SUPERGRID COSTS AND BENEFITS[1]

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A key part of the DESERTEC concept, developed by the TREC international network of scientists and engineers,[2] is the creation of an HVDC "supergrid" spanning the whole of Europe, the Middle East and North Africa and designed to integrate with existing HVAC transmission grids.[3] The "TRANS-CSP" report[4] from the German Aerospace Centre (DLR) estimates that a 100 GW supergrid would cost about €45 billion and that 10 GW of capacity between between North Africa and the UK would cost about €5 billion.

Of course, these are large sums of money but we need to ask what the benefits might be and how they compare with the costs. And if the investment does represent good value for money—as I believe it does—we need to consider how it might be paid for.

Qualitative benefits

In qualitative terms, the benefits of a large-scale HVDC supergrid are clear:

- *Reducing wastage*. Without a grid, electricity supply systems waste energy and this is particularly true with renewable forms of energy. If for example, the wind is blowing strongly in Scotland, producing more electricity than the local people can use, that surplus energy is simply wasted unless it can be moved to places where it is needed. If there were affordable systems for bulk storage of electricity, that would make a difference but it would not remove the need to move electricity from areas of surplus to areas of need.
- *Accessing sources of renewable energy*. Without a transmission grid, it would not be possible to take advantage of the large amounts of energy that may be obtained from large-scale but remote sources of renewable electricity such as wave farms, offshore wind farms, tidal lagoons, and tidal stream generators—and concentrating solar power!
- *Opening up new sources of energy*. A related point is that a large-scale transmission grid can open up entirely new sources of energy that might not otherwise be considered. For example, there is potential to import geothermal energy into the UK from Iceland via a submarine HVDC transmission line.[5]
- *Smoothing out variations in supply and demand*. Another advantage of transmission grids is that, if they cover a large area like Europe or EUMENA,[6] they reduce the variability of energy sources such as wind. The wind may stop blowing in any one spot but it is very rare for it to stop blowing everywhere across an area the size of a continent. Without a large-scale grid, it may be

[1] An electronic copy of this document, with live links, may be downloaded from http://www.trec-uk.org.uk/resources.htm#PDFdocs.
[2] See http://www.desertec.org/ and http://www.trec-uk.org.uk/.
[3] Details of several other similar proposals may be found at http://www.trec-uk.org.uk/elec_eng/grid.htm#large_scale_grids.
[4] Which may be downloaded via links from http://www.trec-uk.org.uk/reports.htm.
[5] See http://www.timesonline.co.uk/tol/news/uk/article1782183.ece.
[6] Europe, the Middle East and North Africa.

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necessary to maintain conventional power stations on 'spinning reserve' to supply electricity at short notice if the wind drops, and this spinning reserve is wasteful. In a similar way, large-scale grids can help to smooth out variations in demand.

- *Reducing the need for 'plant margin'*. A transmission grid helps to reduce the amount of 'plant margin' that is required—the difference between actual generating capacity in any area and the theoretical minimum generating capacity. This is because a large-scale grid smooths out much of the variability in electricity supply and demand and because spare generating capacity that is needed to meet contingencies can be shared across a relatively wide area, thus reducing the amount that is allocated to any one area.
- *Security of supply*. A related point is that large-scale transmission grids help to ensure the security of electricity supplies in any one area. This is because any local shortage of electricity or local peak in demand can almost always be met from one or more other areas where there is spare capacity.
- *A large-scale supergrid is needed for the proper working of a single market for electricity across a wide area*. The UK government and the European Commission are aiming to create a single European market for electricity (as we have in the UK), unbundling power generation from power transmission and promoting competition between different suppliers and sources of electricity. A large-scale HVDC supergrid is needed for the proper working of that single market.[7]
- *Getting the best available price for electricity.* Transmission grids that cross time zones may increase the value of electricity by moving it, at any one time, from areas where it is cheap to areas where it will fetch a good price. More generally, large-scale grids allow customers to obtain electricity from wherever it is cheapest at any one time, and that may vary throughout each day.
- *Stabilisation of frequencies and voltages*. An HVDC supergrid can help to stabilize frequencies and voltages in the HVAC grids to which it connects.
- *Export potential*. The UK (and Scotland in particular) has great potential for wind power, wave power, and power from tidal lagoons and tidal streams. If these are developed as they should be, stronger grid connections to the continent will be needed to facilitate exports of renewable electricity from these sources.[8] Likewise for Ireland, bearing in mind that it has a much smaller population than the UK.[9]

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[7] In that connection, Andris Piebalgs, EU Commissioner for Energy, has written: "The single electricity market could not exist without electricity interconnections, and the lack of a European electricity market, as for gas, weighs heavily on the internal market as a whole. This is why it is essential to optimize the use of interconnections, and to invest in the 'missing links'" (from the Foreword to "Report on electricity interconnection management and use," EU Commission de régulation de l'énergie, June 2008).

[8] See "Study backs undersea cable to export Scotland's wind and wave power", http://thescotsman.scotsman.com/scotland/Study-backs-undersea-cable-to.3681414.jp.

[9] See "Ireland launches ocean energy initiative", http://www.renewableenergyaccess.com/rea/news/story?id=51146.

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Quantitative benefits

There are studies that appear to show that, when the value of the several qualitative benefits of a supergrid are expressed in terms of money, they normally outweigh the cost of building the supergrid. It appears that the difference can be substantial.

A useful source of information in this area is the article "Interstate transmission superhighways: paving the way to a low-carbon future" published by RenewableEnergyWorld.com on the 30th of July 2008.[10] Here are some quotes from the article:

- Referring to a proposed 19,000 miles of new 765-kilovolt (kV) transmission lines at an estimated cost of US$60 billion, the article says "While the size and cost of the transmission superhighway may sound large at first glance, it is important to keep these numbers in perspective. Given that electricity transmission infrastructure typically remains in service for 50 years or more, the cost of the investment for the average household would be equivalent to about US$0.35 per month, less than the cost of a postage stamp."
- "… a 2006 study by the Electric Reliability Council of Texas (ERCOT) found that over time an investment in new transmission infrastructure would produce benefits many times larger than the cost of the investment."
- A more recent ERCOT study "found that the smallest transmission investment plan would bring enough new wind energy online to save US$1.2 billion per year in fuel costs—enough savings to cover the US$3.8 billion cost of the transmission infrastructure in a little over three years."
- A study by the Midwest Independent System Operator (MISO) found that "Although the overall generation and transmission costs reached an estimated investment of US$13 billion, the project produced annual net savings of US$600 million over its costs. These savings are in the form of lower wholesale power costs and prices in the eastern U.S. resulting from greater access to lower cost generation in the western states such as Iowa and the Dakotas."

And so on. On the strength of this kind of evidence, it appears that large-scale transmission grids are good value for money.

Paying for the supergrid

In his article, "Interstate transmission superhighways …", Michael Goggin says:

> *… our inability to build new transmission is fundamentally a public goods problem. In most regions, policies require wind plant developers that want to connect to the electric grid to pay for the full cost of an upgrade to the grid network, even though the majority of the benefits of this upgrade would accrue to millions of electricity consumers and other power plants that could piggyback on this investment. Across the country, hundreds of wind projects comprising tens of thousands of wind turbines are on hold because no one wants to step forward and pay for upgrades that will primarily benefit others.*

Since the several benefits of large-scale transmission grids are spread very widely, it is not reasonable to put the burden of paying for transmission links on to the shoulders

[10] See http://www.renewableenergyworld.com/rea/news/story?id=53193.

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of individual project developers. Probably, the simplest and most effective way to spread the burden of paying for a EUMENA-wide supergrid is for the costs to be shared amongst national governments throughout the region, perhaps with contributions from the EU. No doubt, richer countries would pay more. However, with the right framework of incentives, it is possible that this infrastructure could be financed by private investors.[11]

If the costs were shared amongst 30 or more countries in this way, and bearing in mind that the costs would be spread over about 10 years, then the average annual expenditure by any one government would be €150 million or less. In general, the cost of building the supergrid is quite modest compared with other things that governments spend money on:

- €132.5bn (£90bn) is Gordon Brown's estimate of the cost of cleaning up the UK's nuclear legacy.[12]
- €7.5bn (£5.1bn) is the estimated cost of adding a new lane to the M1 motorway.[13]
- €12.3bn (£9.3bn) is the estimated cost of the London Olympics, as of March 2007.[14]
- The Metronet fiasco has cost UK taxpayers €2.68bn (£2bn).[15]
- €100.6bn (£76bn) is the estimated cost of renewing Britain's Trident nuclear missile system.[16]
- And, of course, huge sums have been spent on bailing out the banks.

[11] See "Imera announces EUR4.4 billion pan European electricity grid project", PRNewswire, 2009-02-02, http://sev.prnewswire.com/utilities/20090202/3828897en_iCrossing02022009-1.html.
[12] See "Nuclear costs to hit £90bn, warns Brown", The Observer, 2006-06-04, http://www.guardian.co.uk/business/2006/jun/04/theobserver.observerbusiness.
[13] See "M1 widening to cost £21m per mile" The Observer, 2007-05-06, http://www.guardian.co.uk/uk/2007/may/06/transport.world.
[14] See "Lottery cash for Olympics not repaid until 2031", Daily Telegraph, 2008-01-29, http://www.telegraph.co.uk/sport/othersports/olympics/2290447/Lottery-cash-for-Olympics-not-repaid-until-2031.html.
[15] See "£2bn of public money goes down the Tube as Gordon Brown counts cost of failed deal", The Times, 2008-02-07, http://www.timesonline.co.uk/tol/news/politics/article3321667.ece.
[16] See "New Trident system may cost £76bn, figures show," http://www.guardian.co.uk/uk/2006/sep/21/military.armstrade.

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