



## *Concentrated solar power:*

Advocates of concentrated solar power (CSP) have asked the EU to invest \$10 billion in a large-scale programme that would allow most of Europe to run on solar energy in one fell swoop. However, the risks of such an 'Apollo' project are significant. Some experts prefer a more gradual expansion of CSP.



CSP-installation in Kramer Junction, California, in the Mojave desert.

# revolution or evolution?

| by Hans Verwijs

Prince El Hassan bin Talal of Jordan, former president of the Club of Rome, attracted attention near the end of last year with the presentation of a White Book to the European Parliament which described a path towards the large-scale introduction of CSP in Europe. He represented Trec (Trans-Mediterranean Renewable Energy Cooperation), an international network consisting mainly of scientists as well as some politicians who are actively

promoting the application of renewable energy in northern Africa, the Middle East and Europe. Trec was established in 2003 by retired German physicist Gerhard Knies (70) with support from, among others, the Club of Rome.

A few years ago, Knies contacted the famous environmental club that rose to world fame in the 70s after publishing 'The Limits to Growth: A Global Challenge'. Not much has been heard from the Club

of Rome in recent times, though they still hold annual meetings with leaders from around the world. 'In fact, the Club of Rome had accepted the idea that we are already too late. I convinced them that there is a way forward by using the abundance of the sun. The Club of Rome turned out to be an excellent forum for influencing higher levels in politics,' says Knies.

The authors of the White Book made

a case for adapting desert locations into receptors for solar energy. At the same time, residual heat could be used to desalinate sea water. This will serve multiple purposes: accessibility of water in dry areas, durable electrical power for Europe, and the development of technology. This initiative can only succeed if a new type of collaboration develops between Europe, the Middle East and northern Africa. Trec calls this ideal collaboration Eumena and compares it to the establishment of the European Coal and Steel Community in 1951, on which the current EU is based.

The White Book describes how the 'Solar Powerhouse Desert' can be created in seven steps. One of the most important steps is the construction of a HVDC (High Voltage Direct Current) transmission grid that will enable transportation of electricity over great distances without too much loss. For this purpose, a government-funded infrastructure fund must be set up. According to Trec, the project can be realized within seven years - just like the Apollo programme. This would result in sufficient basis for an ongoing, commercial development of CSP.

Trec has asked the EU for a contribution of €10 billion to finance its Apollo programme. This money would be used to construct an infrastructure, as well as making new technology operational. €10 billion, says Knies, is an estimate. 'It could be 6 billion or 15 billion, depending on a number of factors.' According to Trec, this concerns a one-time-only financial injection: after this amount has been invested, a scale will have been achieved at which the market can finance itself. Increase in scale will decrease investment as well as operational and maintenance costs.

What will the 10 billion be spent on? Knies sees two options for enabling this leap in development. The first alternative is the construction of an HVDC grid. In that case, EU will be its owner. The construction of the grid will have 2.0 - 5.0 GW transport lines running from 20 to 40 different desert locations to their destinations in Europe. Trec

thinks that when the infrastructure is complete, investors will be eager to build and manage CSP stations. A preferable alternative, according to Knies, is the introduction of a European feed-in tariff where the difference between the cost price of CSP and the market price of fossil and nuclear energy is compensated by the EU. The advantage of this system is that there is a relationship with oil prices: When they rise, subsidies can decrease.

It is difficult to say whether the €10 billion estimate by Trec is realistic. Trec



Prince El Hassan bin Talal of Jordan (left) and Dr. Gerhard Knies (middle) present the CSP white book to Hans-Gert Poettering, president of the European parliament. Photo: Trec

expects current costs of electricity to increase to levels between €0.057 - 0.068/kWh by 2020. In order to be competitive, the required scale for CSP would have to reach 28 GW globally by 2020, while it is now just 415 MW. If Eumena could account for approximately half of this increase, the necessary costs covered by the feed-in tariff will exceed €17 billion. The White Book bases its prognosis of electricity prices on a publication by Prof Dr Robert Pitz-Paal of the Solar Research Department of the German Aerospace Centre (DLR). However, he tells European Energy Review that he will not venture a prediction of costs. He thinks the seven-year period is much too short to launch the programme with respect to the level of investment that will be required. Pitz-Paal prefers a feed-in tariff with a yearly digression of 5% as currently applied in Germany. By agreeing on a feed-in over an extended period of time, a situation has

been created that will secure financing for the industry. A longer term is also desirable, according to Pitz-Paal, because when large-scale stimulation packages are announced, the market is given such an impulse that shortages develop, so that the desired price decrease will not occur initially. That phenomenon is taking place currently in offshore wind energy, where the price of turbines has increased dramatically as a result of high demand.

Dr Remko Ybema, director of policy studies at the Energy Research Centre of the Netherlands, expresses himself a little more cautiously. He is pleased that the Trec initiative will put CSP securely on the map. However, he does wonder if it is not being presented a little too insistently as the only available option. He believes in a more evolutionary growth of CSP. 'The political instability of countries with a great deal of desert sun causes investors to hesitate,' he feels. 'This is delicate equipment that can easily be damaged. In addition, a great deal of guidance will be required to mobilize the many different parties into a single direction.' He fears a kind of distortion of facts if too much is wagered on CSP. For this reason, he does not support a 'quick' EU investment of €10 billion. 'The risk of loss is simply too great.' At the same time, he warns against quarrelling about what will be the best source of durable energy. 'CSP is a good building block in the durable energy mix. However, its growth will take place gradually, in response to market forces. Technological development functions best in a home market. This is why sunny areas, such as California and Spain, will develop most CSP applications. It is a general rule that costs decrease when scale increases. That will result in countries in northern Africa applying CSP locally. Only then will interest in importing cheap energy from northern Africa or the Middle East develop in Europe.'

Knies is less concerned about the instability of non-European countries. 'Revenue is too important for the desert countries, and they will not want to risk any hiccups in the money flow. If the EU provides a feed-in tariff, local

non-European countries will have their electricity at market price, and Europe will gain technological power.'

Jan Terlouw, the former Minister of Economic Affairs of the Netherlands who has been promoting CSP for years, sees another possibility. As long as the HVDC lines have not been constructed, he proposes to exchange electricity for gas with northern African countries such as Libya. The idea behind this is that the EU will build CSP power stations and deliver electricity to Libya, while in exchange Libya will deliver gas to the EU.

In the meantime, the introduction of CSP is well under way in places like Spain. At least five new CSP power stations are planned for Spain. The German company Solar Millennium is building two 50 MW stations (Andasol I and Andasol II) near Granada. Investment costs are €300 million per station. A third station (Andasol III) is planned for the future. The Spanish company Aste, a joint venture between Aries and ABN Amro Infrastructure Capital Management, has announced the construction of two CSP stations of 50 MW each in Castilla La Mancha. The Israeli company Solel will supply the solar receiver systems. The growth of CSP in Spain is based on a generous assistance arrangement set up by the Spanish government. Spain guarantees a €0.26/kWh price for electricity supplied in the course of 25 years, with room for inflation correction. This offer is valid until 2010 for a maximum of 500 MW of newly constructed capacity.

Solel is also the owner of the first large-scale CSP installation (354 MW) that was built in the mid-1980s in Kramer Junction, California, in the Mojave Desert. In this installation, parabolic mirrors are used to focus the sun's rays on a heating pipe, so that the heat transfer fluid reaches temperatures of approximately 390°C. The heat transfer fluid creates steam, which drives a turbine in combination with a generator in the conventional manner. After the developer of Kramer Junction went bankrupt, partially as a result of changes in California's fiscal regime, CSP stopped expanding for a long time. Now

Solel has taken over operations and is producing electricity from the station at a cost price of \$0.12/kWh.

In the meantime, technological development has not been standing still. For example, it has become possible to generate electricity at night by storing heat in molten salt. A new kind of collector tube has been developed, so that the heating fluid travelling through it sustains a loss of 20% less heat than its predecessors. The expensive parabolic-shaped Fresnel mirrors, named after French physicist Augustin-Henri Fresnel, are being replaced by flat, cheaper mirrors.

#### Future Trec plans |

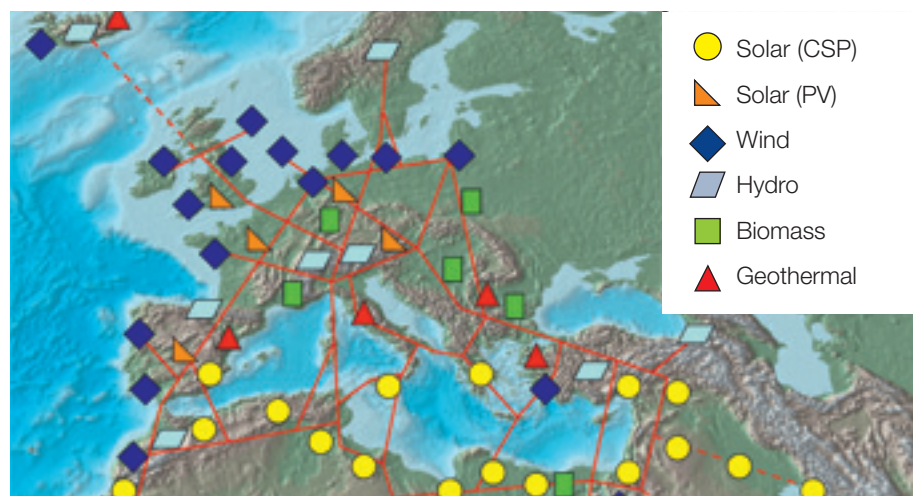
What will follow the presentation of the White Book? Knies: 'More than 300 people were present and they showed a good deal of interest. As a result, the president of the European Parliament, Professor Pöttering, invited me to attend a European Mediterranean Parliamentary Assembly to come up with proposals for cooperative projects. CSP is seen as a viable application of the so called Neighbourhood Policy. The "technology belt" in the north and the "sun belt" in the south stand to gain a lot from each other. Deserts have no value to countries, unless solar power plants are built in them. The proposals, if accepted by the Assembly, will be channelled on to Parliament.'

A kick-off conference will be held from April 22-24 at the Hannover Messe. The conference will be open to the general

public. Many solar industry manufacturers will attend, as well as politicians from a broad range of interested regions: US, India, Australia, Europe and North Africa. 'I hope that a kind of Apollo programme will result from this conference, drawing many players on board,' says Knies.

The position taken by the European Committee is crucial for the future of CSP. Pietro Menna of the Directorate General for Energy and Transport mentions with some pride that the European Commission started stimulating CSP more than 10 years ago, and has distributed at least €25 million in subsidies, leveraging additional private investments worth several hundred million euro. As a result, the solar power station PS10 (11 MW) in southern Spain has become successfully operational. Collaboration with non-European countries is also being encouraged. For example, in the call for projects relating to the EU 7th Framework Programme for Research and Development, the topic 'Using CSP for Water Desalination' was included, which requires collaboration with Mediterranean partner countries. Proposals are being negotiated with contract partners, potentially resulting in new projects.

Menna, however, was unwilling to respond to the Trec proposals. In the Renewables Directive of 23 January, the Commission had little to say about CSP. Energy commissioner Andris Piebalgs told EER that he is enthusiastic about CSP, but does not believe in "Apollo programmes". ■



The ideal mix of renewables for Europe. Source: Trec



**Interview** Dr. Knies

# 'I see no risks'

*EER interviewed Gerhard Knies, the man behind the Trec-proposal to build a huge concentrated solar plant in Northern Africa.*

*Dr. Knies, you are a physicist by training, and in your scientific work you focused on quarks and other elementary particles. Now you are involved in the macro world of renewable energy supplies. What caused the shift?*

I was always interested in energy and climate change. I wondered how population growth and the carrying capacity of the planet could be balanced. Human beings have no natural enemies on earth and therefore no balancing forces exist. We have the ability to annihilate ourselves, and have almost done so with nuclear weapons. We owe it to the behaviour of the Russians that it did not happen. Now we are changing the earth's climate, which implies a reduction of its carrying capacity. For example, the Netherlands could flood as a result of global warming. In the meantime, the earth's population will grow from 6 to 10 billion. In the past we could always migrate to other parts of the world, but we cannot migrate away from earth. As intelligent humans, we can take measures to avoid this collapse. An interesting question for a scientist! Since fifty percent of global warming is caused by the energy sector, that is where solutions must be found. After my retirement I had more time to focus on this matter. In 2002 I visited a conference on this subject. One of the speakers, a leader of the trade union for coal miners, told us that he realized that something should be done to prevent climate change. However, it should not cost his miners their jobs. No one in the audience reacted! This is when I realized that real change had to be imposed, because there is simply too much resistance to it. No one signs up for suffering.

*What makes concentrated solar power so special?*

First of all, there is plenty of sun energy to harvest. With an area of 300 by 300 km we can provide enough electricity for the entire world. There are various locations both in the northern and in the southern hemisphere to achieve that. Deserts will not be harmed if the sun's heat is used for the generation of electricity, and is not dissipated back during the night. Distribution by power lines can go almost anywhere. Deserts are therefore the most appropriate sites for power plants. Temperatures up to about 400 °C can be stored at night, which will overcome the lack of night-time solar energy and improve the amortisation rate of the plant. Fossil fuels can be used to bridge extended cloudy periods because electricity is generated in the conventional way.

Secondly, solar energy is the least invasive power supply. I see no risks. Nuclear power, for example, has too many unresolved issues. There is always the danger of intentional abuse of its

waste. The process can become unstable due to human error during operation.

Thirdly, I do see drawbacks in other renewable sources. Hydropower has a substantial impact on landscape and biotopes. Biomass, though storable, has low efficiency and may even compete with food production. Photovoltaics may be useful as well, but are limited by available light and relatively low efficiency.

*Some scientists dispute the relationship between CO<sub>2</sub> increase and the burning of fossil fuels. It has been suggested that the influence of humans has been exaggerated. Ocean production of CO<sub>2</sub> is said to have more impact than human interference. What is your opinion?*

Everyone has the right to doubt, but also has the responsibility to justify his doubts. Measurements have shown that CO<sub>2</sub> increase in the atmosphere corresponds with the reduction of oxygen. This implies that CO<sub>2</sub> has formed in the atmosphere and that no other sources are responsible for its current increase. Oceans may also produce CO<sub>2</sub>, but have not done so on the scale that mankind has in the recent past. However, oceans will respond to higher global temperatures by producing more CO<sub>2</sub>. Scientists warn of the danger of passing a so-called tipping point. A process could start that cannot stop of its own accord. We had better not play a game of self-destruction.

*How will the transport sector be powered by CSP?*

Batteries will improve in the coming years. I expect cars to be driven by electric motors.

*What about hydrogen?*

Hydrogen still requires production. It is not directly available like fossil fuels. It can be produced by solar power, but with low efficiency. Hydrogen will be reserved for a niche market; for islands or areas remote from deserts. Greenland or Japan, for example. However, 90 percent of the planet can be reached by cables from the deserts. The question whether to apply hydrogen or not is an economic issue.

*What about air traffic?*

I have no renewable solution for that. Maybe hydrogen. But in that case, airplanes cannot fly too high, since water is made from hydrogen and water is also a greenhouse gas. At greater heights, water will languish for ages and behave as a greenhouse gas like CO<sub>2</sub>. ■