

# **STUDY ON THE COMPARATIVE MERITS OF OVERHEAD ELECTRICITY TRANSMISSION LINES VERSUS UNDERGROUND CABLES**

## **Submission 6-3-08 from Professor M J O'Carroll**

### Preamble

Given the short response time, these comments firstly address general procedural issues and secondly, on substantive issues, concentrate on a few salient points.

### 1. General comments

1.1 The study is very much welcomed and timely in respect not only of Irish grid developments but also of developing technology.

1.2 The timescale for the study is ambitious. Firstly a short time is provided for public submissions prior to 7<sup>th</sup> March, so that process is likely to be incomplete or curtailed. Secondly the study itself is expected to be completed in April 2008. While recognizing that this is a private study which escapes the procedural timescales of public inquiries, the scope is wide. Just one topic (environmental impact) to be covered corresponds to formal Environmental Impact Assessment (EIA) which can take months, albeit that this study focuses more on generic matters so does not require site-specific study. The scope of the study compares with that of the generic parts of public inquiries, which may take months as for example in last year's Beaulieu-Denny inquiry in Scotland. A single topic (possible health issues) has occupied the UK SAGE group some years and the WHO Precautionary Framework has required a longer time and has not yet produced a final Framework.

1.3 In view of the timescale, the study is unlikely to include serious original work on specific issues, but must concentrate on collecting, coordinating and summarizing off-the-shelf and state-of-the-art information. Since there has been a short time for submissions, the submissions themselves are likely to form an incomplete basis of information. The appointed consultants will need time to invite additional input from appropriate sources.

1.4 There is a potential issue of evaluating, rather than merely summarizing, the collected information. Some evaluative judgment may be appropriate, but that raises the problem of expertise and independence of the consultant over such a wide field, from transmission engineering to tourism and health economics. Few if any single consultancy firms will be well placed to deliver expertise and independence on such a scale. Therefore summary might generally prevail over evaluation, so that the report might carefully emphasize assumptions, uncertainties and ranges, rather than presenting sharp preferences and quantitative estimates. It could still be a very useful aid to government decision making, showing where there is better or worse convergence and indicating rational scope for political choice.

1.5 In order to address the problem of expertise and independence, there could be a case for engaging a small team of consultants from different backgrounds: grid companies, cable companies, EIA consultants and public interest groups. The timescale may make that difficult but not impossible. A modest extension, say to June, might result in an improved report.

1.6 In collecting information it will be important to note the interests of the sources. It may be that the perspectives of grid companies tend to be pessimistic about changes to traditional practice, and in particular about underground transmission, whereas cable system suppliers tend to be more optimistic. I do not assume that, but the consultants should be alert to the possibility. It will be important that information is collected from a range of potentially conflicting interests and compared and balanced accordingly. In particular I am advised that Europacables will make submissions; they are well placed from the perspective of cable suppliers and their consultant has submitted evidence to recent public inquiries and has updated presentations.

1.7 One important aspect, significantly affecting cost, is that of capacity of proposed new lines. The cost of underground solutions can be significantly reduced where capacity requirements are realistically limited, whereas

overhead lines may provide spare capacity at little or no extra cost. The view of the relevant grid company on capacity needs will be particularly important, but should not be closed to challenge. The All Island Grid Study 2008 will be a useful reference point. While this aspect seems not to be specified directly in the terms of reference, it should be included within the scope of “relative technical performance”.

1.8 In this generic study, a wide strategic perspective would be appropriate. The study will have a bearing potentially on a range of future projects in Ireland including external inter-connectors. The possible context of an under-sea DC European and/or British Isles grid supporting renewable energy developments on- and off-shore should be considered, albeit that the more immediate purpose of the study may be to compare on-shore overhead and underground transmission. While the study itself may not require a Strategic Environmental Assessment, there is the question of such assessment for subsequent policies and programmes.

## 2. AC and DC underground alternatives.

2.1 Following from 1.8 above, it would be helpful for the study to include HVDC transmission, with input from leading companies such as ABB. The study should cover new technology and costs for converter stations. The prospect of shared or multiple take-off points from a long HVDC line would make assessments project-specific, but the study could usefully assemble key generic information.

2.2 At 110kV there are said to be examples of underground cable installed to serve wind farms (e.g. Ballywater-Crane in County Wexford). The cost and impact is said to be reduced by trenching cables under roads and by a novel installation method using pushing rather than pulling to negotiate bends. It will be important for the study to take evidence directly from such suppliers and installers.

2.3 When assessing the impact, and particularly electric and magnetic fields (EMF), from underground AC lines it will be important to note the more benign alternative of deeper burial in sensitive situations. The argument that magnetic fields immediately above shallow-trenched cables may be higher than those spreading from an overhead line should be taken in the situational context with deep-burial alternatives.

2.4 It will be important to be realistic in reporting constraints due to shallow (trenched) undergrounding. I have seen false statements from grid companies, perpetuated in EU consultants’ reports, and claims at public inquiries, to the effect that a wide sterilized swathe is created through the countryside. There is temporary disruption during construction and subsequent constraints on, e.g., deep-rooted planting, but in most cases these are immaterial and crops are grown directly over the buried cables as normal.

## 3. Potential health impacts.

3.1 Potential health impacts appear to feature very strongly in the public concerns in Ireland prompting this study. It will not be feasible in the time available for an investigation to do justice to the wide ranging issues relating to these concerns and potential impacts. An even-handed account should be taken of the range of views and professional opinions, rather than simply to adopt Irish statutory advice or, say, WHO advice out of this wider context. This submission gives some pointers but is not exhaustive.

3.2 While potential health impacts are described as “uncertain”, meaning unproven, there is nevertheless a large and growing body of scientific evidence giving rational grounds for concern. Power-frequency magnetic fields are recognized by the WHO body IARC as a “possible human carcinogen” and classified as Class 2B accordingly. That places such exposures squarely in the realm of precautionary policy, as addressed in the draft WHO Precautionary Framework and in the WHO EHC document vol.238 of 2007.

3.3 Complementing the WHO documentation there are other reviews, such as that by the California Department of Health Services in 2002, and the Bio-Initiative Report 2007.

3.4 The First Interim Assessment (FIA) of the UK SAGE Group, reporting to the Department of Health, can be particularly relevant. It is based on current best practice in uncertain risk assessment as recognized by the UK government. It identifies common ground over a wide range of stakeholders. It also identifies key differences,

especially the question of considering impact of childhood leukaemia alone (CL), or childhood leukaemia plus other associated diseases (CL+). Please consult the FIA and my comments on it at

<http://www.rkpartnership.co.uk/sage/>  
<http://www.revolt.co.uk/sage/index.php>

3.4 As noted in the SAGE FIA, the assessment of the uncertain impact for CL, after allowing for “cure” rates and for discounting future benefits, is equivalent to a one-off capitalized sum of about £1,000 per home exposed typically above a time-weighted average of 0.4  $\mu$ T. That does not allow for under-estimation due to the unsatisfactory “threshold assumption” that lower exposures are entirely harmless. The assessment for CL+, allowing for uncertainty factors, is acknowledged to be about 100 times higher, i.e. about £100,000 per exposed household, when all the associated diseases are taken into account. More background on this can be found at <http://www.electric-fields.bris.ac.uk/ocarroll.html>

3.5 New research and evidence, for example regarding adult leukaemia and regarding Alzheimer’s disease, reinforces the case for considering CL+. Please refer to my note 3-3-08 to the HPA EMF Discussion Group and its three enclosures, all provided herewith:

- [1] O’Carroll, Note to HPA EMF-DG, 3-3-08
- [2] O’Carroll & Henshaw, Risk Analysis 28(1), 225-234, 2008
- [3] Garcia et al., Int. J. Epidemiol. 2008 (advance copy)
- [4] Gee, BCPT 102, 257-266, 2008

3.6 In addition to magnetic fields, there are potential effects from ionized particles arising from corona ions from powerlines. Health aspects of such ions are less extensively researched, though their physical presence is basic physics and not in dispute. Such ions are detected at several hundred metres from 400kV lines. Epidemiologic findings of increased incidence of CL up to 600 metres (Draper et al., 2005) may correspond to this effect, though many questions and opinions have been suggested.

3.7 For typical UK lines, with phase-transposed double circuits, the threshold of 0.4  $\mu$ T is said by SAGE to be reached at about 60 metres from the centerline of 275 and 400 kV lines. In Ireland, 400kV lines have been, and are expected to be, typically single-circuit. The magnetic field from single-circuit lines, for the same total load and voltage, spreads much more widely than those from phase-transposed double-circuit lines. For a similar load per circuit, a more reasonable expectation, and for similar conductor separation, the magnetic field at 60 metres from a phase-transposed double-circuit line would occur closer to 100 metres from a single-circuit line.

3.8 Therefore, subject to the assumptions of similar load per circuit and similar conductor separation, the UK corridor of 60 metres each side of the centerline of a phase-transposed double-circuit line would correspond roughly to a corridor in Ireland of 100 metres each side of the centerline of a single-circuit line. As usual, this is an estimate capable of revision in the light of project-specific data, but it provides a ball-park basis for consideration.

3.9 Given the relatively sparse population in Ireland with average density of 60 people per sq km, the above basis would lead to an assessed value of residential health impact from a single-circuit 400kV overhead line, ignoring exposures beyond 100m, of from several thousand to several hundred thousand Euro per line km, depending on the underlying CL or CL+ assumptions.

#### 4. Impact on property value

4.1 The impact of overhead powerlines on property value, whether attributable to health concerns and/or visual impact and/or other factors, is distinct from the impact of uncertain health hazards upon residents. There is a body of academic research which once again is indicative rather than prescriptive. Please see both the SAGE FIA and the paper:

- [5] Sims & Dent, Urban Studies, Vol. 42, No. 4, 665–694, April 2005.

4.2 While property devaluation due to powerlines can be 30% or more, the effect is highly situation dependent. In typical tranquil rural Ireland high voltage powerlines can be particularly incongruous. The usual single-circuit towers in Ireland are about half the height of typical double-circuit towers in the UK. Their heavy structure will still have a pronounced impact, but because of the reduced height the effect will not extend so far laterally. Where the approaches to a settlement or key nearby features are affected, this can have a damaging impact on the settlement as a whole as a desirable place to live, so effects can propagate beyond the area of visibility.

4.3 In view of the above, and noting the importance of site-specific assessment, a broad ball-park estimate of overall impact on property value may be a figure of 10% devaluation on homes within 1 km of the centerline. Those figures can be varied and it should be borne in mind that they are merely ball-park guidelines and not at all precise. On this basis, and with average population density around 60 people per sq km, the impact on residential property may be of the order of a million Euro per km of 400 kV line.

#### 5. Aggregation of impacts and cost-benefit analysis

5.1 It will be helpful if the study can make some attempt to compare overhead and underground alternatives in respect of all their costs and benefits in aggregate. This will require not only capital and revenue costing with appropriate discounting, but also full lifetime costs including losses. A short discussion of some costs and benefits is given in:

[6] EU Background Paper, 2003

5.2 It will be important to aggregate the impacts of each alternative technology. From section 4 above, the potential health impacts on people and impacts on property, taken together, may be of the order of 1 to 2 million Euros per km of 400kV overhead line in rural areas with average population density for Ireland. These impacts would be practically absent from underground options bearing in mind the possibility of deep burial with remote drilling in sensitive areas.

5.3 In addition there are impacts on heritage, tourism and communities to consider, as well as the range of EIA factors.

#### 6. In conclusion

6.1 This welcome and timely study will need to take care to be sufficiently comprehensive while also identifying assumptions, qualifications and uncertainties.

6.2 A broad aggregate cost-benefit analysis would be helpful, with appropriate qualifications about site-specific variation and about imprecision, not to determine answers but to provide a background against which political decisions may be made.

6.3 I have identified some key points to take into account, including recent work on assessing the impact of possible health effects and new research illustrating the continuing strengthening of evidence.

6.4 I would ask that the web-linked references be consulted and the attachments [1] – [6] provided herewith be taken into account.

6.5 I would be willing to be consulted on any of the above or related matters.

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