Solar Power Stations in North Africa and an Energy Partnership with Europe

Several Comments from an Economic Perspective

By Peter Winker and Christoph Preußner

It seems that the use of renewable energy sources, even on a larger scale, is an obvious energy alternative, given massive price increases for fossil fuels and the discussion surrounding greenhouse gas induced climate change. One component of this could involve the construction of large thermal solar power stations in North Africa. The electricity would be transported using a high voltage direct current technology that has been in use for over 50 years and that loses little energy along the way. This idea is also pursued in the framework of the recently founded 'Union for the Mediterranean' where it is called 'A Solar Plan for the Mediterranean'. At which costs could solar thermal power be generated in Africa and which economic incentives could be offered for investment in solar power stations?

If this idea is self-evident and if a technical realization seems at least possible (see Schäfer in this volume) one has to ask why, with the exception of a small test facility in Egypt, there are no such facilities currently running or under construction in Africa. As is evident from the other contributions in this journal, there are a great number of reasons, ranging from historic experiences to geographic aspects.

In this essay we will solely focus on economic considerations. This is a simple question of cost, that is, at which costs could solar thermal electricity be generated and which prices would the end-consumer in North Africa and Europe pay. Transport costs would play a significant role in this. The second question concerns the economic incentives to encourage investment in solar power stations in North Africa. At first the question seems easy to answer. If solar electricity from North Africa can be offered at a lower price than locally produced electricity, particularly from fossil fuels, then a supplier will be found and sufficient numbers of customers will want this electricity. In practice, the situation is somewhat more complicated. On the one hand, large investment decisions would have to be taken in the face of considerable uncertainties, for example the projected price development of other kinds of energy sources. On the other hand, from a political regulatory perspective a separation of generation and distribution is called for. Who will guarantee that there will be a network to transport the generated electricity? Alternately, who will guarantee the network company that there will be power stations that will need their electricity transported? What effect will a high capacity network have on the development of prices in the participating countries, even independently of the construction of large solar thermal power stations?

In the following sections we will attempt to provide an overview of available cost estimates and discuss the uncertainties, all of which suggest a need for further research. Subsequently, several of the economic incentive problems will be presented. It must be said that this does not claim to provide a comprehensive analysis. The article ends with a short conclusion and a look at the questions that will need to be answered before it is possible to make definite statements about the economic incentives for the construction of solar thermal power stations in North Africa.

How much does solar electricity from North Africa cost?

There are a number of estimates available for production costs of electricity from thermal solar power stations with parabolic trough design. These primarily originate from the many years of experience that the facilities set up in the 1980s in California provide. More recently, Czisch et al. (2001) estimate that for locations in Spain pure production costs run at 14 cents/kWh. As a result of the higher solar radiation in North Africa, these costs could be reduced to 9,5 cents/kWh without storage facilities and 7,5 cents/kWh with storage facilities for the night hours. A further reduction of 1-2 cents/kWh could be achieved through connected desalination plants. Other studies show results of roughly the same order of magnitude, albeit with substantial variation. As a general upper limit the buy back price given by the Spanish government, of 18 and 22 cents/kWh, can be used as this amount seems to allow for the profitable running of facilities, like the three 50 MW facilities that are currently under construction in Andalusia. This includes any additionally provided subsidies. The first of these parabolic trough power stations, Andasol 1, started operation in the summer of 2008, in the Province of Granada.

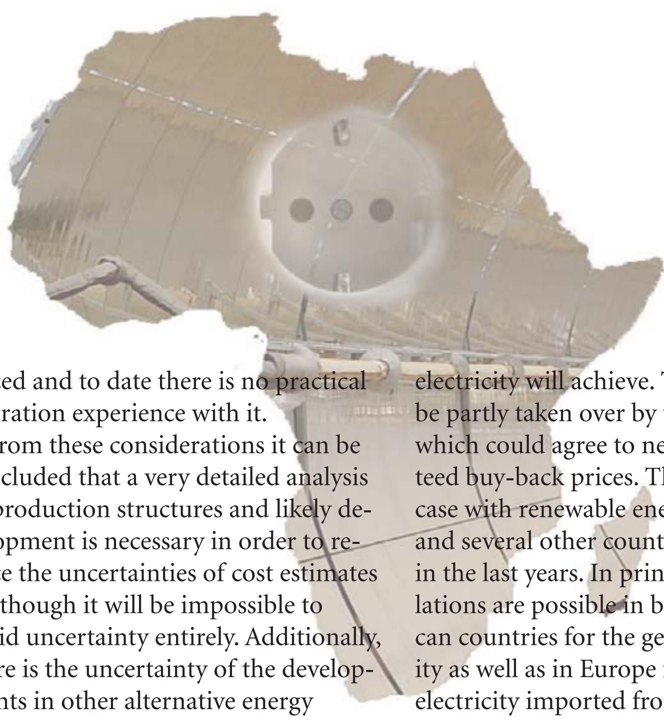
Costs before transport are still too high compared to the 5 cents/kWh quoted by Quanschning (2005) as competitive. However, the relative costs could still develop in such a way that solar power becomes relatively less expensive. Especially given the consistent use of carbon credit trading and a further increase in the price of fossil fuels. Furthermore, there is often a significant cost reduction with new technologies that stem from the improvement of degrees of efficiency, learning curves in terms of facility planning and in the company, as well as economies of scale from ever increasing units. For example Czisch et al. (2001) calculated that beyond a capacity of about 7GW, collector costs would be halved. In several studies, calculations show that given a massive development of solar thermal power stations a reduction of costs somewhere between 20-50% could reasonably be expected (compare to the table in Schüssler 2008).

The high voltage direct current transfer enables low loss and inexpensive transport of large amounts of electricity over long distances. This has been demonstrated by a multitude of installations particularly connecting large hydropower facilities to distant agglomeration centres. The energy lost is less than 5% per 1000 km. Nevertheless, for the transport from North African to Central Europe an additional cost of about 2 cents/kWh would have to be included.

Risk and Return on Investment

Only at the first glance do the cost questions seem to be answered by the available data. The estimates still have significant uncertainties. Some of these uncertainties are typical for the introduction of new technologies on a grand scale. One assumes, and generally correctly assumes, that the costs of production will drop. However, it is not easy to correctly estimate the amount and speed of cost reductions.

In addition, there can be opposite effects, like when key parts of facilities become scarce and more expensive as a result of an increase in demand. A similar phenomenon has been observed over the last years with respect to the



production of photovoltaic facilities. In their case, the projected production costs were on the mark, but the total costs had not reduced in the same way as a result of the increased prices for crystalline silicon. Currently, Solar Millennium, one of the leading providers of solar thermal power stations is offering an open bond "to secure important power station components early on", so as to have a buffer against price increases.

In addition there are cost risks, which result from construction and operation of the power plant in desert regions. The absence of local infrastructure also increases logistics expenses, which will be noticeable especially during the construction phase. Furthermore, there is no experience yet regarding the reliability and longevity of the reflector materials in desert conditions and how the heat storage technologies will react to the extreme changes in temperature between day and night. The problem of cooling is only referred to here from the perspective of completeness. A dry cooling is technically possible but the efficiency of the facility would be reduced and to date there is no practical operation experience with it.

From these considerations it can be concluded that a very detailed analysis of production structures and likely development is necessary in order to reduce the uncertainties of cost estimates – although it will be impossible to avoid uncertainty entirely. Additionally, there is the uncertainty of the developments in other alternative energy sources. For example, the generation of electricity from photovoltaic facilities might become much less expensive during the run time of a solar thermal power station, which is at least twenty years. Then, the revenue from solar thermal power stations would be reduced. Alternately, a positive effect would result from a further increase in the cost of fossil fuel resources i.e. due to carbon trading. Similarly positive effects can result from benefits in the context of international legal agreements (Kyoto-Protocol).

A potential investor faces considerable economic risks. Risks include: the real costs for facilities and the generated electricity, but also the price that the electricity will achieve. These risks can be partly taken over by the government, which could agree to negotiate guaranteed buy-back prices. This has been the case with renewable energy in Germany and several other countries of Europe in the last years. In principle such regulations are possible in both North African countries for the generated electricity as well as in Europe for the solar electricity imported from North Africa.

If the risks are not predictable, for example due to political reasons, then the investor must be compensated with a higher rate of return, which in turn increases the price of the electricity. This also applies to the primarily non-economic risks, which are explored in other articles of this volume. So for economic decisions the relevant costs are not simply the pure production costs. Rather, in these conditions considerable risk-surcharges must be applied.

Economic Incentives for Investments

These explanations have shown that the current costs of production and transport are still too high to provide direct economic incentives for the construction of solar thermal power stations in North Africa. Only if the expected revenues, with the consideration of the associated risk, are greater than the revenues from alternative investments will investors and financers take on the necessary investments.

An additional problem is the projected minimum size for solar thermal power stations and their connections. The fixed costs are high and include amongst others the preparation of the infrastructure for the construction of the power station and, in particular, the networks for transmitting the produced electricity to North African population centres and customers in Europe. Given the large cost of these networks, even given falling costs, it is only possible to generate electricity inexpensively if there are a very large number of facilities. In this respect solar thermal power

Prof. Dr. Peter Winker
Fachbereich Wirtschaftswissenschaften
Licher Strasse 64
35394 Giessen
Telephone: 0641 99 22640
Email: Peter.Winker@wirtschaft.uni-giessen.de

Peter Winker was born in 1965 and is a Mathematician. His studies included Mathematics and Economics in Constance and Paris. He worked on his PhD during his time as a researcher in the special research area, Internationalising the Economy (SFB 178) at the University of Constance. He received his Habilitation in Mannheim in 2000, and then moved on to an Associate Professorship at the International University in Germany and then Professor for Economic Sciences with a particular emphasis on Econometrics at the University of Erfurt. In 2006 he became Professor of Statistics and Econometrics at the Justus-Liebig-University of Giessen. He is the Managing Editor of the Journal of Economics and Statistics, Associate Editor of Computational Statistics and Data Analysis and an elected council member of the European Regional Section of the International Association for Statistical Computing (IASC) at the International Statistical Institute (ISI). Since 2006 he is also the coordinator of the Marie-Curie Research and Training Networks COMISEF (FP 6).

facilities are different from photovoltaic facilities or onshore wind farms, as the latter can develop in a series of small steps. In the case of the solar thermal power stations, the decision type is comparable to that of constructing large hydropower facilities (Itaipu, Three Gorges Dam) or offshore wind parks.

Anyone who is supposed to decide on such an investment needs a much more exact estimate of the expected costs and profits than the currently available information allows. Beyond this, it must also be clear that any future profits go back to the investor. Not only political risks must be considered but also economic ones. At the moment that the power station is complete, the investor no longer has the option to cancel the investment. The network operator could therefore be tempted to try to exploit his monopolistic position. However this incentive problem exists in reverse as well, that is from the perspective of the network operator. A simple solution to this incentive problem would allow one party to run both the power station and network. On the one hand, this increases the size of the investment required. On the other hand this type of vertical integration would not necessarily fit well into the current political landscape of the European Union. There are good reasons the EU is currently attempting to separate electrical generation from distribution. A lot of thought will need to go into the

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Gerus – high voltage direct current substation, Namibia

investor and operator model in order to set up the right incentives for all involved parties.

It is possible that in one form or another state involvement will be necessary. The term state in this case means less the nation-state but more the group of states that are interested in the realisation of this project, like the Union for the Mediterranean (see the article by K. Westphal). Such a state intervention could result in a guaranteed buy-back plan, in order to partially cushion the cost-risks or in the form of a state network agency. Whichever structure is found to be the most advantageous from an economic perspective requires a more thorough analysis than is possible in this overview.

Conclusion and Outlook

As a key conclusion it must be noted that the construction and operation of solar thermal power stations and the associated network infrastructure by private investors is only possible when the expected profits correspond to the necessary risk. This is currently not the case, since the expected production costs lie over market prices. A state subsidy would be required. However, the limits set on C02 emissions, as well as increasing prices for fossil fuels work in favour of solar thermal power and other renewable energy sources.

Should a solar energy partnership between Africa and Europe become a relevant option then the respective subsidy instruments must be developed and implemented. An exact analysis of economic incentive structures will be necessary in order to achieve the goals with as little use of public funds as possible. This optimal use of state funding should be considered along with alternative political measures. If a similar supply of energy from other renewable sources (geothermal, photovoltaic etc.) could be achieved by using fewer state funds, then these measures should have priority. The same applies to support for measures to increase electrical efficiency. It still has to be shown that a subsidy of the solar energy partnership is the preferred solution. This could also include other desirable side effects like development aid and political cooperation. •

Christoph Preußner
Fachbereich Wirtschaftswissenschaften
Licher Strasse 64
35394 Giessen
Telephone: 0641 99 22647
Email: christophpreussner@web.de

Christoph Preußner was born in 1984 and has studied Business Economics at the Justus-Liebig University of Giessen since 2004. In 2005 he became an active member of Student Council for Economics. Since October of 2007 he is a student research assistant in various projects in the area of Statistics and Econometrics.

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