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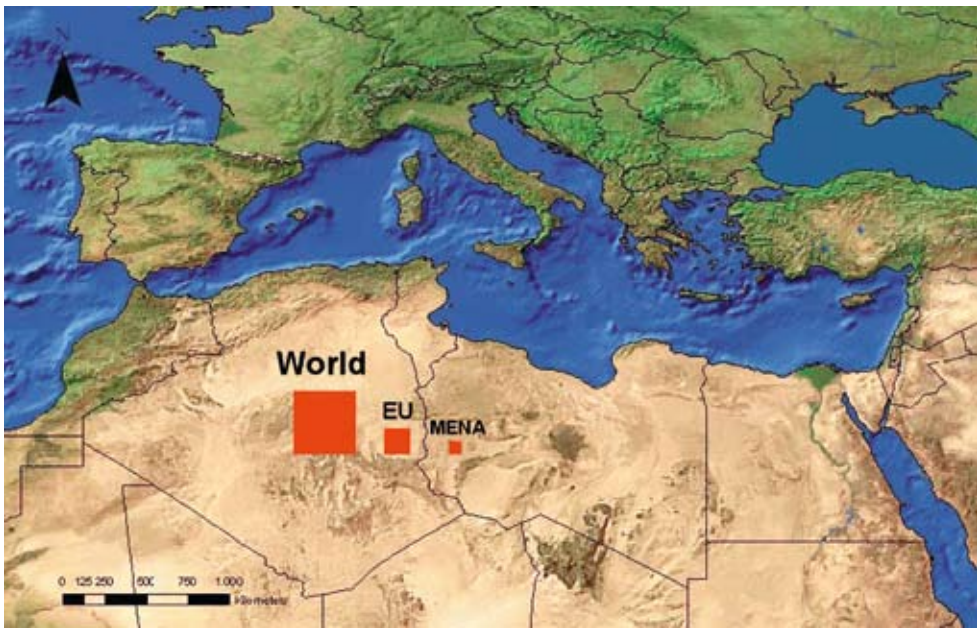
Clean power from deserts

Concentrating Solar Power (CSP) is the remarkably simple technique of arranging mirrors to concentrate sunlight and using the resulting heat to raise steam to drive turbines and generators, just like a conventional power station. CSP works best where there is direct sunshine and lots of it, as in deserts.



Less than 1 per cent of the world's deserts, if covered with concentrating solar power plants, would produce as much electricity as is now used by the whole world.

Solar heat may be stored in melted salts (e.g. nitrates of sodium or potassium) so that electricity generation may continue at night or on cloudy days. And gas or biofuels may be used as a stop-gap source of heat when there is not enough sun. With facilities for storing solar heat and hybridisation with other sources of heat, CSP can provide any combination of base load power, intermediate load or peaking power. This is a great advantage for power engineers trying to match supplies of electricity to demands for electricity which are constantly varying.

The potential

CSP plants have been supplying electricity in California since the mid 1980s, new plants came on stream recently in Spain and Nevada, and others are now being planned or built in many places around the world.
The potential is enormous. Every year, each square kilometre of 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. It has been calculated that less than 1 per cent of the world's deserts, if covered with CSP plants, would produce as much electricity as is now used by the whole world.

Given that not many people live in deserts, how could this solar bounty be used? One possibility is to move energy-intensive industries to desert areas and use the energy where it is produced. Or CSP may be used to generate hydrogen which may serve as a fuel for trains, cars, ships or even planes. But otherwise the best option is to transmit solar electricity directly to where it is needed using highly-efficient high-voltage direct-current (HVDC) transmission lines. With transmission losses at about 3 per cent per 1000 km, plus AC/DC conversion losses of 1 per cent or less at each end of an HVDC transmission line, there would, for example, be less than 10 per cent loss of power between North Africa and the UK.

Using low-loss HVDC transmission lines, it is feasible and economic to transmit electricity for 3000 km or more. It has

been calculated that 90 per cent of the world's population lives within 2700 km of a desert and could be supplied with solar electricity from there. Thus CSP could become a major source of clean power for the whole world.

The DESERTEC concept

The ideas that I have sketched are part of the 'DESERTEC' concept, a set of proposals for Europe, the Middle East and North Africa (EUMENA) that has been developed by the Trans-Mediterranean Renewable Energy Cooperation (TREC), an international network of scientists and engineers. The proposals are described in detail in the 'MED-CSP', 'TRANS-CSP' and 'AQUA-CSP' reports prepared by a team of researchers at the German Aerospace Centre (DLR). Copies of these reports may be downloaded from http://www.trec-uk.org.uk/reports.htm.

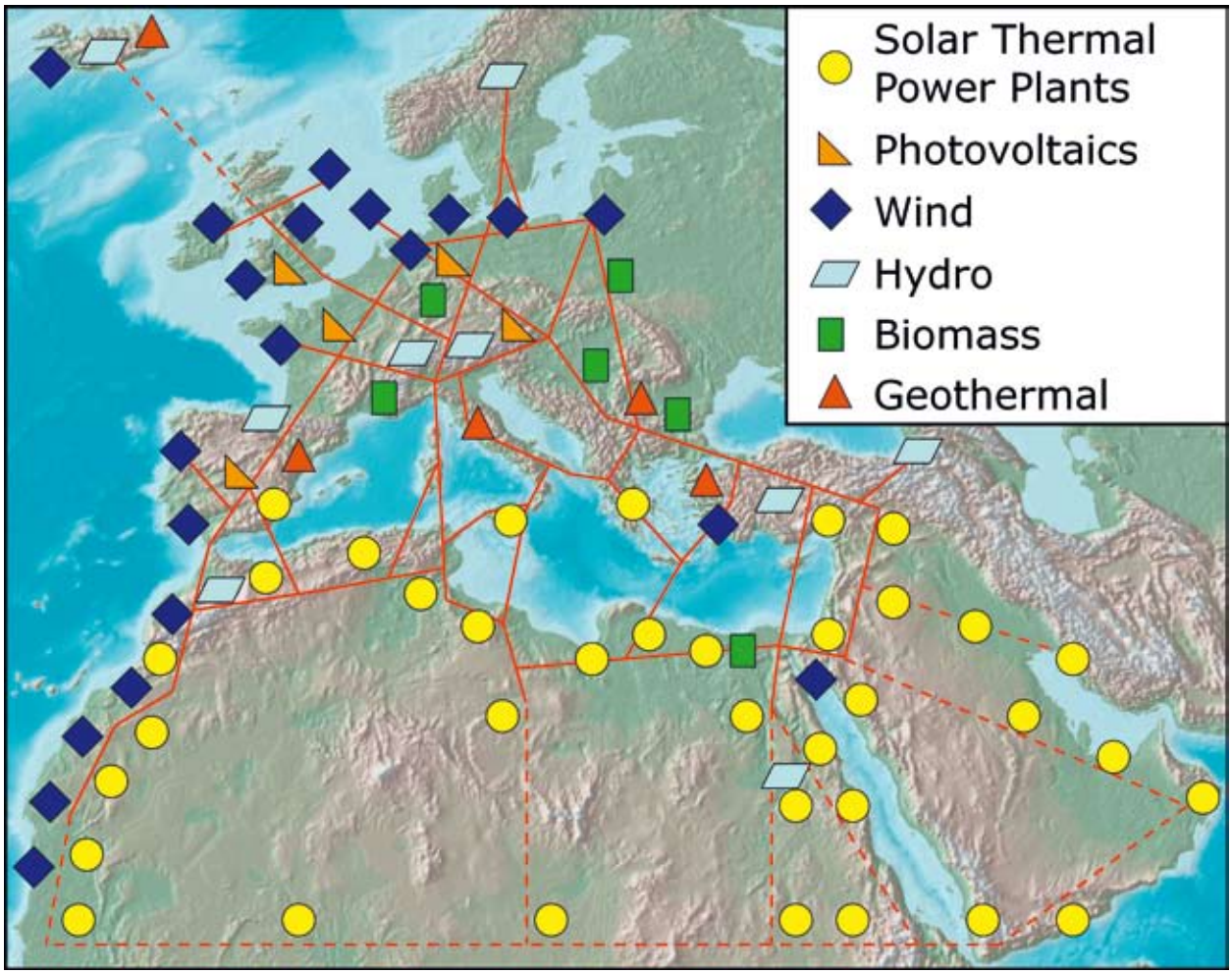
The TREC group have given a lot of prominence to CSP, partly because it has not been very well known until recently and partly because its potential in desert regions is so large. But they recognise that there is also great potential for wind power in desert regions. And in the scenarios up to 2050 that are described in the TRANS-CSP report, imports of CSP electricity into Europe would provide up to 15 per cent of Europe's electricity and the rest would come from wind farms, wave farms, photovoltaics, tidal stream generators, and so on. In the TRANS-CSP scenarios, there would be no need for any new nuclear power stations and existing ones would be gradually phased out.

Bonuses

An interesting bonus from CSP is that waste heat from CSP plants may be used for the desalination of sea water – especially welcome in the kinds of arid regions where CSP plants work best. Also, the shaded areas under CSP solar collectors may be used for many purposes, including horticulture using desalinated sea water, thus bringing land into use that would otherwise be unproductive. By alleviating shortages of energy, water, food and usable land, the DESERTEC concept can reduce the risk of conflict over those resources. Throughout EUMENA, there would be jobs and earnings in a large new industry. And the development of a win-win collaboration amongst countries of EUMENA should help to promote good relations across the region.

The Supergrid

An important part of the DESERTEC concept is the creation of an HVDC 'Supergrid' spanning the whole of EUMENA, and designed to work in



A schematic map of the HVDC Supergrid envisaged by the TREC group, connecting diverse sources of renewable energy to consumers via existing HVAC grids.

conjunction with existing high-voltage alternating-current (HVAC) grids. This chimes well with an independent proposal by the wind energy company Airtricity to create a Europe-wide HVDC Supergrid. It is interesting that, in their proposal, the entire Supergrid would be created using submarine power cables, thus avoiding problems of visual intrusion and simplifying the construction process.

But even before any Supergrid is built, countries throughout EUMENA may begin to benefit from "clean power from deserts" via existing transmission lines. In many ways, a transmission grid works like a lake or pond. It is possible to add a litre of water at one side of a lake and take out a litre of water at the other side so that, in effect, the water has been transmitted from one side to the other – although the water that is taken out is not the same water that was put in. In a similar way, solar electricity that is fed in to one part of a transmission grid means that an equivalent amount may be taken out at any other point in the grid.

As the quantities of electricity increase, the transmission grid can be upgraded by the addition of smart electronics that allow HVAC lines to work more efficiently, by converting HVAC lines to HVDC (which can substantially increase their transmission capacity), and by building new HVDC transmission lines. The end result will be the Supergrid envisaged by the TREC group and others.

Apart from providing access to remote sources of renewable energy like CSP, the Supergrid can reduce wastage (by allowing surplus power in any one area to be transmitted to areas that need it), it can smooth out much of the variability of wind power (because the wind is much less variable across a wide area than it is in any one spot) and it can increase the security of energy supplies (because any local shortfall can almost always be met from elsewhere on the grid).

Costs

The MED-CSP report suggests that CSP will need public support for a time (like other renewable forms of energy) but that, with economies of scale and refinements in the technology, the cost of CSP electricity will fall. Meanwhile, the cost of coal-fired and nuclear electricity is rising. Google Inc has identified CSP as a key technology in its project to produce renewable electricity more cheaply than it can be produced from coal. U.S. venture capitalist Vinod Khosla says that electricity from CSP is already cheaper than electricity from "clean" coal. The TRANS-CSP report calculates that CSP is likely to become one of the cheapest sources of electricity in Europe, including the cost of transmission. CSP is proving to be increasingly attractive to investors.

Close up view of parabolic trough and heat collector.

Let's do it

The DESERTEC scenario, which has been developed with considerable professionalism and care, shows that concentrating solar power can be an important source of clean electricity, not just for countries in the sun belt but for many other countries as well. Additional potential benefits include supplies of fresh water, "CSP horticulture," and the not-insignificant price of improved relations amongst different groups of people.

All the relevant technologies are available now. With the right political impetus, the necessary infrastructure can be put in place quite soon.

For more information visit www.desertec.org and www.trec-uk.org.uk.

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Clean Power from Deserts
Trans-Mediterranean
Renewable Energy Cooperation
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