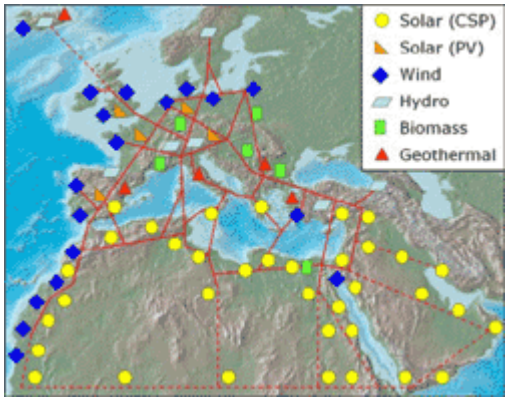
From Solar Server: http://www.solarserver.de/solarmagazin/solar-report_0207_e.html

Solar power from the desert rather than desert in Germany: renewable energy in a trans-European context

by Rolf Hug
23.02.2007

Should the global temperature increase by a mere five degrees “the Sahara would end in Berlin”, chief climate consultant of the Federal government and Director of the Potsdam Institute for Research on Climatic Consequences, Joachim Schnellnhuber, warned with regard to the United Nations report on climate changes on 2 February 2007. In order to avoid this the Trans-Mediterranean Renewable Energy Cooperation (TREC) developed a solution with which our electricity may be obtained in future from the desert. TREC bases its approach on an initiative of the Club of Rome and does not only give an answer to what is to happen when the sun sets over the desert oil supplies (“Twilight in the desert” is the latest book by George W. Bush’s former energy consultant Matthew R. Simmons). TREC, established in September 2003, developed a comprehensive concept for energy, water and climate security in Europe, the Middle East and Northern Africa, in short: EUMENA (EUrope, Middle-East, Northern Africa).

The far-reaching recommendations made by TREC are based on scientific studies conducted by the German Centre for Aviation and Space Travel (DLR) that prove that the deserts of Northern Africa and the Middle East could become a permanent source of clean energy for the countries of Europe by the middle of the 21. century, that greenhouse gas emissions could be reduced by 70% and that nuclear energy can be abandoned.



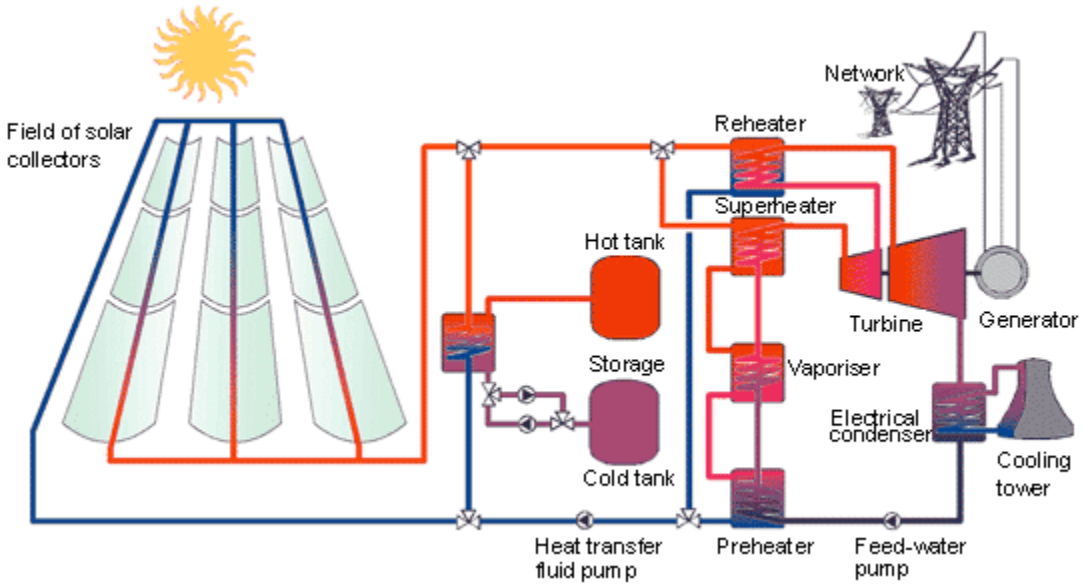
Solar thermal parabolic trough power plant; planned sites for the power plants (concentrated solar power; photovoltaics, water power, biomass and geothermal energy. High-voltage direct-current power lines (red lines); Source: Solar Millennium, TREC.

TREC considers the feeding of desert electricity into the European network as a complementary measure and under no circumstances as an alternative to the utilisation of European renewable energy resources. Power from the desert is to speed up the reduction of CO2 emissions in the MENA states as well as in Europe and is to increase energy security in EU states in which the utilisation of renewable energy is not yet advanced and – in the long run – it is to lead to a reduction of electricity rates. Since the implementation of the concept will take at least two decades, political measures are to be taken immediately

and a favourable economic framework is to be established, TREC emphasises.

Proven technologies are available already

TREC focuses primarily on wind energy and concentrated solar power (CSP) with which electricity can be generated in solar thermal power plants that can then be supplied to consumers in Europe with the help of efficient HVDC transmission. Technologies required for this are available already and have stood the test of time. What has been sadly lacking up until now is the political will to go ahead with such an energy turnaround, a framework in which this form of power supply can prove its realistic competitiveness with regard to conventional production from fossil-nuclear sources and the necessary courage of potential investors. The international network of scientists and politicians now wants to implement the concept that also includes photovoltaics, hydro power, geothermal heat and biomass at the respective most appropriate locations together with representatives from politics, industry and finance.



Function scheme of a solar thermal parabolic trough power plant. Source: DLR. [Wording: Field of solar collectors, Hot tank, Storage, Cold tank, Heat transfer fluid pump, Reheater, Superheater, Preheater, Network, Turbine, Condenser, Feed-water pump, Generator, Cooling tower

Greenpeace, the german Green Party, the German Physics Society (DPG) and the Scientific Advisory Council of the Federal Government for Global Environmental Changes (WBGU) together with other institutions and associations support this project. The Solar Report outlines the so-called DESERTEC concept, focuses on certain technical aspects of power generation in the desert as well as the transmission of power and shows the perspectives of this ambitious project that are well worth broad-based discussions. History and technology of solar thermal power plants were already discussed in the reports titled "Solarthermische Kraftwerke als Option für eine klimafreundliche Elektrizitätsversorgung" and "Solarthermische Kraftwerke: Technologie-Transfer in den "Sonnengürtel" (links and further information at the end of this Solar Report).

Solar heat driving efficient 100 MW steam turbines

Thus far solar power supply from the desert was a mere play of ideas, was hardly perceived

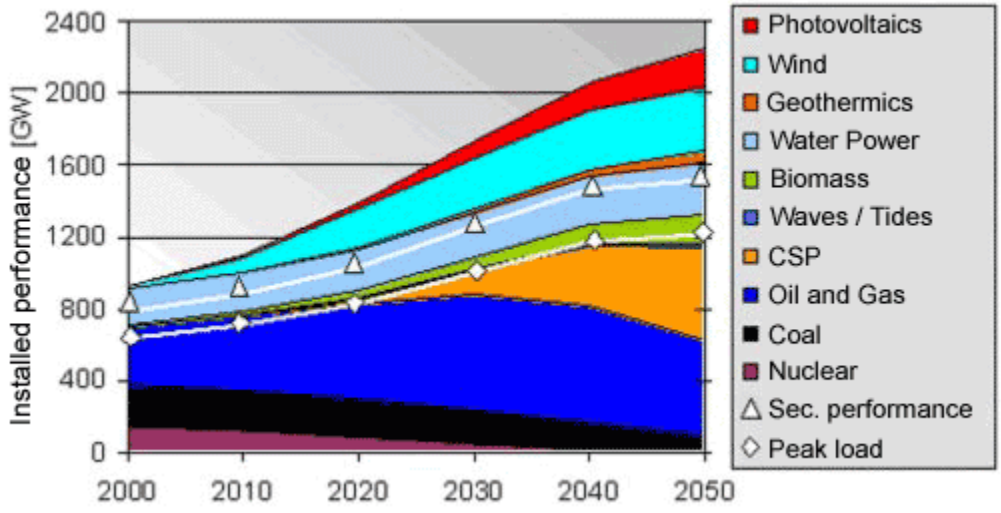
by the public and was rightfully criticised. The idea to produce gigantic amounts of hydrogen with the help of photovoltaics and to transport these to Europe on tankers, upon closer scrutiny, proves to be a cul-de-sac: this results partially from the enormous and thus costly conversion losses in the production and distribution of solar hydrogen, for which the oil industry infrastructure would merely be copied. And, solar thermal power plants in sunny locations around the Mediterranean Ocean, where electricity is generated in steam turbines with heat from concentrated sunlight, have distinct advantages in comparison to the generation of electricity with photovoltaic modules.

Plannable electricity supply, even if the sun's not shining

Contrary to photovoltaics, where solar radiation is directly transformed into electricity by solar cells, solar thermal power plants boast high degrees of efficiency and low electricity production costs even in great heat. This is generally unknown to the public, as is the fact that solar thermal power plants do not only provide electricity when the sun is shining. They have heat storage tanks (e.g. liquid salt tanks) that can be heated over the hottest hours of midday with surplus solar energy and can thus enable the production of solar power after sunset. And also during the day this stored heat can be used to produce electricity if the need arises.

Because of solar thermal power plants having the capacity to provide power according to demand, they are one of the few technologies for the utilisation of renewable energy that can not only cover the ever increasing electricity demand in EUMENA countries, but can also reduce or even replace conventional power plant capacities.

The DLR scenario requires covering of peak consumption plus 25 % reserve capacities and this is what is currently being practised. According to TREC this is only practically possible if by 2050 the fossil power plant capacities were doubled or if solar thermal power plants are utilised, since other renewable energy sources either generate too little controllable electricity (photovoltaics and wind) or are restricted in terms of their energy potentials (biomass and hydropower). The DLR scenario thus envisages to maintain gas-driven peak-load power plants with low capacity utilisation until 2050, whereas conventional base-load power stations will disappear almost entirely.



Power supply scenario in EUMENA countries until 2050. According to this EUMENA future model solar thermal power plants will be utilised to cover 68 % of the local electricity demand in MENA and Europe by 2050, 13 % for desalination of water in MENA and 19 % are allocated to the export of electricity from MENA to Europe. Source: DLR [Wording of

graph: Installed performance [GW]; Photovoltaics, Wind, Geothermics, Water power, Biomass, Waves / Tides, Solar th. power plants, Oil and gas, Coal, Nuclear, Secured performance, Peak load

If solar thermal plants also utilise co-generated heat, e.g. for air-conditioning, for generating industrial process steam or for desalination of sea water, ideally up to 25 % of the captured radiation can be transformed into electricity and an additional 40 % into utilisable energy. According to TREC, this exceeds the energy utilisation efficiency of conventional photovoltaic plants by four to six times.

If large-scale construction of solar thermal power plants is carried out in the coming years and if all possible benefits of scale are utilised, the DLR has calculated that production costs, including the transmission to Europe, will amount to approximately five euro cents per kilowatt-hour. Currently production costs of solar thermal power plants are approx. 15 to 20 cents per kilowatt-hour according to calculations by TREC and DLR, and are thus significantly lower than those of photovoltaics. In hybrid operation with an improved utilisation of the steam generating power plant with added combustibles, this price could even be decreased to below 10 ct/kWh. Electricity generation costs of a modern wind energy plant with an output of 2 000 kilowatt at an average location are 6.4 ct/kWh; 15 to 20 years ago they were on a similar level as the costs of solar thermal power plants. This shows that – as was the case when wind energy was introduced to the market – public investments are necessary to fully utilise the potential of solar thermal power plants, TREC emphasises.

Solar thermal power plants can achieve the highest degrees of efficiency and thus also the lowest electricity costs among renewable energy forms. Source: Solar Millennium.

Studies prove feasibility and high electricity yields

Two studies conducted by the German Centre for Aviation and Space Travel (DLR) in 2005 and 2006 prove with satellite-supported data that solar thermal power plants can generate sufficient electricity to cover the increasing demand of the MENA states and Europe by utilising less than 0.3 % of the desert areas of MENA. Furthermore, sea water can be desalinated in the process and thus drinking water is produced. Complemented with wind energy plants that can, for example, transform the strong Passat winds in southern Marocco into electricity, new perspectives for a secure and climatically neutral electricity supply with new dimensions are created.

250 gigawatt-hours of electricity each square kilometre per annum

DLR researchers Franz Trieb and Hans Müller-Steinhagen calculated that a surface area of one square kilometre in the desert can produce approx. 250 gigawatt-hours of electricity per annum.

This is 250 times more than can be harvested from one square kilometre of biomass and still five times more than from the best wind energy plants and hydro power plants.

Trieb and Müller-Steinhagen elucidate this by way of an example: a surface area the size of Lake Nasser in Egypt (6 000 km2, see picture) receives as much energy from the sun as is currently extracted in the Middle East in the form of oil (9 billion barrels per annum – 1 barrel equalling to 159 litres).

Source of photos: CIA Factbook

The DESERTEC concept does not envision the erection of a few gigantic power plants but rather for the construction of many decentralised power plant blocks with capacities of between 50 and 200 MW that are spread among the MENA states.

Renewable energy from the desert: tried and tested in the USA and also possible in Europe

Solar thermal power plants at suitable locations are currently already capable of producing economically feasible electricity. This is proven by nine solar power plants in the Mojave Desert (southern California) with an output of 254 megawatt (MW). For about two decades they have been producing approx. 800 mWh of solar power per annum. The parabolic trough systems used are currently the most cost-effective method of generating electricity from solar energy. In the province of Granada in southern Spain the German company Solar Millennium AG is currently driving ahead three projects with this technology that was developed in Germany.

Solar power station at Kramer Junction (USA): over 2 million km2 of parabolic trough collectors with an electricity generating capacity of 354 MW produced almost 10 billion kWh of solar power and yields of approx. 1.5 billion US$ by the end of 2001.

Sources: Forschungsverbund Sonnenenergie; DLR.

High-voltage direct current from the desert to Europe

In order to transmit the electricity produced in Northern Africa and the Middle East to, for example, Germany, TREC is counting on high-voltage direct-current transmission since the conventional AC net is not capable to transport electricity over distances of a few thousand kilometres. In the case of underwater lines, a few hundred kilometres are the limit. The solution is a combination of conventional AC nets for the local distribution of electricity and HVDC transmission technology for long-distance transmission. This is characterised by low

transmission losses and is already used between Norway and Germany and many other locations worldwide.

High solar power production and low transmission losses

Northern Africa is already connected to Europe via electricity cables that would merely have to be expanded, states Dr Gerhard Knies of TREC. "These cables run through the sea and we use the high-voltage trick," the doctor of physics says. "If we transport energy through a power line and increase the voltage tenfold, the losses decrease to one percent." The losses in HVDC transmission amount to about 3 % per 1 000 kilometres. The transport to Europe would thus amount to losses of between 10 and 15 %, depending on the exact distance. In Northern Africa two to three times as much solar thermal electricity can be generated than could be with the same plants in Europe. HVDC lines with capacities of up to 1.5 gigawatt have been utilised by ABB and Siemens for many years over long distances. The connection with Northern Africa and the Middle East is no problem, both companies confirmed at the World Energy Dialogue at the Hannover Fair 2006.

Left: Control room of one of the two frequency converting stations of the HVDC transmission line (1 800 MW) covering 960 km between Tianshengqiao and Guangzhou in China. Right: Thyristor ventilators of an HVDC line in China. Source: Siemens AG.

More supply security without oil, gas and nuclear energy

Since the first oil crisis in 1973 Europeans are well aware of the riskiness of oil supplies; that the gas tap is not always open either was shown by Russia recently. And most also agree on the risk that nuclear power poses at home and in politically unstable countries. The TREC concept provides an alternative to oil and gas monopolies with its solar thermal power plants and wind energy plants that are to be operated by numerous private and public owners. The creation of jobs in MENA states, trade with desert electricity and the resulting economic and social upliftment can further enhance security, TREC argues. Many "small" solar power plants with a joint output of between 50 and 200 megawatt and numerous power lines to Europe create a decentralised production structure and offer alternative means of transport.

White paper with concrete projects and solutions for the energy crisis, water supply and climate protection

Currently TREC is developing a white paper for the Club of Rome that summarises the DLR studies on "Clean Power from Deserts" as well as interesting opportunities for co-operation between the EU and MENA countries. Particularly in the wake of the alarming climate report of the United Nations and the shocking results of the report by the chief economist of the British Government, Sir Nicholas Stern (Stern-Review), on the economic

consequences of climate changes, these are topics that should be at the top of the agenda in Brussels and the various governments of the member states, because German and European research institutes and companies are among the global leaders in the development of solar thermal power plants and their components. It is also the opinion of the Federal Ministry of Environment in Berlin that such systems for environmentally friendly electricity generation should be exported to and realised in the sun-belt countries in the south. This would not only further the protection of our climate but would also create jobs – even in Germany. "If the European industrial policy is serious about its Lissabon Strategy, it must smooth the way for solar thermal power plant technology. Now," the technology group SCHOTT, manufacturer of receivers for STK, states in a memorandum.


Left: A solar receiver collects concentrated solar energy. Right: SCHOTT employees in Mitterteich manufacturing and testing parabolic trough receivers. Source: SCHOTT AG

But this will not be sufficient: in order to build up export capacities of 100 gigawatt – which corresponds to the output of about 100 nuclear power plants – by 2050 in addition to covering the demand of MENA countries, state subsidies would be required for the construction of power plants and transmission lines. A single-digit billion figure would suffice. Experts calculated that the implementation of a single large solar thermal power plant project as suggested by TREC would reduce the costs of solar thermal energy production to below the costs of most fossil fuels. Currently the price for heat from concentrated collectors that correspond to one barrel of oil is already approx. 50 dollars. According to TREC this would render the production and transport of electricity competitive and thus attractive to state and private investors. In terms of the DLR scenario the total investment would amount to just below 400 billion euro, spread over approx. 30 years.

The beginning: solar thermal power plants for the Gaza Strip and in Yemen

In order to realise their concept, TREC suggests endeavours comparable to those of the Apollo space travel programme with which humanity discovered space. Besides the required feed-in regulations or purchase contracts for clean power from the deserts, an "Apollo DESERTEC" programme could be driven ahead with three projects that would enable EUMENA to accomplish significant progress. First investigations have shown that these are technically feasible, but urgently require financial and political support:

- Gaza Solar Power and Water Project
  Solar thermal power plants for the simultaneous production of drinking water and electricity – as a part of an international reconstruction programme in the autonomous Palestinian territories – could be located on Egyptian territory and could supply two to three million people in the Gaza strip through power and water lines. This project is to become a turning point to the current catastrophical developments in the Gaza region, regarding economic and social problems, the conflict around drinking water and the stagnating peace process between Israel and Palestine. The total investment, according to TREC, would amount to approx.

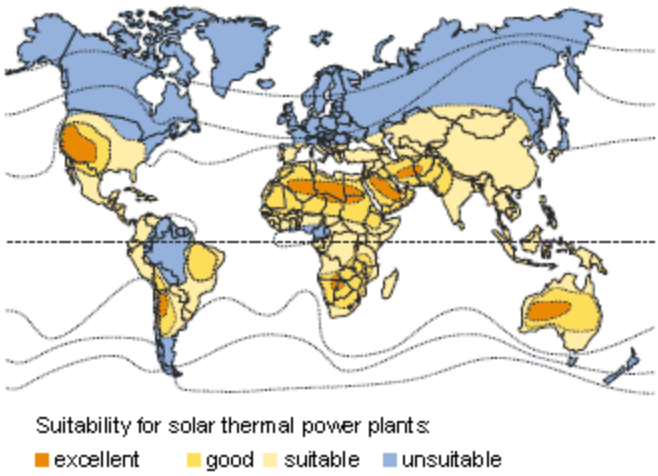
five billion euro.

- Sana'a Solar Water Project
  A sea water desalination plant at the Red Sea and the construction of pipelines to the capital of Yemen (Sana'a), the drinking water reserves of which will dry up in about 15 years, could prevent a humanitarian disaster and social unrest in Yemen and would contribute to saving a cultural world heritage site. Since the alternative of relocating 2 million people would cost about 27 billion euro, an investment of 5 billion euro into the drinking water pipeline and the related solar thermal power plants for operation of the pumps would be a solution that is economically far more feasible, TREC emphasises.
- A new South-North Power network
  Starting the construction of a power network from South to North to transport electricity from the deserts to Europe would lead to an investment boom in the field of renewable energy in MENA countries from 2020 onward and would allow Europe access to cost-effective, clean electricity. According to the DLR study, the costs of the required HVDC lines for the first 10 gigawatt are also estimated to amount to five billion euro.


Hands-on approach in support of power from the desert. Assembly of reflectors for a demo-version of a parabolic trough system, assembly of absorber pipes. Source: Solar Millennium AG

Europe and the Mediterranean countries can only benefit from such a co-operation

TREC demands that the European Union, as a first step, supports a campaign that is to convince the governments in the Middle East and Northern Africa that solar thermal power plants will be more cost-effective in the long run than plants running on fossil fuels. MENA countries would benefit from this, even without exporting electricity.



Clean power from the sun-belt of our earth: California and Northern Africa are ideal locations for solar thermal power plants. Large industrial centres in the North can be reached with HVDC lines.

Source: SCHOTT AG

[Wording: Suitability for solar thermal power plants: excellent, good, suitable, unsuitable

Furthermore, the EU is to give MENA countries a guarantee that it will import clean electricity that could be produced from 2020 onward. This is why TREC is of the opinion that the option of solar power from the South should immediately become part of the EU Energy Portfolio and should also be followed by the policies of member states. The EU could accelerate the construction of solar thermal power plants in MENA countries by consulting and assisting their governments in introducing feed-in regulations and compensation according to the example of the German Renewable Energy Law (EEG). Further steps could be international purchasing obligations on the basis of local feed-in regulations as well as pre-discussions for planning HVDC lines and the inclusion of the EUMENA project into the so-called Barcelona Process. This provides an institutional framework for the Mediterranean policy of the EU and is based on the concept of intensive co-operation of countries on either side of the Mediterranean Sea on an equal rights basis. The purpose of this "Euro-Mediterranean partnership" is peace, stability and prosperity. A secure and climatically neutral energy supply forms the basis of these.

"Energy is an indispensable fundament for socio-economic development and is a basic ingredient in the recipe for peace. It is a basic right that all societies and human beings should have fair access to energy markets, bearing in mind that energy production and consumption must be sustainable for future generations," President of the Club of Rome, His Royal Highness Prince El Hassan bin Talal from Jordan, emphasised in his address at the World Energy Dialogue 2006 in Hannover.

Further Information on Supporting TREC by actions or financially:http://www.trecers.net/de/support.html

Further information:

- Strom aus Solarwärme: Solarthermische Kraftwerke als Option für eine klimafreundliche Elektrizitätsversorgung
- Solarthermische Kraftwerke: Technologie-Transfer in den "Sonnengürtel"
- TREC on the Internet: http://www.trec-eumena.net