PLUGGING IN – the relative costs of new grid connections

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It is well documented that the UK is facing significant challenges to its energy supply due to the combined problems of climate change and energy security. Plans are being drawn up and being implemented to install new forms of electricity generation to replace coal fired power stations and the UK's ageing nuclear fleet. Without replacements the UK faces a cold, dark future. There are many issues related to these new installations and one of the biggest is their location.

The UK's electricity supply system was designed in the 1940s to connect efficiently electricity generation (then mainly located near coalfields and industrial areas) with the main urban areas of demand. It was designed to be a resilient, one-way network. Generate – Transmit – Distribute – Use. Large electricity generating stations are connected to a national electricity grid to move the electricity around the country efficiently at high voltage. At various points this is connected to the low voltage distribution network by which the electricity is delivered to consumers. So when you flick a light switch, the light bulb is instantly connected to a generator somewhere in the UK that has to work that little bit harder.

This system works well until new types of electricity generation need to be connected. These are often sited nowhere near existing power stations, or embedded in the distribution network, or located in a place that will put extra strain on the existing grid. For example, wind farms are often sited on remote hill-tops or off-shore, and nuclear power stations are usually placed in coastal locations. Both of these might be some distance from the nearest grid circuit and the majority of electricity consumers. The answer to this problem is to join them into the existing electricity transmission grid through new connections or "circuits".

The technologies to do this are well established. Electrical circuits can be constructed using overhead wires and pylons or cables laid underground or under the sea. Choosing which technology (or mix of technologies) to employ depends upon many factors such as cost, capacity, topography, geology and environmental impact.

The planned installation of new circuits has become a hot topic in many places, with local people opposing the erection of lines of pylons across the countryside. Many of the arguments have revolved around the relative cost differences between circuit technologies and their differing environmental and visual impacts. However, direct cost comparisons are not easy, particularly when taking into account different locations, technologies, geology, capacities etc. For example, tunnelling through fractured rock in a mountainous area can be significantly more expensive than through clean clay in an easily accessible location. It was this variability that led the Infrastructure Planning Commission to ask the Department for Energy and Climate Change to produce a definitive cost comparison study.

It was important that such a study should be carried out independently and gather information from as wide a range of sources as possible. To this end, National Grid plc asked the Institution of Engineering and Technology (IET) to set up and run the study. Under the IET's guidance, the consulting firm Parsons Brinckerhoff was engaged to carry out the study. A Project Board, chaired by the IET, was created to oversee the project, and two senior IET

Fellows were recruited to review and approve the quality of the final report. The study sought data from equipment manufacturers, installers and network operators from around the world and asked for input from interested parties, including local authorities and pressure groups.

The work took five months, resulted in a 300-page report which details comparable cost estimates for overhead, underground and subsea transmission technologies. This is further broken down to estimate the costs of installing underground cables directly in the ground and in tunnels, as well as the cost of installing Gas Insulated Line (GIL) circuits. GIL is a relatively new technology but, so far, rarely used in the UK.

In the final report the costing results are presented in summary and also in considerable detail. The latter allows the reader to "flex" the estimates to get better indicative costs for real life routes and installations, as well as estimate the impact of changes to material costs, raw material prices and exchange rates.

A transmission circuit is made up of three conductors (or wires in the case of pylons), and a typical pylon supports two circuits comprising six wires in total, suspended from its six arms by ceramic insulators. Because the length and power carrying capacity of each installation has a direct bearing on the costs, each technology has cost estimates for circuits of 3, 15 and 75 km in length and low, medium and high capacities. Each of these options is further broken down to show the fixed and variable build costs along with the whole life (40 year) operating costs. Also included is an indication of the major cost sensitivities of each technology.

The intention of the report was not to produce a quotation checker, but to allow interested parties to gain a deeper understanding of the figures presented in planning applications, and in particular to make realistic cost comparisons between the various transmission technologies for a particular application.

The study found that an overhead line circuit (ie using pylons) is the cheapest transmission technology, with costs varying between £2.2 million and £4.2 million per kilometre. Directly buried underground cable costs vary between £10.2 million to £24.1 million per kilometre, with tunnel based underground installation and GIL technologies costing considerably more. The study did not attempt to answer whether the additional cost of burying a particular transmission circuit could be justified, as it did not seek to estimate the value of a particular landscape, or the amenity value to tourism etc. However it has set a benchmark by which the relative costs of the commonly discussed technologies can be assessed.

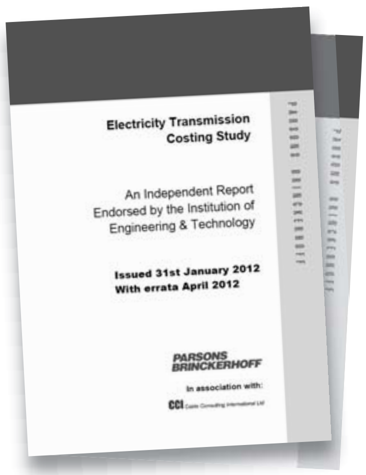
The study considered the whole life costs of the transmission circuits, including the build and operating costs. This highlighted a possible source of confusion caused by the common practice of comparing overhead and buried cable costs in terms of simple ratios. All circuits suffer from energy losses due to the laws of physics – the electrical resistance of a wire causes the wire to heat up when an electrical current flows through it. Whilst the losses will vary between the different transmission technologies, for the levels of power typically experienced on National Grid's circuits the costs of losses are of the same order for all the technologies. However, although the annual costs of these losses are small in comparison to the build cost, when they are considered over the lifetime of the circuit they can have a considerable impact on the technology cost ratio calculation. This is because, whilst the costs of losses experienced by all technologies are similar, they are also roughly equivalent to the total cost of building an overhead line circuit. The total lifetime costs of the overhead line are thus, roughly, twice the build cost, whilst those of underground cables are only around 10% above their build costs (as their build costs are considerably higher). This significantly changes a straight cost ratio calculation, from for example 10:1 underground to overhead to 5:1. It is therefore worth being very cautious when considering arguments based simply on cost ratios.

. . . the UK faces a cold, dark future . . .

. . . the whole life costs of the transmission circuits . . .

The final report includes a comprehensive appendix which provides details on the different technologies and future developments, including explanations of terms such as superconducting cables.

The report was published in January 2012 and has been widely accepted as authoritative. It has been referenced by both National Grid and various pressure groups in documentation and in press coverage relating to transmission planning applications. The Planning Inspectorate has reported that it has found the study to be of value, although it is too early to determine its value in the context of the examination, recommendation and decision stages of a planning application. The report does of course have a shelf-life and, as both technology and the UK energy system continue to develop, it will need to be reviewed and updated at regular intervals in order to maintain its usefulness.



The report can be found on the IET website at http://www.theiet.org/factfiles/transmission.cfm