visible and measurable successes. The construction of CSP power stations across North Africa would create very concrete landmark projects. In the southern partner countries there is still a widespread perception that the EU acts above all in its own security and economic interests,[20] and grumbling about asymmetries in economic cooperation. The solar initiatives possess the potential to minimise these asymmetries, with the Desertec Initiative making a symbolically important start by including the Algerian Cevital in its founding consortium. The basic point here is to harness the many existing complementary and overlapping interests of Europe and the southern Mediterranean states to develop a real partnership. If it really turned out to be possible for North-South cooperation to both alleviate electricity shortages in North Africa and supply the European market with solar electricity from the desert that would represent a huge step forward for Euro-Mediterranean cooperation.

Secondly, Europe hopes that successful implementation of the ambitious initiative would have positive spill-over effects in the field of security.[21] Since the beginning of the Barcelona Process in 1995, Euro-Mediterranean cooperation has been based explicitly on the assumption that prosperity is an important pillar of stability in the Mediterranean region. It is rightly argued that the lack of economic prospects (in combination with political repression) that affects in particular the younger generations has destabilising consequences for the North African states, ranging from social unrest to organised crime and militant Islamism.[22] Europe in turn feels the effects of youthful

17 Ummel and Wheeler, *Desert Power* (see note 15).

18 Ibid.

19 Interviews with Algerian, Moroccan and Tunisian ministry officials and parliamentarians, Algiers, March 2009, and Berlin, June and July 2009.

20 Roberto Aliboni, Ahmed Driss, Tobias Schumacher and Alfred Tovias, *Putting the Mediterranean Union in Perspective*, EuroMeSCo Paper 68 (June 2008), www.euromesco.net/images/paper68eng.pdf.

21 See for example Michael Thumann, "Desertec & Nabucco: Besser als jeder Militärpakt", *Zeit Online*, 16 July 2009, www.zeit.de/online/2009/30/desertec-nabucco (accessed 21 December 2009).

22 Isabelle Werenfels, *Qadhafi's Libya: Infinitely Stable and Reform-Resistant?* SWP Research Paper 2008/RP05 (Berlin: Stif-

disaffection in the form of increasing migration pressure. Because of the multiple potential economic yields, the solar initiatives could be seen as one – modest – component in the process of stabilising the southern Mediterranean and thus ultimately as a contribution to European security.

Table 1
Logic of a solar partnership:
Starting situations in Europe and North Africa

Europe	*North Africa*
High per capita GDP	Low GDP and per capita income and enormous need for economic development
Relatively widespread availability of capital and technology	In the main little capital; very little know-how and technology
Great demand for energy (growing demand in electricity sector)	Growing energy demand (starting from a relatively low level)
Few fossil fuel resources, limited potential of solar energy	Huge energy resources, both fossil and renewable
Lack of space; solar radiation too weak	Immense thinly populated and unpopulated regions in the sun belt
Committed to the two degrees climate target	Severely affected by climate change (drought, desertification)

Source: Based on Manfred Hafner, "What Potential for European Energy Security Does the Mediterranean Union Really Hold?" 4th Annual European Energy Policy Conference, Brussels, 17–18 March 2009.

tung Wissenschaft und Politik, July 2008); Isabelle Werenfels, *Bouteflika zum Dritten: Stabilitätsgarantie oder Stabilitätsrisiko?* SWP-Aktuell 19/2009 (Berlin: Stiftung Wissenschaft und Politik, April 2009).

The Story So Far

It took more than a global environment turning favourable because of worries about climate change and energy security to bring about the launch of the solar initiatives in 2008 and 2009. In fact, the lead-up involved creating the first institutional and regulatory foundations for the promotion of renewable energy both in Europe and in the southern Mediterranean. The technology has advanced in leaps and bounds and – largely unnoticed by the wider European public – the first solar thermal power stations have already been built around the Mediterranean.

Technical Progress Well Advanced

The technology has advanced enormously, to the point where technical feasibility is no longer the principal obstacle. In 2005, 2006 and 2007 the German Aerospace Centre published three groundbreaking technical studies on CSP funded by the German Federal Environment Ministry. As well as elaborating the technical details, the studies on the basic principle of concentrating solar power (2005),[23] electricity transmission (2006),[24] and seawater desalination using CSP (2007)[25] also indicate where political pressure is needed and what the socio-economic and ecological implications are.

Map 1 (p. 14) illustrates how the potential of renewable energy could be harnessed in a trans-Mediterranean integrated electricity transmission network. The DII is actually open-technology because wind and solar power both play a role in North Africa, but CSP attracts most attention because it also paves the way for intensified use of other forms of renewable energy.

As well as its enormous electricity-generating potential, the new technology of CSP offers another important advantage over photovoltaic and wind power. The energy of the sun's radiation is converted into superheated steam to power turbine and generator, and heat is relatively easy to store. So in contrast to photovoltaic systems, electricity can also be generated at night using stored heat. That gives CSP baseload capability, the capacity to supply electricity at any time of day or season. CSP is also open to hybrid fuelling arrangements, for example in combination with gas or biomass. That is a decisive advantage over renewables that depend on wind, weather or time of day and are therefore subject to great fluctuations. Because CSP is controllable it is an "enabling technology" offering the possibility to increase the share of other forms of renewable energy. It also has a good climate footprint: the CO_2 emissions associated with production, installation and operation over an average life of twenty years are already "paid back" within the first three to six months of operation.[26]

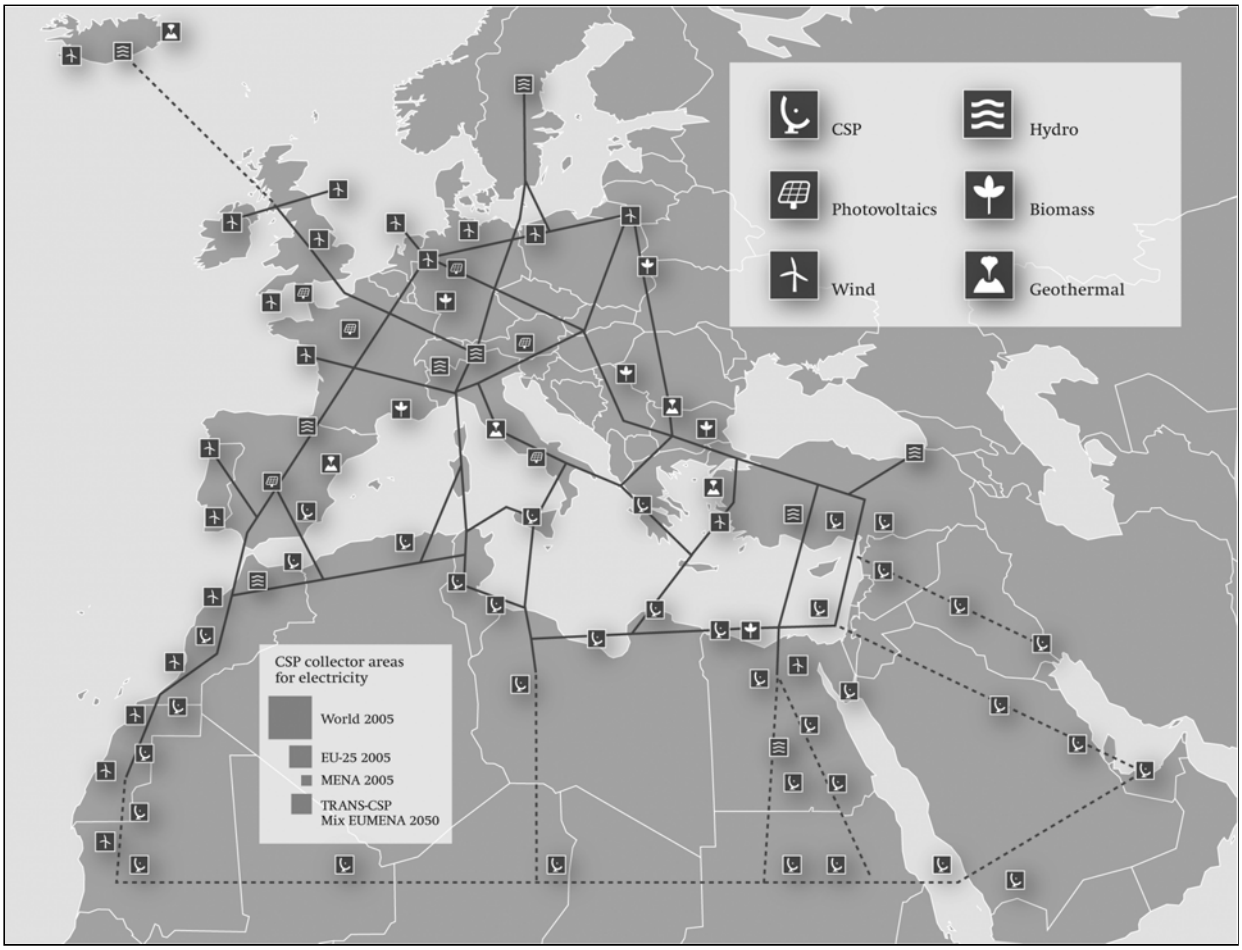
But because CSP technology depends on strong solar radiation, its use is restricted to the sun belt between latitudes 35° north and 35° south, which includes the Sahara Desert. And the mirrors required to focus the sun's rays require a great deal of space, additionally restricting the choice of location. Under these criteria the great deserts of the sun belt are an obvious choice. Although these locations present specific problems of their own (for example from an economic and ecological perspective neither power station cooling nor mirror cleaning after sandstorms should be carried out simply using water), but alternative solutions are in sight.[27]

By 2009 there were 430 MW of installed CSP generating capacity up and running worldwide, 500 MW under construction, and up to 9,000 MW in advanced stages of planning. Spain is the leader for CSP generation: in 2009 six plants with 81 MW of capacity were on the grid, and a further twelve with 839 MW of capacity under construction. The United States is the

23 German Aerospace Centre, *Concentrating Solar Power for the Mediterranean Region* (see note 4).
24 German Aerospace Centre, *Trans-Mediterranean Interconnection for Concentrating Solar Power* (see note 4).
25 German Aerospace Centre, *Concentrating Solar Power for Seawater Desalination* (see note 4).

26 Greenpeace International, SolarPACES and ESTELA, Concentrating Solar Power (see note 10), 63.
27 Solar Millennium uses the more costly dry cooling method at its CSP plant in the Nevada Desert. The plant's efficiency suffers, but water consumption is cut by 90 percent; Todd Woody, "Solar Developer Abandons Water Plans", *New York Times*, 16 November 2009, http://greeninc.blogs.nytimes.com/2009/11/16/solar-developer-abandons-water-plans (accessed 5 January 2010).

Map 1
Desertec – Planned network of power stations generating electricity from renewable sources and transmission lines between the EU, North Africa and the Middle East



Source: Desertec Foundation, adapted and optimised for publication by Can&Able.

leader in planning with between 3.9 and 5.2 GW of capacity in the pipeline, followed by Spain with 2.2 GW. By way of comparison, the German Krümmel nuclear plant has a rated output of 1.4 GW, the German lignite-fired power station at Schwarze Pumpe 1.6 GW.

Research and development are still needed in four central areas:

- Technological improvements to reduce costs and improve performance and reliability;
- Flexibility in generation through hybrid operation and heat storage;
- Increasing economies of scale in terms of both plant size (installed output) and number of plants;
- Improving the ecological footprint (consumption of land and water).[28]

28 ESTELA, *Solar Power from the Sun Belt* (see note 3), 10.

Electricity transport and distribution also turn out to present great challenges, not only in completing a transmission ring round the Mediterranean and undersea connections crossing it, but also absolutely centrally the expansion and modernisation of the European and above all North African networks. Because of the uneven geographical distribution of renewable energy sources – solar, water, wind, geothermal, and biomass – a supergrid (or transnational distribution network) is essential if we are to open up their full potential and convey their power to the centres of consumption (see Map 1).

The purely technical questions surrounding transmission of "green electricity from the desert" are resolvable. High voltage direct current (HVDC) transmission lines are the obvious choice. Such lines spanning distances of 2,000 kilometres already exist in China. The transmission losses of 3 to 4 percent per

Text Box 1
Concentrated Solar Power (CSP)

There are several different approaches for using solar thermal energy on a large scale by concentrating the power of the sun. Two technologies currently look especially promising for commercial application: parabolic trough and central receiver.

In **parabolic trough** power plants long trough-shaped parabolic mirrors concentrate sunlight to heat a medium in a pipe running in the line of focus. Linear Fresnel technology, which functions similarly, represents an advanced variant. In both cases the plant comprises a solar array and a generating block, which means that the technology is open for hybrid operation where the steam turbines can also be powered by gas. Depending on the arrangement of collector units, parabolic trough power stations can generate 10 to 300 MW of electricity. This technology is used in the Andasol complex in the Spanish province of Granada, and also in the Californian Mojave Desert. Commercial plants have been operating since 1984.

In **central receiver** power plants (also known as solar power tower) the solar radiation is focussed onto the top of a solar tower by a circular array of mirrors (heliostats). The operating temperatures that can be achieved match those of the conventional steam power cycle, which opens up the possibility of powering a turbine using steam generated directly in the solar tower. Large plants comprising hundreds of square metres of heliostat and tower heights between 100 and 200 metres can generate many hundred megawatts of electricity. The high operating temperatures enhance efficiency, because more heat can be stored. Europe's first commercial plant of this type went into operation in Seville in 2006, other pilot plants are operating in the United States and Israel. The plants that have already come on stream have outputs between 10 and 20 MW; stations with up to 50 MW output are already in planning.

Dish-Stirling units generate between 10 and 50 kilowatts using a concave mirror that tracks the sun and focuses its energy onto a heat exchanger (receiver) where the concentrated solar energy heats up the medium (helium or hydrogen) of a Stirling engine. Large numbers of Dish-Stirling units can be connected together in "solar farms" generating several megawatts of electricity, but the technology is of most interest for decentralised generation, as well as for isolated off-grid applications in rural areas not connected to the national grid.

Source: ESTELA, *Solar Power from the Sun Belt: The Solar Thermal Electricity Industry's Proposal for the Mediterranean Solar Plan: A Programme of the Union for the Mediterranean* (Brussels, June 2009); Jens Hobohm and Kirsten Westphal, *Strom aus der Wüste – technisch-wirtschaftliche und politisch-regulative Herausforderungen*, Arbeitspapier FG8, 6/2009 (Berlin: Stiftung Wissenschaft und Politik, December 2009); Daniel Schäfer, "Solarthermie: Physik und Technik der Solarthermie in Afrika", *Spiegel der Forschung* 25, no. 2 (December 2008), 11–15.

thousand kilometres are comparatively small. Overhead lines can now carry 800 kV DC at costs comparable to AC lines. But underground and underwater cables are restricted to 350 to 500 kV and cost a good deal more.[29] The longer the distance, the more strongly the cost per kilometre falls, because the transformers at the beginning and end are the most costly element, while the investment in cable is similar to AC lines.

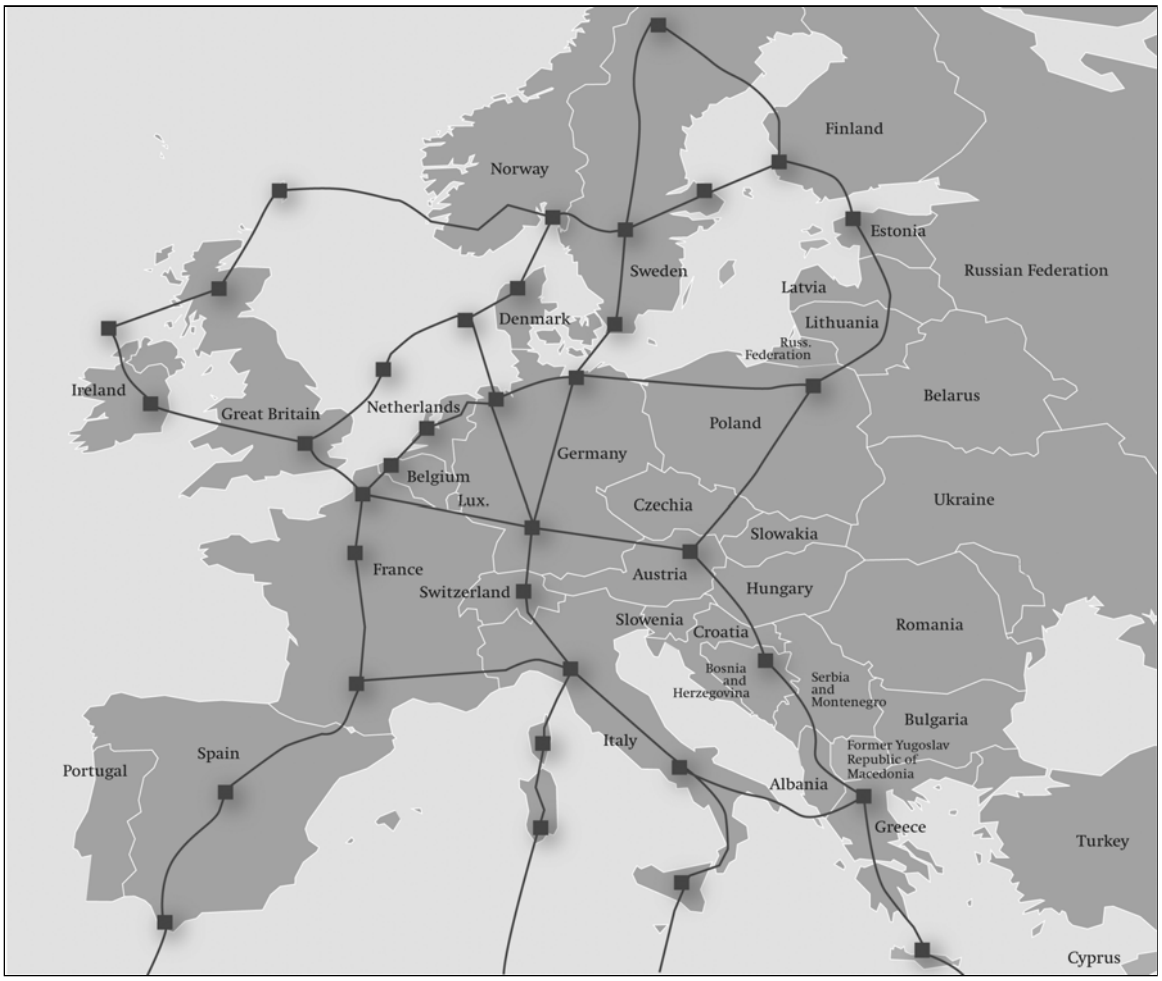
At this point the problem becomes more complex. Point-to-point transmission is technically feasible, but complicated. It demands the interconnection of different grid systems, where load and tension alter when electricity is fed in. Furthermore, as a secondary source of energy, electricity is difficult to store, meaning that generation and consumption need to be matched and coordinated with one another.

Under these conditions the question of where imported green electricity is to be fed in needs to be weighed up very carefully. Fundamentally the advantages of larger grids are obvious: the larger and denser the network, the less expensive spare generating capacity needs to be kept ready. But because network expansion also causes considerable costs, an economic optimum between expansion and reserve capacity needs to be sought.

The great challenges associated with electricity transmission on the southern shores of the Mediterranean are self-evident, because the transmission ring round the Mediterranean is not yet functioning, in fact does not yet exist at all. The electricity networks of Morocco, Algeria and Tunisia are synchronised with

29 ESTELA, *Solar Power from the Sun Belt* (see note 3), 10.

Map 2
Projected expansion of the European long-distance grid



Source: ABB; adapted and optimised for publication by Can&Able.

the continental European UCTE network. But so far neither the Libyan nor the Egyptian network is synchronised with the continental European network or with its neighbours. The Mediterranean transmission ring also lacks connections from the Turkish and other eastern Mediterranean electricity grids to the European network.

To sum up, we can say that the technology for generating and distributing solar electricity has been developed and already finds itself in the trial and testing phase. But it is still comparatively expensive, because the economies of scale in production and construction have not yet taken effect to a sufficient extent. But the time is favourable for more intensive application of this technology, because many power stations and networks are due for replacement, modernisation and expansion. It is increasingly apparent that the network in particular is becoming a bottleneck, standing in the way of massive expansion of electricity from renewable energy (and with it, significant reductions in greenhouse gas emissions). Production of renewable energy (e.g. offshore wind parks, hydro power in Scandinavia and the Alps) takes place far from the centres of consumption. In order to make full use of the locational advantages of renewables, a major cross-border transmission network is needed (a supergrid). The larger the quantities of fluctuating renewable energy fed into the grid, the more important will be the technical and "intelligent" dimension of the network (smartgrid), in order to coordinate supply and demand.

Apart from clarifying the technical questions, establishing a political and regulatory framework is crucial if we are to advance transmission networking and establish commercially profitable CSP technology in the market.

Text Box 2
The Supergrid Challenge

An electricity grid has to maintain a dynamic equilibrium between the level of generation and strongly fluctuating consumption, otherwise network voltage and frequency may drop, leading in the worst case to complete power failure (blackouts). Transmission network overload can lead to similar consequences. To account for this vulnerability the transport and distribution systems for electrical power are constructed as dense networks so as to preserve the functioning of the system as a whole in case of failure at a single point (power station or transmission line) (the [n-1] principle).

A transmission network must be capable of coping with temporary local loss of load or input. The load curve fluctuates according to the time of day (categorised as base, mid and peak load). The conventional spectrum of power generation has specific solutions for each load category. Different types of power station can be powered up with different degrees of flexibility and can therefore be applied in combination to cope with the various load configurations. The biggest challenge with renewables is their fluctuation. For example, electricity from wind turbines is supplied according to the strength of the wind rather than following the load curve.

Half Way There: Legal and Institutional Framework

Over the past decade the EU and the states of North Africa have successively created an initial legal and institutional framework for large-scale expansion of renewable forms of energy, for their domestic use and for their export. The political environment for renewables to play a greater role in the individual national electricity markets has improved. The EU is also making steady progress in establishing a regulatory framework.

Nonetheless there remain two fundamental problems that are closely tied up with the creation of a legislative and regulatory framework: Firstly, the existing energy policy framework in Germany and in the EU is still one tailored to conventional energy systems. Fossil fuels account for 58 percent of the electricity mix in the EU-27, with another 17.6 percent from nuclear and 18.4 percent from hydropower. Fossil fuels are subsidised directly, or at least indirectly through externalisation or inadequate pricing in of their environmental and climate costs. This is one reason why clean renewable energy requires "expensive subsidies". Secondly, the energy sector is highly structurally conservative, with investment cycles of thirty or forty years. So, simply on a structural level, the innovation potential is comparatively small. Associated with this, there has been, thirdly, a lack of the bold big decisions required to enable functioning cross-border trade in green electricity.

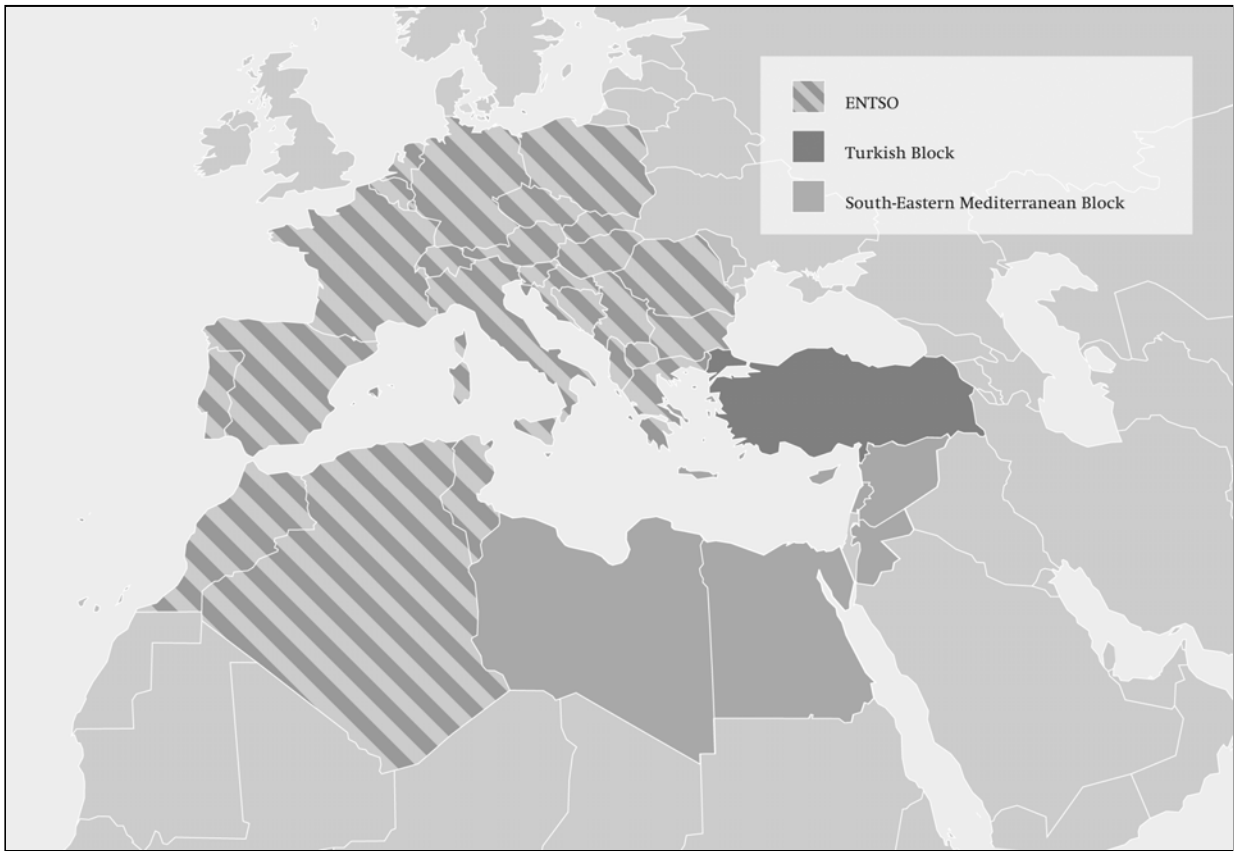
European level

With the 20-20-20 initiative, launched in January 2007 with the publication of "An Energy Policy for Europe", the EU took an important step towards an EU-wide expansion of renewable energy.[30] The 20 GW target of the Mediterranean Solar Plan is also based on this initiative. The 20-20-20 initiative sets a legally binding target of increasing the proportion of renewables in the overall energy mix to 20 percent by 2020. That would mean generating 34 percent of electricity from renewables. Even if the sector has recorded growth rates of around 250 percent over the past seven years,[31] the EU is still going to narrowly miss its self-imposed objective of generating 21 percent green energy by 2010.[32]

The April 2009 directive on the use of energy from renewable sources represented a practical step forward for the desert solar projects.[33] Unlike its precursor, this directive opens up the possibility for the EU member states to encourage project-based

30 See footnote 5.
31 "EU-Industrie meldet starkes Wachstum bei erneuerbarem Strom", Euractiv.com, 25 November 2009, www.euractiv.com/de/energie/eu-industrie-meldet-starkes-wachstum-erneuerbarem-strom/article-187659 (accessed 27 November 2009).
32 European Commission, *The Renewable Energy Progress Report: Commission Report in accordance with Article 3 of Directive 2001/77/EC, Article 4(2) of Directive 2003/30/EC and on the implementation of the EU Biomass Action Plan, COM (2005) 628*, Brussels, 24 April 2009, COM (2009) 192, 3.
33 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, *Official Journal of the European Union*, L 140 of 5 June 2009, 16–62.

Map 3
Existing networks in Europe and the Mediterranean region



Source: UCTE, adapted and optimised for publication by Can&Able.

Table 2
Proportion of renewable energy in electricity mix and national targets in the EU

	*2020 target**	*2010 target***	*Proportion of renewable energy in electricity mix in 1997 (reference year)*	*Proportion of renewable energy in electricity mix in 2006*	*Proportion from hydropower (2006)*	*Proportion from wind power (2006)*	*Proportion from solar power (2006)*
EU-27	20%	21.0%	12.9%	15.7%	9.2%	2.5%	0.007%
Germany	18%	12.5%	6.3%	12.6%	3.2%	5.0%	0.358%
France	23%	21.0%	15.6%	14.3%	11.1%	0.4%	0.002%
Italy	17%	22.55%	15.5%	18.3%	10.3%	0.8%	0.010%
Spain	20%	29.4%	16.5%	19.1%	8.7%	7.9%	0.042%

* 2020 target is binding and refers to the proportion of renewables in the overall energy mix.
** 2010 target is not legally binding; states a desired proportion of renewables in electricity generation.
Source: Eurostat 2008; European Commission, *Renewable Energy Progress Report*, working paper, Brussels, 24 April 2009, SEC (2009) 503 final.

infeed of renewable energy from third countries (Articles 9 and 10). It must be noted, though, that while the member states are granted flexibility in this respect, no concrete EU-wide targets are set. The directive also sets national targets under which the member states must draw up national action plans for expanding renewables energy by June 2010.

Although it is positive that such measures apply a certain pressure on European governments to focus more strongly on renewables – for example the lead nations for the solar projects, Germany, France and Spain, have all created stable conditions for domestic expansion of renewables by guaranteeing fixed feed-in tariffs for fifteen to twenty-five years – they are primarily concerned with domestic production, because its expansion contributes to both climate protection and reducing dependency on imports. For the same reason the EU still has no harmonised regulatory framework for cross-border trade in renewables. If such conditions did exist then the principles of non-discrimination and most favoured nation would apply and force countries to open up their national markets. Germany has joined the opposition to such a move, out of concern about the impact on its domestic wind and photovoltaic industries that currently profit from protected and to that extent very favourable national conditions.

The power of Brussels in energy policy is also constrained because this is a field with shared responsibilities. The Commission's Strategic Energy Technology Plan (SET Plan) of 2007 seeks to promote expansion and secure commercial application of future energy technologies without creating the impression of interfering with national sovereignty over the composition of the energy mix, which would provoke knee-jerk defensive reactions in the member states.[34] The Commission is similarly cautious on the question of grid expansion, which is ultimately subject to private-sector commercial calculations. The relevant Trans-European Energy Networks programme (TEN-E) has so far largely funded feasibility studies addressing questions of an intelligent bi-directional network.

But gradually a political and thus structural transformation has been able to take hold. As also demonstrated by the third internal market package of 2007, EU energy policy has long been swayed by the competition paradigm and the principles of unbundling and liberalisation. Here too, the primary focus was on the level of the individual member states, which meant that the question of real integration of the markets was left by the wayside.[35] The fact that the EU lacks a common energy market, with its constituent national (or at best regional) markets largely cut off from one another is increasingly coming to be regarded as a problem, and not only in Brussels. Above all – as one lesson from the gas crisis of 2009 – the insight is gaining ground that a functioning internal energy market with integrated regulation and infrastructure would also represent a step towards greater energy security. But this can only be the case if the cross-border connections are expanded and similar access and trading rules exist in all the member states. To that extent, the EU and its member states have arrived at a turning point in European energy policy.

In July 2009 all the European transmission system operators joined together in a single organisation that replaced the former six associations and now includes forty-two system operators from thirty-four countries. Also in July 2009, the EU issued a series of regulations concerning the internal market in electricity, expansion of cross-border connections and creating a level playing field for all electricity companies that must be implemented in national law by 3 March 2011.[36] The previously voluntary cooperation of the national regulatory authorities has shifted to the Community

34 It says a great deal that the lion's share of investment in CSP technology (56 percent) has so far come from the private sector, above all from German and Spanish companies. The member states of the EU contributed 38 percent of spending and the EU 6 percent from the Sixth Framework Programme. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Investing in the Development of Low Carbon Technologies(SET-Plan), Brussels, 7 October 2009, SEC (2009) 1295, 47.

35 See Susanne Dröge, Oliver Geden and Kirsten Westphal, *Internationale Energie- und Klimapolitik – Spielräume für Akzentsetzungen der Bundesregierung*, SWP-Aktuell 59/2009 (Berlin: Stiftung Wissenschaft und Politik, November 2009).

36 Regulation (EC) No 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators, Official Journal of the European Union, L 211 of 14 August 2009, 1–14; Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003, Official Journal of the European Union, L 211 of 14 August 2009, 15–35; Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, Official Journal of the European Union, L 211 of 14 August 2009, 55–93.

level with the creation of a new agency (ACER), which gives it a binding character, and the agency itself has been given clear powers. But structural changes in the electricity sector take a long time: The harmonisation of seven regional European markets and improving and increasing transparency in management of interconnector overload have been on the agenda of the regulatory authorities since 2006 but they have so far been unable to make any great visible progress.

The extent of wrangling between Brussels and the member states especially over questions of the electricity market means it is difficult to estimate to what extent the new measures will advance cross-border trade in electricity. And with the deadline not until 2011 it is still too early anyway. But the package of measures demonstrates the will of Brussels to make progress in establishing an integrated electricity market, also with an eye to intensifying the use of renewable non-fossil electricity sources. Uncertainty about whether this really means a decision of principle is costly because it delays and hampers commercial planning.

Interregional level

In the context of establishing a political and regulatory framework at the interregional level, it is relevant that the EU has been working since 1995 through the multilateral Barcelona Process (Euro-Mediterranean Partnership) for a gradual integration of electricity grids and promoting programmes whose focus lies on renewables.[37] However, progress to date has remained exceptionally modest. The creation of the Union for the Mediterranean on 13 July 2008 and the launch of the Solar Plan have sent important political and institutional messages (although largely still just on paper). The organ that is supposed to push forward, coordinate and supervise implementation of the Solar Plan, the secretariat, does not even exist yet. Although scheduled to begin work in May 2009, disputes over its budget and staffing still kept it from operating in spring 2010.

This was above all because of political obstructionism following the Gaza War of winter 2008–09 and tussles within Europe over the secretariat's form. The Solar Plan was only able to advance in an informal working party made up of Egypt, France, Germany, Italy, Morocco, Spain and Tunisia with the European Commission as observer. The original three-phase timetable schedule is already close to a year behind (2009–10 preparation of a strategy plan; 2010–11 initiation phase; 2011–20 implementation of the master plan).

Since 2004 the EU has been working above all through the framework of the European Neighbourhood Policy (ENP) to effect changes in the legal and regulatory framework in the Mediterranean region. Harmonisation of energy policies is central here,[38] seeking a gradual and selective adoption of the energy-relevant parts of the acquis by the ENP member states. The EU places great importance on exporting its body of common legislation in the fields of market liberalisation, regulation and environmental protection. Corresponding provisions are found in the bilateral ENP Action Plans negotiated with Egypt, Morocco and Tunisia, but these are mostly vaguely worded. The EU also signed a Memorandum of Understanding on intensified energy cooperation with Morocco in 2007, and one with Egypt in 2008. Egypt and Tunisia have received funds from the Neighbourhood Investment Facility for electricity grids and for generating electricity from renewables.[39] And last but not least, in 2008 the regional policy platform RCREEE (Regional Centre for Renewable Energy and Energy Efficiency) was founded in Cairo to advance joint research projects and networking of relevant actors in the region, co-funded by the European Commission and Germany.

But reforms in the energy sector are politically and materially costly for the North African states, so persistence will be required. Thus far only Tunisia and Morocco have partly liberalised their electricity markets. Far-reaching liberalisation of the sector and the associated deregulation of energy prices would – at least in the short term – come with high socio-economic costs (and possibly provoke protests). Matters are further complicated in the oil- and gas-

37 For example projects and programmes such as Med-EMIP (Euro-Mediterranean Energy Market Integration Project), MEDREG (Association of the Mediterranean Regulators for Electricity and Gas), IMME (integration of the Maghreb electricity market), MED-ENEC I&II (energy efficiency and promotion of renewable energy in construction and related sectors).

38 Council Decision of 29 May 2006 on the conclusion by the European Community of the Energy Community Treaty, Official Journal of the European Union, L 198 of 20 July 2006, 15–17 (16).

39 European Commission, Implementation of the European Neighbourhood Policy in 2008, Sectoral Progress Report, SEC (2009) 522/2, Brussels, 23 April 2009, 17, http://ec.europa.eu/world/enp/pdf/progress2009/sec09_522_en.pdf (accessed 2 December 2009).

rich states of Libya and Algeria by their emphasis on national sovereignty as the leading paradigm in this strategically crucial sector. Both countries steadfastly resist externally induced reforms, and both accordingly refuse to this day to participate in the neighbourhood policy. It is anybody's guess to what extent the negotiations over a framework agreement for Libyan cooperation with the EU, which have been running since 2008, will prioritise regulation and harmonisation in the field of energy (and indeed whether it will be signed at all in the foreseeable future). Although in the works for years, a memorandum of understanding on energy cooperation with Algeria has still not been concluded.[40] Especially in sectoral cooperation in the field of energy, the EU is in the weak negotiating position of a "demandeur". The EU can perhaps offer states the privileged partnership of a "statut avancé" (as has existed with Morocco since 2008) but ultimately in the southern Mediterranean it simply lacks the incentives and sanctions associated with an accession perspective.

In the southern partner states

The fact that in North Africa legal and institutional foundations for using renewable energy have been laid during the past decade is largely connected with internal developments. Within just a few years awareness has rapidly emerged that the rising consumption of energy demands greater investment in generating capacity and electricity grids, and in some cases costly electricity imports. In the meantime all the states in the region – with the exception of Libya – possess corresponding legislation (Algeria, Morocco, Tunisia), or at least draft proposals (Egypt) and programmes for promoting renewables. Beyond that, each now has state agencies researching renewables and supporting relevant projects, as a rule principally in the field of solar and wind power as well as geothermal. Several North African states are now pursuing exceptionally ambitious concrete goals in relation to the proportion of renewables in the national electricity mix.

- *Egypt* has set itself the target of increasing the proportion of renewables in the national electricity mix to 20 percent by 2020. The draft of the new national energy act proposes numerous incentives for the production of green electricity.[41]
- *Algeria*, a leading producer of oil and gas for Europe, aims to cover 6 percent of its electricity needs from renewables (solar, wind, biomass and geothermal) by 2015 and 10 percent of its energy demand by 2025.[42] The Feed-In Act of 2004 seeks to increase the use of solar in hybrid plants through price premiums linked to the solar share achieved.[43]
- *Morocco* hopes to boost the share of renewables in the national energy mix to 10 percent by 2012. In November 2009, in the presence of US Secretary of State Hillary Clinton, the king launched an open-technology solar project into which $9 billion are to flow. By 2020 this initiative should be producing 2 GW of solar electricity.
- *Tunisia's* energy programme for 2008–2011 proposes reducing energy consumption by 20 percent by 2011 and covering 4 percent of the remaining consumption from renewables.[44] In 2009 the government started Plan Solaire Tunisien, which has an investment volume of €2 billion and is state-subsidised to the tune of €590 million. It funds forty projects above all in the fields of solar technology, wind power and bioenergy, but also energy efficiency. Of all the North African states Tunisia has thus far pursued energy savings most energetically and thoroughly.

The feed-in arrangements for solar thermal power stations are still largely unclarified, even though these more than all else are decisive for their financing. For the moment, developments are proceeding according to the principle of "regulation by contract". Investors in solar thermal projects conclude supply contracts with private or state-run energy companies. The Algerian solar thermal power station at Hassi R'Mel, for example, which is due for completion in 2010,

40 Ibid., 13.

41 Kilian Bälz, Egypt – New Law to Boost Renewable Energies (Cairo: Regional Center for Renewable Energy and Energy Efficiency, 2009), www.rcreee.org/documents/articles/Egypt.pdf (accessed 5 January 2010).

42 Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power* (see note 10), 44.

43 Algerian Minstry of Energy and Mines, Guidelines to Renewable Energies: 2007, www.mem-algeria.org/fr/enr/Guide_Enr_ang.pdf (accessed 5 January 2010); see also Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power* (see note 10), 44.

44 Agence Nationale pour la Maîtrise de l'Énergie, *Programme Quadrennial de Maîtrise de l'Énergie 2008–2011*. Tunisia also operates with direct subsidies and tax breaks; République Tunisienne, Ministère de l'Industrie, de l'Energie et des Petites et Moyennes Entreprises, La loi n°2004-72 du 02 août 2004 relative à la maîtrise de l'énergie, Tunis 2004, www.anme.nat.tn/sys_files/medias/documents/publications/loi_72.pdf (accessed 5 January 2010).

was only built because the state oil and gas company gave purchase guarantees.

Most of the North African states are likely to miss their self-imposed short- and medium-term targets for renewables. But simply setting goals has placed the governments under a certain pressure to act and generated positive dynamics – not least because of long-standing rivalry between states (e.g. Algeria and Morocco, Tunisia and Morocco) when it comes to demonstrating their progress and modernity to the outside world.

Early Days Operationally

The record of the recent years is certainly encouraging on paper. The picture on the ground is more ambivalent, though, because realisation of the various large-scale projects is still in the early stages and developments are basically starting from scratch.

Decentralised production and consumption of electricity using wind power and photovoltaic have been going on in parts of North Africa for more than a decade already. In Morocco at the end of 2008, for example, a good 10 percent of the villages electrified in the past decade were using solar electricity (3,653 of 34,419).[45] By summer 2008 Tunisia had used solar to bring electricity to almost 12,000 households in remote regions and to two hundred schools. Wind farms are found in Egypt, Morocco and Tunisia. In Morocco wind is already producing several hundred megawatts of electricity and the perspectives for expanding its use in a big way are excellent, especially on the Atlantic coast.

But there is not yet one single solar thermal power station on stream in North Africa. In Egypt, Algeria and Morocco the first hybrid plants are at least under construction (see Table 4), but their solar component will be very small. Only in the Algerian case will solar thermal amount to more than 5 percent of total output. Two further 400 MW hybrid power stations with a solar component of 70 MW each are in planning in Algeria, and Morocco intends to invite tenders for three power stations of the same type in 2010 or 2011. Tunisia, finally, is currently preparing a partly German-funded CSP study and intends to invite tenders for its first power station in 2010.[46]

Funding of plant construction has so far tended to be rather untypical for large-scale projects. In the Egyptian and Moroccan cases funding comes above all in the form of grants from institutions like the World Bank and the Japanese and African development banks, where the donors prioritise technology-testing and the aspect of development transformation; consequently profitability was not a decisive criterion.

Alongside the construction of generating capacity, the realisation of the solar initiatives also presupposes the expansion and modernisation of transmission networks. This means not just the transmission links across the Mediterranean, but also integration in the European interconnected network (UCTE), which in turn connects different networked regional and national electricity markets which all already face specific problems.

At the regional level in North Africa, the first steps have already been taken towards creating the MedRing, a transmission ring running around the Mediterranean, the first precondition for feeding North African electricity into the European grid. Interconnectors already link all the North African states. The capacity of the links between Algeria, Morocco and Tunisia is currently being upgraded from 220 to 400 kV. Libya has also been connected with Tunisia since 2003, but synchronisation has thus far been impossible so neither Libya nor Egypt are yet connected to the UCTE grid. A transmission line between Morocco and Spain across the Straits of Gibraltar opened in 1997 (capacity 1,400 MW), but so far electricity has flowed predominantly from Spain to North Africa. Implementation of the desert solar projects would also require functioning transmission lines from Tunisia to Italy and Turkey to Greece.

45 Interview with the Moroccan energy minister, *Jeune Afrique* 2514 (15–21 March 2009), 71.

46 Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power* (see note 10), 45.

Table 3
Share of renewables and national goals in North Africa

	Goals	*Share of renewables*
Egypt	2020: 20% of electricity mix	1.2% of electricity production (2009)
Algeria	2015: 6% of electricity demand	< 1.0% of electricity production (2008)
Morocco	2012: 10% of energy mix	3.9% of energy mix (2009)
Tunisia	2011: 4% of energy consumption	1.0% of electricity production (2009)

Sources: Royaume du Maroc, Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement, *Energie renouvelable*, www.mem.gov.ma/Realisations/energie_renouvelable.htm; New and Renewable Energy Authority (Cairo); New Energy Algeria.

Table 4
Solar thermal power stations in North Africa

	Location	*Status*	*Type*	*Output*	*Funding*
Egypt	Kureymat	planned completion 2010	Solar/gas combined cycle	150 MW, of which 20 MW solar	includes World Bank, Japanese Development Bank, Egyptian state
Algeria	Hassi R'Mel	planned completion 2010	Solar/gas combined cycle	150 MW, of which 30 MW solar	Algerian state
Libya	–	–	–	–	–
Morocco	Ain Beni Mathar	construction start 2008	Solar/thermal combined cycle	472 MW, of which 20 MW solar	includes African Development Bank, World Bank, Moroccan state, Istituto Credito Official (Spain)
Tunisia	Project study	–	–	–	includes Kreditanstalt für Wiederaufbau through the Neighbourhood Investment Facility

Sources: New Energy Algeria; New and Renewable Energy Authority (Cairo); Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power: Global Outlook 2009: Why Renewable Energy Is Hot* (Amsterdam, Tabernas and Brussels, 2009), 44, www.greenpeace.org/raw/content/international/press/reports/concentrating-solar-power-2009.pdf.

Structural Barriers and Conflicts of Interest

Even if the trend is encouraging, our stocktaking of the situation with renewables north and south of the Mediterranean produces an ambivalent picture. There is no saying whether solar electricity from North Africa will become reality or remain a dream. The solar projects are complex, and structural hurdles and conflicts of interest need to be overcome on three levels (nation-state, EU, interregional) and in numerous policy fields (energy, economic, financial, security, foreign policy). Upon closer examination we find that most of the obstacles are surmountable, and that the conflicts of interest need not represent a serious impediment to implementation.

Financial and Commercial Hurdles

Cost of power stations

The investment volume proposed by DII is enormous: €400 billion by 2050. Even with a timeframe of forty years and investment shared by a broad consortium of banks and businesses, the amount the individual partners would have to find annually would swallow up or exceed their normal investment budgets.

For implementation of the Solar Plan and construction of 20 GW of capacity by 2020 the solar thermal industry estimates the cumulative investment to amount to about €97 billion. Of that sum, €81 billion would flow into power station construction and €16 billion into the transmission lines.[47]

At least two specific aspects of the energy business have a bearing on these huge investments.[48] Firstly, investment decisions must be made under conditions of considerable uncertainty. The future price trends of other fuels are unknown, for example. The relationship between power station construction and transmission line construction produces another source of uncertainty. A decision to build a power station presupposes that the electricity it generates can be fed into a grid (and exported). The grid operator in turn would like to have security that transmission lines will actually be used and thus pay their way before making such a huge investment. This "chicken and egg" problem is exacerbated by the EU's wish – in line with the competition paradigm – to keep generation, transport and distribution of electricity in separate hands. Economic vagaries are joined by uncertainty about future developments in the political and regulatory framework in the different markets.

Secondly, there is currently a lack of direct economic incentives for investment in solar power stations in North Africa. The mean capital costs per kilowatt of installed capacity amount to €4,000 (2008), which is greater than the comparable figures for offshore wind power (€3,000), nuclear power (€3,500), coal with CCS (€3,500), conventional coal (€1,200) or gas/steam turbines (€1,000).[49]

This shows very clearly that the costs at which solar thermal electricity can be produced in North Africa are too high for this option to compete on the European markets – still less on the North African markets where electricity prices are generally highly subsidised (see "Cost Calculations in Detail", p. 25).

The figures discussed above are intended to show the relative order of magnitude and should not be regarded as absolute. Ultimately a series of unknowns need to be factored in. New technologies usually pass through several phases before they become competitive: from research and development through demonstration of feasibility and reliability to cost reduction for competition. CSP technology today has arrived at a point where it still has to be made a bankable commercial proposition. Experience suggests that we can expect a considerable cost degression when the technology is refined and tested in the upcoming stages. Efficiency improvements and learning effects in planning and operation of plant and components will also take effect. And by building ever larger power stations economies of scale will be achieved.

47 ESTELA, *Solar Power from the Sun Belt* (see note 3), 12.

48 For more detail see Peter Winker and Christoph Preußner, "Solarkraftwerke in Nordafrika und Energiepartnerschaft mit Europa: Einige Anmerkungen aus ökonomischer Sicht", *Spiegel der Forschung* 25, no. 2 (December 2008): 34–38, http://geb.uni-giessen.de/geb/volltexte/2009/6735/pdf/SdF_2008-02-34-38.pdf.

49 Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power* (see note 10), 67.

Text Box 3
Cost Calculations in Detail

Even if the relevant studies largely agree on the order of magnitude, the variance in the data is large. The production cost of electricity from CSP currently amounts to about 15 cents per kilowatt-hour (kWh) in locations with strong solar radiation and 23 cents/kWh at sites with less strong solar radiation. The Solar Plan calculates on the basis of production costs of 21.6 cents/kWh. By way of comparison, the average generation costs of conventional power stations are 3 to 18 cents/kWh, but here the costs of global warming and pollution are largely externalised.[a] The average cost for onshore wind turbines in good locations is 3 to 5 cents, for offshore wind turbines 5 to 8 and for photovoltaic systems 16 to 54 cents/kWh.

Heat storage – which is the essential precondition for night-time operation and its great potential for improving cost efficiency – could reduce the cost by a further 2 cents. Another reduction could be achieved through revenues from seawater desalination. But the cost would still be too high, because an estimated additional 2.3 cent/kWh must be allowed for subsequent transport. This produces total costs of 23.9 cent/kWh. Studies suggest that the cost of the collectors should halve once total installed capacity reaches 7 to 10 GW, which would bring the pure production cost down to 10 to 14 cent/kWh by 2020. By that time, it is assumed, transport costs will also have fallen to 1.8 cent/kWh. Under these conditions the power station projects would be commercially profitable and fundable through the banks.

a Estimates put the externalised costs at 1.1 to 3 cent/kWh for gas-fired and 3.5 to 7.7 cent/kWh for coal; Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power: Global Outlook 2009: Why Renewable Energy Is Hot* (Amsterdam, Tabernas and Brussels, 2009), 61, www.greenpeace.org/raw/content/international/press/reports/concentrating-solar-power-2009.pdf).

Sources: Ibid.; ESTELA, *Solar Power from the Sun Belt: The Solar Thermal Electricity Industry's Proposal for the Mediterranean Solar Plan: A Programme of the Union for the Mediterranean* (Brussels, June 2009); Deutsche Bank, *The CSP Industry: An Awakening Giant* (Frankfurt am Main, 16 March 2009).

Under a concerted expansion solar thermal power stations could be operating profitably within ten to twenty years. By that time, with corresponding development of the technology paths and the existence of suitable regulatory paths, the prices of renewables could have come down close to those of fossil fuels, and solar thermal might indeed even be cheaper.

The speed and extent of cost reduction is, however, difficult to predict. And countervailing effects are conceivable. For example rising demand could make crucial plant components scarce and thus more expensive. Construction and operation in desert regions might involve unforeseen risks. Logistics costs will be higher because infrastructure is lacking on the ground. And the costs of security are not to be neglected. If we take the existing security measures in the Algerian oil and gas sector as a point of reference, considerable sums would have to be earmarked for this matter. Furthermore, the long-term reliability of the applied technologies – above all the collectors – in these regions has yet to be established in practice. Fluctuations between day- and night-time temperatures will impact the heat storage, cooling and generation technologies, as will sandstorms. So far there is a great lack of practical experience here.

In short: In view of the difficulty of calculating risks, the expected returns are currently too small for the private sector. The cost of electricity gained from solar power is too high for export – let alone for the local electricity markets.

The barriers to market entry mean that political support is crucial if the production of solar electricity is to make progress nonetheless. It is worth remembering the experience of the 1970s when solar thermal was first developed in response to the oil crises of that period. After the situation in the oil markets had calmed down most of the state research funding disappeared along with the economic incentives and much time was wasted.

Cost of transmission networks

A further problem is that system decisions have to be made concerning the expansion and overdue modernisation of the grids. Estimates put average investment costs for electricity links across the Mediterranean at €2 million per kilometre for a 400 MW cable. In the event of realisation of a Euro-Mediterranean grid the costs for cable and transformers would fall substan-

tially. The transmission costs could then be around €10/MWh per thousand kilometres.[50]

In a more general sense there is an increased investment risk. Because of the high fixed costs for the provision of infrastructure for building power stations and above all construction of the required network connections it is virtually impossible to proceed in small steps or units as has been the case with photovoltaic systems and onshore wind power. Even with falling costs only large plants will be economic, as is the case with the construction of large offshore wind farms or hydroelectric plant. Investments are subject to the risk of sunken costs, meaning that a power station or transmission line can only be relocated or dismantled at great extra expense. In North Africa there is moreover a risk that network operators could exploit their monopoly position vis-à-vis power station operators to keep the price high.

Political Hurdles

Fundamental decisions needed

The starting situation in Europe is difficult. Firstly, the given energy policy framework still caters to the conventional energy system, secondly, domestic sources of renewables are given unequivocal priority and thirdly, there are still only national or at best regional electricity markets. Generating capacity has grown in recent years but the required expansion of the networks has been neglected. The grids have become a veritable bottleneck, because both the national transmission networks and the interconnectors are operating at full capacity. This is not inconsequential for the expansion of renewables. As the EU Commission's *Renewable Energy Progress Report* of April 2009 states, about 30 percent of green electricity projects in the EU member states are turned down, often on grounds of inadequate grid capacity. The share of projects confronted with transmission problems is about 10 percent in France, over 30 percent in Germany and nearly 60 percent in Spain.[51] Cross-border electricity transfer in Europe is opaque and of marginal significance.

50 ESTELA, *Solar Power from the Sun Belt* (see note 3), 10. Desertec names a figure of up to €50 billion by 2050 for innovative HVDC lines between North Africa and Europe; Paul van Son, "Zeit für eine Revolution", *Süddeutsche Zeitung*, 17 February 2010, 21.

51 European Commission, The Renewable Energy Progress Report, SEC(2009) 503 final, working paper, 24 April 2009, 9f.

Energy nationalism and structural conservatism still predominate among member states and companies, reinforced by uncertainty about the future development and shape of the electricity network and the internal market. The new EU directive on the internal market in electricity also complains that this market lacks liquidity and transparency and hinders "the efficient allocation of resources, risk hedging and new entry".[52]

With maxims of liberalisation, low operator costs and third-party access to networks dominating the EU's thinking, incentives for expanding and modernising networks are unlikely. Furthermore, it is by no means decided who will bear the additional costs of network expansion, because it often suits businesses well to retain the current situation of largely isolated national markets. It remains to be seen whether the exemptions for major infrastructure projects such as the construction of direct current interconnectors provided under Article 17 of the new regulation on access to the network for cross-border exchanges in electricity of July 2009 will suffice to overcome the dominant market logic.[53] The existing nationally aligned infrastructures perpetuate entrepreneurial and management path dependencies, as well as regulatory ones. In a sense a vicious circle begins here. At the national and company level there is strong resistance to attempts to initiate "system breaks" at this point through network integration, and that undermines the financing and realisation of interconnectors. The conflicts between national and international interests in energy policy are very apparent here.

National electricity markets and conflicts of interest

Developments in energy mix and infrastructure are determined by particular path dependencies that rest above all on the profit-based operating logic of private energy companies. But aside from that, the realisation of a technically sensible solution (e.g. point-to-point transmission over a long distance into a purpose-built network) may be difficult for political reasons. For example, what interest does a transit region or country have in allowing additional transmission lines?

52 Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 (see note 36), 59.

53 Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 (see note 36), 24.

This question is central, given that it is becoming politically ever more difficult to realise grid development projects anywhere in Europe. Approval processes are often dragged out by objections based on the principle of "not in my backyard" (or in this case "not under and over my backyard").

The complexity of interests becomes clear if we examine the core group of four European states seeking to advance the Solar Plan.

Germany. As the party that proposed the Solar Plan for the Union for the Mediterranean, Germany has also made the greatest progress in the field of renewables. The Federal Environment Ministry's lead scenario for renewable energy of 2009 forecasts that by 2025 21.7 TWh of green electricity will be available annually from the European grid, and by 2050 up to 123 TWh, of which 9.7 TWh (2025) later rising to 84.5 TWh (2050) will be solar thermal.[54] Along with wind power, above all solar electricity from the integrated electricity network with North Africa is projected to cover a good 20 percent of Germany's gross electricity demand. That corresponds to an installed generating capacity of 1.5 GW in 2025 and 13 GW in 2050.[55] It must be noted, however, that this scenario was drawn up under the pre-2009 coalition government's plans to phase out nuclear power by 2020.

In fact Germany enjoys a relatively good situation in terms of electricity supply, and even exports small amounts to neighbouring countries. The country has agreed to successively increase the share of renewables in its electricity mix to 18 percent by 2020, and has already met the interim target of 12.5 percent by 2010. That puts Germany – alongside Denmark and Hungary – in the exclusive club of three states that have already passed this milestone. At the end of 2009 an estimated 43 GW of green electricity were being generated in Germany. In that respect Germany already exceeds its government's expectations by 10–15 percent.

But the energy consensus is crumbling and the new coalition of Christian democrats and liberals has major decisions to take about the remaining operating life of the seventeen nuclear power stations still in operation, new coal technologies and feed-in payments for photovoltaic electricity. At the same time conventional power stations are coming due for renewal and replacement, which is another reason for industry and politics to be interested in the solar partnership.

France. The government in Paris took on board the idea of the Solar Plan for reasons of prestige and for the project's energising effect on the Union for the Mediterranean. In fact France's interests are very mixed because the country is a classical net exporter of electricity. Nuclear power is the dominant source, supplying 80 percent of all France's electricity. For a long time France also found itself in the comfortable position of being able to export electricity from nuclear power. But deficits are becoming increasingly apparent in the power stations and the transmission grid. Several of the fifty-eight nuclear reactors are out of operation (down for maintenance or on strike). A shortage of high-tension transmission lines is also becoming noticeable, and in winter the supply situation can become difficult during peak-load periods in southern France and also Brittany.[56] Although traditionally a net exporter, France will probably increasingly have to import electricity from Germany to cover peak demand. France is also a very long way from meeting its target of 21 percent renewables in the electricity mix by 2010, despite the existence of a feed-in tariff. The reasons for this may lie in the comparatively high level of regulation in the French electricity market, which makes it difficult for newcomers to enter.

For all these reasons France really should have an interest in importing green electricity from North Africa. But at the same time the country is facing the massive problems described above and having to invest enormous sums in its own electricity sector. Another constant factor is France's overriding interest in exporting nuclear technology to North Africa. Although France has agreed to increase its share of renewables to 23 percent of the energy mix by 2020, meeting this target will demand very great efforts.

Spain. At first glance Spain would appear to be an obvious main importer and transit route because it already has transmission lines to Morocco and is geo-

54 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), *Langfristszenarien und Strategien für den Ausbau erneuerbarer Energien in Deutschland: Leitszenario 2009* (Berlin, August 2009), 11f, http://bmu.info/files/pdfs/allgemein/application/pdf/leitszenario2009_bf.pdf.

55 Ibid., 40–43.

56 "Angst vorm Blackout", *Süddeutsche Zeitung*, 5 November 2009, 19.

Text Box 4
Focus on Spain

Spain is a pioneer of the expansion of renewables – above all solar thermal – and theoretically an important bridgehead. The share of renewables in the electricity mix amounts to 25 percent and rising. Wind power accounts for 13 percent and solar power a further 2.5 percent. Spain is the global number two in generating solar electricity and number three in wind power; it is the leader in installed CSP capacity. Nonetheless Spain is facing great challenges in the electricity sector. So it is worth taking a closer look at the country.

Spain imports just 3 percent of its electricity needs. The supplier is France, from where there are just four connecting transmission lines. The last was constructed in 1982 and they are often overloaded. In fact, at the moment Spain is a net exporter of electricity, albeit at a very low level, to Portugal and Morocco. To illustrate: Spain's annual electricity consumption in 2007 was 267.8 TWh, its net exports 5.7 TWh.

The target Spain has reported to the EU for the share of renewables in its electricity mix by 2010 is 29.4 percent. The country's own national planning target from 2005 is even more ambitious at 30.3 percent. In order to meet these targets by 2010, 20,155 MW of wind power, 400 MW of photovoltaic and 500 MW of CSP are to be installed.

Spain is the first country in southern Europe to institute a feed-in tariff. The rate has increased steadily from 12 cent/kWh in 2002 to 26.9 cent/kWh today. It is guaranteed for twenty-five years, after which the rate will fall to 21.5 cent/kWh. With generating costs of between 15 and 23 cents that is attractive, because investments pay returns.

In the field of wind power Spain claimed a new record in November 2009: for a brief period more than half the country's electricity was supplied by wind turbines (53 percent). But it has also been known for output from the installed capacity of 11,000 MW (equivalent to eleven nuclear power stations) to drop to a negligible 200 MW within twelve hours. That illustrates how vulnerable this source of electricity is to fluctuation, and why reserve capacity has to be maintained in the form of flexible gas-fired power stations.

Sources: UCTE, *Transmission Development Plan, Update 2009*, 25–26; UCTE, *Statistical Yearbook 2007*, 40; "Eon will Geschäft mit Solarstrom vorantreiben", *Frankfurter Allgemeine Zeitung*, 26 November 2009, 16; Greenpeace International, SolarPACES and ESTELA, *Concentrating Solar Power: Global Outlook 2009: Why Renewable Energy Is Hot* (Amsterdam, Tabernas and Brussels, 2009), 69; "Spanien: Aufschwung erneuerbarer Energien als Motor für Gaskapazitäten", Euractiv.com, 25 November 2009, www.euractiv.com/de/energie/spanien-aufschwung-erneuerbarer-energien-motor-gaskapazitten/article-187679 (accessed 27 November 2009).

graphically close to North Africa. But in the short term it has little ulterior interest in that role. Spain's energy policy is directed above all towards securing its own domestically generated electricity supply (see "Focus on Spain", above).

The reason for this is that in terms of electricity transmission Spain is an island with very few interconnectors to its neighbours. The country's foremost interest is to meet its self-imposed targets for the electricity mix and to establish spare reserve capacity in fuel-flexible power stations. Spain is already the world's third biggest importer of LNG, and building such capacity will increase its gas imports even further. For the same reason the country continues to subsidise coal mining and build new coal-fired power stations. Spanish electricity generation is largely configured for the "island situation" and self-sufficiency, and interest in importing or transiting electricity is correspondingly small.

Italy. Geographically Italy is another obvious importer and bridgehead for solar electricity from North Africa. Given that Italy today imports about 13 percent of its electricity from its northern neighbours, the starting situation appears favourable – also because the Italian firm of Angelatoni is one of the world's leading manufacturers of the pipes used in solar thermal power stations. So it comes as no surprise that Italy has joined other states in pushing the Solar Plan.

Under the Berlusconi government, however, the situation for expanding renewables has rapidly worsened. In July 2009 Italy initiated a U-turn in energy policy, striking out on a conventional path and cutting back the state subsidies for solar power

introduced under Prodi.[57] The Berlusconi government intends to build four nuclear power stations with French technology whose production would cover one quarter of the country's electricity needs.[58] It also prioritises Italian energy giant ENI's close partnership with the Russian Gazprom and the construction of the South Stream Pipeline to import more gas from Russia. There are also large question marks over the plan to lay a double-cable 1000 MW underwater line from Tunisia to supply electricity from a Tunisian gas-fired power station.[59]

In view of its U-turn on energy policy, ageing power stations and complicated approval procedures in the energy sector, Italy is likely to turn out to be a difficult transit route. But it has reason to remain interested in importing green electricity: the country's climate deficits cost Rome €555 million in additional emissions certificates in 2009.

Photovoltaic lobby versus CSP lobby

Throughout the EU there is a rift between the supporters of domestic renewable energy and those who (also) prioritise imported green electricity. That is illustrated very well by a look at the strong photovoltaic lobby in Germany.

The photovoltaic lobby's strong campaign against the desert solar project expresses sharp rivalry for state subsidies. The German photovoltaic industry has achieved double-digit average growth rates in recent years. Installed capacity is expected to surpass 23 GW in 2020 and reach 90 GW by 2050, and the Renewable Energy Act configures feed-in rates so as to expand the domestic market in the medium term to a point where German companies are able to succeed in the rapidly growing international market.[60] It is hoped that a balanced market expansion will produce rapidly falling costs. In other words, establishing new technology paths also means creating balanced energy price paths. However, these subsidies are expected to decrease.

But for the industries and their lobbies it is also quite simply a matter of an enormous amount of money and guarding privileges. Photovoltaic has experienced an enormous boom fuelled by the incentives of Renewable Energy Act and a speculative bubble. Its supporters argue that decentralised production of solar electricity makes most sense, because this reduces transmission issues.[61] They also argue for production to be located in Germany, echoing those who call for production of alternative energy in Europe for Europe and in the Maghreb for the Maghreb. In this sometimes highly ideological debate between supporters of photovoltaic and CSP it is sometimes forgotten that this is not an either/or question. The Federal Environment Ministry's lead scenario of 2009 is in principle already based on a coexistence of photovoltaic systems and solar thermal electricity from abroad.

Reservations and alternative energy preferences in North Africa

In the North African states, which are indispensable for implementation, a range of reservations and conflicts of interest slow the progress of the solar initiatives. But interests there are anything but homogeneous; too divergent are the different countries' economic and political systems and the quality of their relationships with Europe.

But for all the interest in solar energy, a certain mistrust predominates in all the states of North Africa towards the solar initiatives and the European assertion that this is a project from which all sides will benefit. What they fear is that the strong export component of the initiatives would leave only small amounts of overpriced electricity for domestic consumption. The big winners, it is assumed, would be the Western investors who put money into CSP and the European electricity companies.[62] The Algerian

57 Antonio Cianciullo, "Scure sui fondi per il solare: Oggi il Senato voterà i tagli", *Repubblica*, 21 July 2009, 19, http://ricerca.repubblica.it/repubblica/archivio/repubblica/2009/07/21/scure-sui-fondi-per-il-solare-oggi.html.

58 Ministero dello Sviluppo Economico, "Approvato il Ddl 'Sviluppo': Scajola, legge storica per la modernizzazione del Paese", 9 July 2009, www.sviluppoeconomico.gov.it/primopiano/dettaglio_primopiano.php?sezione=primopiano&tema_dir=tema2&id_primopiano=349 (accessed 4 January 2010).

59 UCTE, *Transmission Development Plan, Update 2009*, 20, http://www.entsoe.eu/fileadmin/user_upload/_library/publications/ce/otherreports/tdp09_report_ucte.pdf (accessed 5 January 2010).

60 BMU, *Langfristszenarien und Strategien für den Ausbau erneuerbarer Energien in Deutschland* (see note 54), 42.

61 Matthias Kaufmann, "Die Kalkulation von Desertec ist absurd", *Manager Magazin*, 13 July 2009.

62 Interviews in Algiers, March 2009, and Berlin, June 2009, with Algerian, Moroccan and Egyptian representatives of the energy sector and "solar lobbyists" from these states. See also

energy minister indeed declared that the participation of Algerian firms and assistance in establishing a domestic solar industry were preconditions for his country's official cooperation.[63] The argument that electricity exports could be just as positive for underdeveloped economies as the cash crops exported to industrialised countries is rarely brought forward in North Africa. Here one often hears that it would be more sensible to establish a local photovoltaic industry and produce decentralised solar electricity.

More broadly, the question of the desired future national energy mix is still up in the air in North Africa too. Wind and solar are a small but growing component in the strategic planning of these states. Gas remains central in Egypt, Algeria, Libya and Tunisia, while coal holds its dominant position in Morocco. Across North Africa from Egypt to Morocco there is moreover a manifest interest in nuclear power. Construction contracts for nuclear reactors may not yet have been concluded – despite the obvious willingness of France and other states (including the United States, Russia and China) to export civil nuclear technology to the region. But it must be expected they will in the foreseeable future, because for these states nuclear power is not least also a question of status and prestige. Indeed, in the past some have shown passing ambitions to acquire military nuclear capacities (Egypt, Algeria, Libya). Even if officials in the North African energy ministries argue that the two options need not be mutually exclusive, solar power could easily become superfluous (or at least lose the incentives for construction) once a series of nuclear power stations were supplying base load (and desalination) to cover basic electricity demand. To that extent, time is of the essence here too.

Ultimately the central problem for implementation is that only a small lobby of academics, politicians and business leaders is yet making the case for CSP in North Africa – with the exception of Morocco where the king himself initiated a gigantic solar project in 2009. In Algeria and Libya the problem is above all the rent-seeking logic rooted in their oil wealth. The ruling elites profit politically and in most cases also personally from oil and gas rents. So the status quo dominates thinking and in the short term there is little incentive to advance the solar initiatives. People at the semi-state-run New Energy Algeria (NEAL) say that to date they neither see the political will nor the financial commitment by the government to promote renewable energy on a grand scale.[64]

So far the agents of "green change" in North Africa are to be found less among the politicians and technological cadres. Instead it appears that business oligarchs are most interested in the projects, such as Issad Rebrab in Algeria, whose firm Cevital belongs to the DII's founding consortium. The companies of the El Sewedy and Sawiris families are discussed as future Egyptian members; the latter are already involved in building the CSP power station at Kureymat. North African oligarchs often think in longer perspectives than most regime elites and maintain at least outwardly a certain distance to their regimes. At the same time they are generally closely allied with parts of the power apparatus; in a state like Algeria only a person who possesses excellent contacts in the security apparatus can build a business empire. As a consequence they mostly have access to channels by which they can feed ideas into the opaque political decision-making processes of the state.[65] Maghrebian entrepreneurs, moreover, have – unlike the political elites – a great interest in projects that advance regional economic integration.

The DII's strategy of including important companies from North African partner states could therefore turn out to be a prudent move. Here too, however, it is wise to spread risk and avoid depending too heavily on individual persons or businesses. Ultimately the technocratic and governing elites (which are not always on good terms with the oligarchs) must be cultivated; the Moroccan energy ministry felt ignored when DII failed to contact it in advance of the founding summit.[66] It is, moreover, absolutely plain that many North African officials still confuse the private-sector DII with the inter-governmental Mediterranean Solar Plan, which is a clear hint to both European politi-

Ali Titouche, "Énergies renouvelables: L'Algérie à la traîne", *El Watan* (Algiers), 24 March 2009.

63 Merouane Mokdad, "Projet solaire Desertec: les conditions et les réserves de Chakib Khelil", *Tout sur l'Algérie (TSA)*, 18 July 2009, www.tsa-algerie.com/les-archives/2009/07/18/#SlideFrame_1 (accessed 4 January 2010). Algeria also intends to open the country's first solar cell factory in 2012.

64 Interview at NEAL, Algiers, March 2009.

65 In the case of Libya it is practically impossible to get around the Gaddafi family, which holds the reins of economic power too. Saif al-Islam, the son with the best chances of inheriting power, has made a name with green proposals and can potentially be regarded as an agent of "green change".

66 Interviews with diplomats from EU member states, Berlin and Brussels, October 2009.

cians and bureaucrats and the Desertec consortium that they need to tighten up their communication.

Regional conflicts and lack of integration in North Africa

Regional conflicts within North Africa and in the broader Arab world regularly have repercussions on South-South and North-South cooperation. The solar initiatives are no exception. The main reason why the Solar Plan has made so little progress is the refusal of the Arab states, including those in North Africa that are geographically further removed from the Middle East conflict, to return to business as usual after the Gaza War. The Arab side had expected a clear condemnation of Israel from the EU and its member states. In this respect the private-sector DII has better cards because it officially represents none of the European states.

One problem that neither the Mediterranean Solar Plan nor the DII will be able to avoid in the medium term is the still unresolved Western Sahara conflict,[67] which raises questions of international law concerning the choice of sites in the contested territory (whose geophysical characteristics make it ideal for CSP),[68] and is also one of the main reasons for the Moroccan-Algerian tensions that have persisted for decades. A little electricity may flow between the two countries, but the land border has been closed for fifteen years. On the Algerian side especially, there is little interest in exporting Algerian electricity to Europe via the existing link in the Straits of Gibraltar. Algeria prefers to think bilaterally and favours its own direct link through the Mediterranean to Europe.[69]

Generally, the balance of neighbourly cooperation in the Maghreb is thin. The Union Maghreb Arabe (Algeria, Libya, Morocco, Mauritania and Tunisia) was founded in 1989 to promote economic integration but exists primarily on paper, and the figures for trade among the Maghreb states remain in the low single-digit percentages. Relations between the individual North African states are marked by rivalry, with Egypt, Algeria and Morocco all seeing themselves as the regional leader.[70] How quickly and severely diplomatic relations in the region can deteriorate could be seen at the end of 2009 following the football World Cup qualifier between Egypt and Algeria.[71]

Nonetheless, the solar power project could generate sufficient pressure for cooperation. Experience with security cooperation in the 5+5 dialogue (Maghreb states plus Malta, Italy, France, Spain and Portugal) shows that productive collaboration is possible if the interests of the participating states are sufficiently congruent – which could be the case with the solar initiatives.

Dysfunctional Union for the Mediterranean

Deadlock in the Union for the Mediterranean caused by the Middle East conflict raises the question of whether to search for a better-functioning international political and institutional framework. Placing the Solar Plan for the Mediterranean under the auspices of the Union for the Mediterranean may have turned out to be positive for the latter (where it is the most ambitious and highest-profile project) but the situation within the Union for the Mediterranean has hampered progress of the project. Cooperation has been able to advance only in small formats at the technical administrative level.

In fact the repercussions of the Middle East conflict and the ensuing obstructionism are not the only problem for the Union for the Mediterranean. Quarrels between Turkey and Cyprus have also massively slowed the process of setting up of structures. The large size of the Union for the Mediterranean and its consensual decision-making fundamentally stand in the way of making rapid progress. The Solar Plan has become a perfect example of the way political and bureaucratic institutions and actors can get in one another's way at the national and international level when too many are involved in a project; ideas about what the plan can and should accomplish diverge widely. In the starting phase Germany wanted the Solar Plan to force the development of a regulatory

67 Morocco claimed the territory when it was decolonised by Spain and has held it occupied since 1975. The indigenous population aspires to independence for the Western Sahara and is supported by Algeria. Various solutions proposed by the United Nations have been torpedoed by objections from one or both of the parties.

68 Schüssler, "Ein 'Meer aus Spiegeln' – aber wo?" (see note 15), 29.

69 Interview, NEAL, Algiers, March 2009.

70 Ibid. See also Tom Pfeiffer, "Morocco Wants Leading Role in European Solar Plan", Reuters, 16 July 2009.

71 "Aus Fußball wird Politik: Algeriens Erfolg über Ägypten hat zu Gewalt auf den Straßen geführt: Große diplomatische Verstimmungen", *Frankfurter Allgemeine Zeitung*, 23 November 2009.

framework. France on the other hand hoped to set to work quickly with landmark projects. But it is unclear who is to actually put the plan into practice. The Union for the Mediterranean currently has no capacity to do so. There is no saying whether the secretariat – which in the best case will start work in early summer 2010 – will be capable of shouldering this task. And quite independently there is a real danger that the Union for the Mediterranean will simply run out of steam. Even involved European diplomats are – off the record –increasingly voicing this fundamental worry.

It stands beyond doubt that both the Solar Plan and the DII will need political backing. At least theoretically the Union for the Mediterranean appears to be the ideal inter-regional forum to work on the regulatory framework that is also vital for the DII plans in the long run. Given that the prospects for a resolution of the Middle East conflict are bleak it could be more promising, at least in the short term, to pursue development of the framework in bilateral formats or in a group of committed states (as already exists unofficially within the Union for the Mediterranean).

Security Risks

One question that both potential investors and European politicians will have to deal with is stability and security in the southern partner states. From Egypt to Morocco the circumstances for the desert solar initiatives are indeed less than ideal in this respect. Although none of the North African states can currently be designated a "failing state", political stability has weakened in all states in the region with the exception of Tunisia (see Table 5). Ultimately most of them are fragile states in terms of criteria such as security, welfare, legitimacy and rule of law.[72] In all of them we find authoritarian political regimes that possess little in the way of legitimacy and find themselves confronted with considerable demographic and socio-economic problems and specific and in some cases substantial social tensions.[73] Regular unrest and revolt are the upshot. An additional potentially destabilising factor are the activities of armed Islamist groups, above all in Algeria, where al-Qaeda in the Islamic Maghreb increasingly pursues pan-Maghrebian objectives, also in the neighbouring Sahel states, and returning to attacks on foreign targets.[74] Last not least the failing states to the south in the Sahel bear a growing potential for destabilisation.

We can identify three categories of security risk that affect the progress of the solar initiatives: legal security and security of investment; security of energy supply under the aspect of political and economic blackmail; and risks to energy infrastructure and the physical safety of foreign personnel.

Security of investment represents a considerable problem in all North African states with the partial exception of Tunisia (see Table 5). From Morocco to Egypt – if in differing degrees – bureaucracies are cumbersome, levels of corruption high and judicial systems lacking in independence. The situation is especially grave in the oil-rich states of Algeria and Libya. Since 2006 Algerian investment laws and production-sharing agreements have shifted more and more to the disadvantage of foreign investors; Libyan leader Muammar Gaddafi repeatedly threatens to renationalise the oil and gas sector and close relations with his inner circle are often more important for investors than the actual wording of legislation. Legal insecurity is also the Achilles heel of contracts tailored to specific (solar) projects. Regulation by contract for individual projects can only be a first step, one that in no way obviates the need to create a clear legal framework and international arrangements.

None of these problems are new or specific to renewables. Experience in the oil and gas sector shows that cooperation can still function if there is political will in the country itself and the profits for both sides are large enough. Although at least in the short term the desert solar initiatives will be nowhere near as lucrative as deals in the oil and gas sector, there are in each of these states politically influential figures with their own (self-)interest in the initiatives – and in the ideal case influence on legislation in the field of commerce. By integrating major North African businesses and oligarchs the Desertec Industrial Initiative could succeed in establishing channels to exert reform pres-

72 For the concept of fragile states see Ulrich Schneckener, "States at Risk – Zur Analyse fragiler Staatlichkeit", in *States at Risk: Fragile Staaten als Sicherheits- und Entwicklungsproblem*, SWP-Studie 43/2004, ed. idem, 5–27 (Berlin: Stiftung Wissenschaft und Politik, November 2004).

73 Claire Spencer, North *Africa: The Hidden Risks to Regional Stability*, Chatham House Briefing Paper 2009/1 (London: The Royal Institute of International Affairs, April 2009); Werenfels, *Bouteflika zum Dritten* (see note 22).

74 See also Guido Steinberg and Isabelle Werenfels, *Al-Qaida in the Maghreb: Just a New Name or Indeed a New Threat?* SWP Comments 6/2007 (Berlin: Stiftung Wissenschaft und Politik, March 2007).

Table 5
The investment environment in North Africa

	Global Competitiveness Index 2009/2010 *(World Economic Forum)* *Ranking among 133 states*	**Transparency Corruptions Perceptions Index 2009** *Ranking among 180 states*	**Most problematic factors for business activity** *(World Economic Forum)*	**Political Instability Index 2009/2010** *(Economist Intelligence Unit)* *Ranking among 165 states* *Stability scale 1–10:* *1 = high stability* *10 = low stability*
Egypt	70	111	Difficult access to financing; inefficient bureaucracy; poorly trained workforce; inflation	106 *5.4* (2007 *4.4*)
Algeria	83	111	Difficult access to financing; inefficient bureaucracy; corruption; poorly trained workforce	61 *6.6* (2007 *4.6*)
Libya	88	130	Inefficient bureaucracy; inadequate infrastructure; corruption; difficult access to financing	137 *4.3* (2007 *2.3*)
Morocco	73	89	Difficult access to financing; corruption; inadequate infrastructure; high level of taxation	98 *5.6* (2007 *4.5*)
Tunisia	40	65	Inefficient bureaucracy; difficult access to financing; restrictive labour laws, currency regulation	134 *4.6* (2007 *4.6*)

Sources: World Economic Forum, *The Global Competitiveness Report 2009–2010* (Geneva, 2009), www.weforum.org/documents/GCR09/index.html; Mo Ibrahim Foundation, *Scores and Rankings* (London, 2009), www.moibrahimfoundation.org/en/section/the-ibrahim-index/scores-and-ranking; Transparency International, www.transparency.org; Economist Intelligence Unit, http://viewswire.eiu.com/site_info.asp?info_name=social_unrest_table&page=noads&rf=0> (accessed 6 January 2010).

sure on governments from within the states in the region.

The other named problems – security of supply and physical safety – are relative. Even the ambitious Desertec Initiative only proposes importing about 15 percent of Europe's electricity from this region. And the principle of diversification is already built in technically: Implementation of the desert solar initiatives would make four or five North African states exporters, so the risk would be spread. Problems in or with one of the states could be compensated through trade relations with the other exporters. Thirdly, experience in the Algerian oil and gas sector allows on the whole reassuring conclusions to be drawn. Throughout the civil war in the 1990s and ongoing activities of armed Islamist groups thereafter energy infrastructure has been spared major attacks. More recent attacks there – on a power station (2004) and gas pipelines (2006 and 2007) – have caused little in the way of significant destruction.[75] Fourthly the expansive solar power stations are not easy targets to destroy. Anyway, some of the alternatives are associated with much greater risks. The consequences of an attack on a nuclear reactor – for whose construction all the states in the

75 Jennifer Giroux, *Targeting Energy Infrastructure: Examining the Terrorist Threat in North Africa and Its Broader Implications*, ARI 25/2009 (Madrid: Real Instituto Elcano, 13 February 2009).

region have plans – would be incomparably graver (and without doubt more headline-grabbing) than those of an attack on a CSP plant. Transmission lines would be considerably more vulnerable, but here it must be remembered that simply for reasons of grid stability there would be several lines. Fifthly, considerably relativising worries about political blackmail, electricity's physical characteristics make it difficult to store. While oil and gas can be left in the ground to extract at a later date the electricity exporter loses his daily revenues irretrievably.

Not least, via the aforementioned mechanisms strengthening local economies, the desert solar initiatives could in the long term also contribute to enhancing stability in the North African states. So European worriers are on shaky ground when they say they wish to see "political stability, democracy and prosperity" established before the solar projects can be launched.[76] Practice, especially in North Africa, has moreover shown that democracy – desirable as it is – need not necessarily be entrenched before attracting foreign investment. Highly authoritarian Tunisia for example exhibits relatively strong security of investment in regional comparison. Thus the legal security required by investors must not necessarily correlate with the level of democratisation.

76 Thomas Kästner and Andreas Kießling, *Energie in 60 Minuten: Ein Reiseführer durch die Stromwirtschaft* (Wiesbaden: Verlag für Sozialwissenschaften, 2009), 93–94.

Conclusion: The Time Is Ripe

The obstacles and costs standing in the way of implementation of the solar projects are significant. So the question of the energy and climate policy alternatives arises. As demonstrated at the beginning, a large-scale shift into solar and wind power is ultimately the most convincing answer to the twin global challenges of securing the global supply of affordable energy and converting to sustainable and climate-friendly systems. Today's energy system is running up against its limits. There are signs that oil and gas are approaching peak production. That not only raises the question of whether a carbon-based energy supply can remain affordable, but also suggests potential conflict over access to, use of and distribution of fossil fuels. Quite apart from that, energy poverty rules many regions of the world and 1.5 billion people have no direct access to electricity at all.

Despite the high start-up costs, the CSP projects are key to a secure and affordable energy supply. Inactivity on climate and energy policy would ultimately be incomparably more expensive, because we would have to cope with the consequences of global warming of up to six degrees Celsius. In terms of the strategic triangle of energy policy – security of supply, economic efficiency and climate compatibility – the desert solar initiatives cause practically no medium- or long-term goal conflicts. The projects could facilitate an international breakthrough for a technology with the potential to be an important building block in efforts to meet the target of limiting global warming to two degrees Celsius. In the context of the solar projects we have to think in such long-term dimensions.

If significant quantities of solar and wind-generated electricity are to flow to Europe by 2050 the decisions must be made now; the time is ripe. Although the UN Climate Conference in Copenhagen in December 2009 will not have made it any easier for the EU to smooth the way for a climate-friendly energy supply. At the same time, the EU urgently needs partners and new instruments if it is to retain its leading role as a pioneer in the global fight against climate change and to advance the international introduction of effective market mechanisms. Copenhagen has also heightened public awareness that time is of the essence and fundamental decisions must be taken. In the European energy sector new investment is due in networks and generating capacity that are coming to the end of their operating lives and national stimulus programmes designed to counteract the economic crisis in the EU member states provide state grants and subsidies for the energy sector. In its dimensions the plan to generate solar electricity in the desert and import part of it is by no means exorbitant – neither with respect to the level of costs nor to the necessary additional investments.

The need to act quickly applies equally to the southern Mediterranean, where fundamental decisions about the construction of new coal-fired and nuclear plants will be made in the coming years. Realising the desert solar initiatives quickly and thus offering a real tangible alternative could reduce the interest in nuclear power, which is currently great in North Africa. It can only be in the interests of European foreign policy if states with a less than predictable internal security situation and a potential "tendency to proliferation" were not to turn to nuclear power.

The difficulty and special challenge consists in bringing about "system breaks" in an exceptionally structurally conservative sector with pronounced path dependencies in infrastructure and technology. Both initiatives – the Mediterranean Solar Plan and DII – depend on having a suitable political framework and presuppose the expansion of trans-European networks.

The establishment of a proper supergrid, intensified use of renewable energy and cross-border trade in green electricity will require a paradigm shift, a break in the regulatory and energy price paths. This break must be initiated and carried through by politics, and politicians must explain why it is sensible and necessary. Only then will the energy sector be willing to complete the necessary break in the technology paths of the conventional energy system too. This process is best illustrated by the question of network expansion and conversion. The existing regulatory framework under the paradigm of competition focuses attention on operational day-to-day business, prioritising third-party access and cost minimisation. Heavy investment in expansion of the underlying infrastructure is unlikely under these premises. It is high time for a fundamental debate about the character of energy infra-

structure as a public good and its importance for future security of supply. But it must also be communicated to the public that expansion of renewable energy cannot proceed without the construction of a supergrid, and that means building transmission lines. Setting up a smart grid also means something like a paradigm shift. Power generation will in future no longer adapt to consumption; instead electricity use will follow supply.[77] Here too, management of public acceptance will present great challenges.

A further difficulty is that the proposed cooperation in power station construction and electricity import involves international networking and interlinkage to a degree that is politically unparalleled. Put in simple terms: the planned electricity alliance outstrips the bounds of present regulatory authority. So it is the job of the politicians to create the necessary cross-border framework in international cooperation. In the medium term energy policy can no longer be a national fiefdom. And horizons will have to broaden on the energy mix too. Even when we consider objectives for 2050, which is apparently such a long way off, we must be aware that the timeframe for the required political decisions is very short. It is clear moreover that the energy revolution demanded very pointedly by the International Energy Agency (IEA) cannot be completed solely by the energy companies in the existing framework.

What Next? – Recommendations

Because of the learning curves involved, these large-scale solar projects will need to have their start-up and differential costs co-financed out of the public purse for a certain period. In the long term that is the only way to acquire a technology that is both low-carbon and least-cost. The social and political interest in a sustainable energy supply and energy security through diversification also justifies state co-financing, not least because realisation is unlikely if the private sector is left bearing the entire burden of risk.

The Solar Plan and the Desertec Initiative need to be considered together. Both are building blocks of the same big project, both ultimately involve the same private sector actors and in the long term both need the same framework conditions in order to be implemented successfully. Consequently what is needed is to identify the central steps and pillars that would allow a consolidation of both the desert solar partnership and transmission grid integration.

In view of the currently difficult circumstances for implementation of the solar initiatives, the following four concrete steps should be foregrounded to start with:

- *Firstly*, to begin as quickly as possible with the realisation of symbolically significant pilot and landmark projects, specifically CSP power stations, that can then serve as cornerstones for further implementation steps. Currently the only practical option for such projects is regulation by contract, analogously to the production-sharing agreements that are common practice in the oil and gas sector. In order to bring about subjectively fair North-South cooperation and balanced supply chains, greater inclusion of North African companies is crucial.
- *Secondly*, the physical export of electricity should not be the foremost concern initially. Instead virtual trading should be organised, for example via certificates. Mediterranean "green certificates" could be created under or modelled on the Clean Development Mechanism of the Kyoto Protocol.[78] EU member states and their companies could be given the opportunity to fulfil their emissions and renewables obligations by purchasing these certificates. Swap deals would also be possible with the gas-exporting states, initially allowing the electricity to be consumed in North Africa in return for gas exports to Europe. It would also be conceivable to manufacture energy-intensive industrial products (e.g. aluminium) using green electricity in the southern Mediterranean and market them under a green label in Europe. Expanding such mechanisms would have a positive side-effect: It would ultimately breathe life back into the EU's leading role on climate policy, after the setback of Copenhagen, and could initiate a groundbreaking process of developing innovative and mutually advantageous market instruments (outreach process of Kyoto mechanisms).
- *Thirdly*, it is the duty of politics on both sides of the Mediterranean to guarantee returns in to balance

77 "Intelligentes Stromnetz", *Süddeutsche Zeitung*, 1 December 2009.

78 Kilian Bälz, "Kommentar", in Jens Hobohm and Kirsten Westphal, *Strom aus der Wüste – technisch-wirtschaftliche und politisch-regulative Herausforderungen*, Arbeitspapier FG8, 6/2009 (Berlin: Stiftung Wissenschaft und Politik, December 2009), 9–11 (11), www.swp-berlin.org/common/get_document.php?asset_id=6663.

the considerable economic risks. That means fixed feed-in prices or long-term purchase contracts. But above all financing must be made easier through improved credit conditions, tax breaks, credit guarantees and green funds (similar to the World Bank's Clean Technology Fund). The EU could take the leading role in coordinating the instruments.

- *Fourthly*, with an eye to the second phase – physical electricity export to Europe – the creation of a trading platform for green electricity should be pursued. It could also then contribute to the emergence of an integrated electricity market.

Beyond that further political and regulatory steps are required at the *level of the European Union*. First of all a clear decision is needed in favour of the desert solar initiative and energy partnership with North Africa and willingness to create the required conditions. These include:

- Establishing a cross-border green electricity market in Europe and providing the required network capacity. That means – as for offshore wind farms in the North Sea – establishing and expanding a smart supergrid.
- As well as infrastructure modernisation, the regulatory and institutional framework must be harmonised in the context of an integrated EU climate and energy policy. A decision of principle for a common green electricity market must be taken in the EU and by the member states.

Interregional level: Here too a staged approach is recommended, which is critical if we wish to proceed to the second stage of exporting electricity to Europe:

- If the Union for the Mediterranean remains ineffectual, which is probable, a "coalition of the willing" should move ahead alone. De facto this is already the case unofficially.
- At the same time it makes sense at the bilateral level of the European Neighbourhood Policy to continue working towards harmonisation of energy markets. In the long run only liberalised markets and the separation of generation, transmission and distribution can provide the required environment for a sustainable electricity sector. To that end, in the sense of positive conditionality, the financing instruments of the "governance facility" could be drawn upon to support reform-oriented states. The bilateral approach of the Neighbourhood Policy offers the advantage that it allows the EU to take account of different developments in different states. With Tunisia and Egypt both seeking a "statut avancé" in their relations with the EU (a kind of privileged partnership that already exists with Morocco) the possibility opens up of bringing reforms in the area of energy more strongly into the negotiations.
- Because the legal uncertainties cannot be resolved through regulation by contract it is worth working towards integrating the North African states in an international treaty arrangement that creates generally binding rules for investment, trade and transit. Here the EU could use the modernisation of the Energy Charter Process adopted in December 2009 to coordinate the necessary rules with the North African states. That could also help to reinvigorate and strengthen the Energy Charter dialogue and its regulatory framework. This will be no easy undertaking, but even gas- and oil-rich states like Algeria and Libya have an interest in investment and transfer of know-how and technology. The need for regulation is expanding steadily in these fields, also with respect to the protection of intellectual property.
- The acceptance of the projects in the southern Mediterranean could be increased through support for desalination projects and the simultaneous expansion of decentralised electricity supply (including photovoltaic). This would benefit the broader population in the Maghreb states and help to correct the idea existing in some parts that cooperation would benefit above all European companies and local authoritarian regimes.
- Information and communication in Europe will be decisive for successful implementation of the initiatives. At least at first solar electricity from North Africa will be associated with increased costs for European citizens. Unless European politicians succeed in persuading the public of the long-term relevance of the solar and wind projects and anchoring the insight that climate protection and energy security are not to be had for free, the solar projects in the planned dimensions will be practically unrealisable, however sophisticated the incentives for investors and North African politicians.

Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
CCS	Carbon capture and sequestration
CEER	Council of European Energy Regulators
CSP	Concentrated solar power (solar thermal)
DII	Desertec Industrial Initiative
DLR	German Aerospace Centre (Deutsches Zentrum für Luft- und Raumfahrt)
ENI	Ente Nazionale Idrocarburi (Italian oil and gas company)
ENP	European Neighbourhood Policy
ENTSO-E	European Network of Transmission System Operators for Electricity
ERGEG	European Regulators' Group for Electricity and Gas
ESTELA	European Solar Thermal Electricity Association
EuroMeSCo	Euro-Mediterranean Study Commission
GIGA	German Institute of Global and Area Studies (Hamburg)
GW	Gigawatt (1,000 megawatts)
HVDC	high voltage direct current (transmission)
IEA	International Energy Agency
IMME	Maghreb Electricity Market Integration (Intégration du marché maghrébin de l'électricité)
kV	Kilovolt
kWh	Kilowatt-hour
Med-EMIP	Euro-Mediterranean Energy Market Integration Project
MED-ENEC	Energy Efficiency in the Construction Sector in the Mediterranean (Efficience Energétique dans le Secteur du Bâtiment en Méditerranée)
MEDREG	Mediterranean Regulators for Electricity and Gas
MSP	Mediterranean Solar Plan
MW	Megawatt (million watts)
MWh	Megawatt-hour
NEAL	New Energy Algeria
NREA	New and Renewable Energy Authority (Cairo)
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency (Cairo)
SET-Plan	Strategic Energy Technology Plan
SolarPACES	Solar Power and Chemical Energy Systems
TEN-E	Trans-European Energy Networks
TREC	Trans-Mediterranean Renewable Energy Cooperation
TW	Terawatt (1,000 gigawatts)
TWh	Terawatt-hour
UCTE	Union for the Coordination of the Transmission of Electricity