CONCENTRATING SOLAR POWER AND THE PROPOSED HVDC SUPERGRID

PARIAMENTARY AND SCIENTIFIC COMMITTEE BREAKFAST BRIEFING ON TUESDAY 13TH NOVEMBER

Dr Gerry Wolff CEng
Coordinator, TREC-UK

Neil Crumpton
Friends of the Earth and TREC-UK

Overview

The Trans-Mediterranean Renewable Energy Co-operation (TREC) – an initiative of the Club of Rome – is a group of scientists and engineers developing a collaboration amongst countries in Europe, the Middle East and North Africa (EUMENA) to take advantage of the truly monumental quantities of energy falling as sunlight on the world's hot deserts – and wind energy in those regions too. TREC-UK is a group of volunteers who are interested in the 'DESERTEC' concept developed by TREC and aim to raise awareness of it in the UK and beyond. Further information about TREC and TREC-UK may be found at www.desertec.org and www.trec-uk.org.uk, respectively.

The DESERTEC concept

Every year, each square kilometre of hot desert receives solar energy equivalent to 1.5 million barrels of oil. Multiplying by the area of deserts worldwide, this is several hundred times the entire current energy consumption of the world. The key technology for tapping in to this energy is 'concentrating solar power' (CSP), which means using mirrors to concentrate sunlight to create heat. The heat may be used to raise steam to drive turbines and generators in the conventional way or it may drive Stirling engines with generators. CSP is very different from the better-known photovoltaics (PV) and should not be confused with it.

Less than 1% of the world's hot deserts, if covered with CSP plants, could produce as much electricity as the world currently uses.

Solar heat can be stored in melted salts or other media so that electricity generation may continue at night or on cloudy days. Also, gas may be used as a stop-gap source of heat when there is no sun.

Efficient, long-distance transmission of electricity

To transmit electricity from renewable sources to where it is needed throughout EUMENA, TREC proposes the creation of a 'Supergrid' of highly-efficient, high-voltage DC transmission lines (HVDC). This would not replace the existing HVAC transmission grids – it would reinforce them and integrate with them.

With HVDC, transmission losses are no more than about 3% per 1000 km. Solar electricity may, for example, be transmitted from North Africa to London with less than 10% loss of power. It is feasible and economic to transmit electricity for 3000 km or more. 90% of the world's population lives within 2700 km of a hot desert and could be supplied with solar electricity from there.

There are several other good reasons, described below, for building a Europe-wide or EUMENA-wide HVDC transmission grid.

The 'TRANS-CSP' report from the German Aerospace Centre calculates that solar electricity imported from CSP plants in North Africa and the Middle East could become one of the cheapest sources of electricity in Europe, and that includes the cost of transmitting it. That report shows in detail how Europe can meet all its needs for electricity from a wide variety of low-carbon sources, make deep cuts in CO_2 emissions from electricity generation, and phase out nuclear power at the same time.

The scenario described in the TRANS-CSP report provides for greater security of energy supplies than we have now.

Potential benefits of the DESERTEC concept include:

- Plentiful and inexhaustible supplies of inexpensive, clean electricity.
- The DESERTEC concept may be applied in many places around the world and could have a huge impact in cutting worldwide emissions of CO_2.
- Jobs and earnings in a large new industry.
- The creation of fresh water by the desalination of sea water using the waste heat from CSP plants – a welcome bonus in arid regions.
- The partially-shaded areas under the solar mirrors have many potential uses including horticulture (using desalinated sea water) – a source of food and other products.
- CSP horticulture can bring land into productive use that would not otherwise be suitable for cultivation.
- By alleviating shortages of energy, water, food and land (at least some of which may be made worse by climate change), the DESERTEC technologies may reduce the risks of conflict over those resources. Also, a win-win solar collaboration amongst countries of EUMENA can help to improve relations amongst different groups of people.

A UK Perspective: How the UK may benefit from the DESERTEC proposals:

Plentiful and inexhaustible supplies of clean electricity: the UK may benefit directly or indirectly from 'clean power from deserts'

Imports of solar electricity on short timescales

On relatively short timescales, the UK may import solar electricity via existing HVAC transmission grids in Europe, even before any HVDC

transmission lines have been laid. It seems likely that as much as 2 GW could be imported in this way, possibly more. More information may be found at www.trec-uk.org.uk/elec_eng/cascade.html. In this connection, a single European market for electricity – like the one which we have in the UK – would facilitate the trading of electricity. The European Commission and the British Government have both called for the creation of such a market.

Imports of solar electricity on longer timescales

On longer timescales, the UK may import progressively larger quantities of clean solar electricity as HVDC transmission lines are installed, as bottlenecks in the existing transmission grid are removed and as existing transmission grids are upgraded with technologies of the Flexible Alternating Current Transmission System (FACTS).

Location of energy-intensive industries

Some of the pressure on UK supplies of energy may be eased by appropriate siting of new energy-intensive industries. For example, the large amounts of heat and electricity needed to convert bauxite into aluminium could, with advantage, be supplied from CSP plants in the Australian desert, close to where the bauxite is mined.

Credits via the Clean Development Mechanism or European 'green certificates'

The development of CSP plants in sunny regions may, via the Kyoto 'Clean Development Mechanism' (or its successor), help the UK to meet its obligations under the Kyoto protocol (or its successor), and may help it to meet European targets for renewable sources of energy.

Security of supplies

The TRANS-CSP scenario up to 2050 provides for greater security of European energy supplies than we have now:

There would be an overall reduction in imports of energy. CSP imports – not more than 15% of European electricity supplies – would be an exception to that rule.

There would be a greater diversity of sources of energy. CSP adds to that diversity.

The HVDC Supergrid can be designed to accommodate damage (like the internet).

The HVDC Supergrid would, in itself, improve the security of energy supplies: HVDC cables may be laid under the sea (as proposed by Airtricity) where they would be relatively safe from attack or other disruption.

A wide range of countries have hot deserts (not like oil or gas).

CSP plants are hard to disrupt and easy to repair.

There can be strategic stores of solar energy in chemical form.

Benefits from the creation of an HVDC Supergrid

Apart from the import of solar electricity from desert regions, the proposed HVDC Supergrid has several other advantages:

Security of supply: a shortfall in any one area can normally be met by spare capacity in one or more other areas.

Reduces wastage: surplus power in any one area may be moved to where it is needed.

A Europe-wide or EUMENA-wide Supergrid would reduce the variability of wind power by integration across a wide area.

A Supergrid would provide access to large-scale but remote sources of renewable energy such as offshore wind farms, wave farms, tidal stream generators, tidal lagoons-and CSP!

A large-scale HVDC grid is needed to enable the single European or EUMENA-wide market for electricity to operate at full capacity.

The Supergrid will allow the UK to become a net exporter of clean electricity from the renewable sources (wind, waves, tides) with which it is so richly endowed.

Many opportunities for "UK plc"

The worldwide potential of CSP and HVDC transmission is huge. There are many opportunities for business, investment and employment in the design, manufacture, installation, management, and maintenance of these technologies.

Bringing down worldwide emissions of CO_2

CSP has great potential to help bring down worldwide emissions of CO_2 and this would be a major benefit to everyone, including people in the UK.

Global Security

An indirect but potentially important benefit for the UK from the DESERTEC proposals would be a strengthening of global security:

Reducing the risks of conflict over shortages of energy, water, food and land.

A win-win collaboration amongst countries of Europe, the Middle East and North Africa can help to improve relations amongst different groups of people.

During discussion the following points were made

The HVDC Grid is not seen as a replacement or alternative to either existing gas or electric grids but as an additional facility that will complement these grids and also, wherever possible, integrate with locally based CHP micro-generation networks. This is not an either/or situation but one where all available energy sources are needed with a gradual shift in time and as rapidly as possible from the more wasteful grid-based model in which fossil fuels are burnt in remote coal-fired power stations without beneficial utilisation of any of the waste heat thereby generated. Many of the renewable sources of energy, such as wave and wind, are also remotely generated in relation to their ultimate destination and will be dependent on a grid facility for delivery to customers. The use of a grid enables security of supply to be guaranteed from the integration of electricity supply from a wider area and range of renewable resources. The downside experience of grid use in the Californian desert is low although sandstorms may be a problem as in northern Nigeria.

Submarine cables could provide a transport system with low environmental impact though the high cost of this solution was challenged. AC lines could be converted to DC lines or added to AC pylons. The power density from solar power is high and only requires the utilisation of 1% of the world's deserts which thereby enables protection of much larger areas of

the world's ecosystems such as tropical rainforests. One square mile of desert will generate as much electricity as 100 square miles of organic crops grown specifically for energy production. Electricity generation from biomass is therefore far less efficient than it is from solar power.

There are major unresolved issues relating to the involvement of industry in a European supergrid. However, this would be dependent on the prior existence a single European market for electricity. In addition to Africa, Spain is also a potential source of solar power and the Spanish and German Governments have been working together on this project for over ten years. In the USA, California and Nevada are currently very interested.

The use of low technology solar energy electricity generation is considered preferable to the development of high technology, fourth generation Pu-based reactor systems.

The timescale required to install the grid was not presented which indicated the need for incentives based on contraction and convergence to help promote the greater use of solar power. The supply and demand system for solar electricity across the grid will also require careful management. The UK should be on a war footing in relation to climate change and this could accelerate the wider use of solar power in Europe as it only takes three years to build a solar power plant with an energy pay-back time of only five months compared with a total of 20 years for a nuclear plant built in the UK. However, wider public acceptance of solar power is currently expected to take several years.

PARLIAMENTARY AND SCIENTIFIC COMMITTEE VISIT TO VICTORIA AND ALBERT MUSEUM

TUESDAY 11TH DECEMBER 2007

Report by Dr Douglas Mills, Technical Secretary, Institute of Corrosion

On a lovely sunny day (it seems a visit by the Committee guarantees good weather!) seventeen members of the Committee visited the Conservation Department of the V&A Museum. It was only a three hour visit – not enough time really to obtain more than a glimpse of what goes on. However what a fascinating glimpse it was! This correspondent's interest is in corrosion and a fellow Committee member (Stephen Benn) asked him early on whether the standard definition of corrosion would include the majority of objects in the V&A. Well, a broad definition states that corrosion is the deleterious interaction of the surface of any material with its environment. Hence it is occurring on the V&A objects just as strongly as it is on the steel hulls of ships or an aluminium alloy bridge.

We were welcomed with coffee and biscuits by Sandra Smith, Head of Conservation, who gave a brief presentation on the role and activities of the Conservation Department in the V&A. Only since WW2, ie the last sixty years, have those working in the Department been known as conservators. Before that they were known as repairers and certainly in Victorian times most of their activities were conducted in dark, dingy basements. However, things have improved and now sixty people work in well-lit laboratories and studios trying to help preserve the seven million items (or 4.6 million objects) that the V&A and its sister museums have. A very important aspect is education and the sharing of knowledge. Work is published whenever and wherever it can be and expertise exchanged with other museums and galleries throughout the world.

Within the conservation group there is a Science section. Silver, sculpture, paper, stone, textiles and plastics are all "corroding" away at different rates and it was part of the job of the science section to try to understand the mechanism and hence try to come up with ways of ameliorating loss (this dovetails with what a corrosion scientist and engineer does). Graham Martin, Head of the Science section, then introduced the tour. Much of what his group does is analysis, ie working out what an object is made of. This is necessary to enable the conservator to suggest the best approach to preserve it. Sometimes this analysis enables what purport to be very old items to be exposed as fakes, eg five papyrus claiming to date from Ramysses III's time (which if they had done would each have been worth upwards of £1million) were found to date from some 3000 years later than that (1960 rather than 1000BC). Problems associated with the lacquer degradation on the Mazarin chest (qv) and the battle between the clothes moth and the "Great Bed of Ware" were other examples or work that the Science section got involved with.

We then went on a studio visit. Some of the analysis techniques used by the V&A include FTIR, NMR and Raman spectroscopy. During this part of the tour we also met people involved in a major project (OCEAN) which is designed to monitor the environment within the museum. (It was suggested that the most destructive source in a museum is the people that come around it!) The V&A is increasingly utilising daylight to display its collections and is increasingly moving away from air-conditioning to more sustainable ways of using the building and controlling the environment. The success of these developments in minimising the impact of the environment is something the V&A is justifiably proud of. However, more could be done with more money!

This was followed by a visit to the paper and books studio where we saw the techniques involved in the preservation of a unique "gradual" (an Italian music manuscript which is being prepared for the Medieval and Renaissance gallery). Also being worked on was a Round the World in 80 Days mid-18th century Theatre by Philippe Jacques de Loutherbourg and wallpaper from the Festival of Britain. Very interesting were some Indian papers including a 15th century edition of the Kama Sutra. The