POSITION STATEMENT: CRITERIA TO DETERMINCE THE USE OF EHV CABLES IN NEW ENERGY INFRASTRUCUTE PROJECTS ON LAND

The European underground cable industry, Europacable, and its member companies have spent 30 years investing in innovative technology for underground cabling that overcomes the limitations of overhead lines (OHLs) in certain circumstances. Notably underground cables (UGCs):

- require a narrower band of land to install;
- emit no electric field and can be engineered to emit a lower magnetic field than an overhead line (see Annex II);
- have lower transmission losses;
- can absorb emergency power loads;
- have lower maintenance costs;
- create less visual and environmental impact that often generates opposition from local communities; and
- are less susceptible to the impacts of severe weather.

Europacable recognises that underground cables are – at installation – more expensive than overhead lines. Cost comparisons often only address costs of installation and ignore costs such as maintenance, decommissioning, losses and outage costs that a comprehensive lifecycle cost analysis should address. While such analysis will vary from case to case, the attached example suggests that the cost factor can be as low as 4 times under a balanced lifecycle analysis (see Annex I).

For this reason, Europacable believes that it can only responsibly promote the use of underground cables on land if it publicly recognises that EHV underground cables are rarely, appropriate for an entire new AC power transmission project. Instead, Europacable strongly recommends that guidelines should be established for the appropriate use of UGCs to balance the needs of economic stakeholders, local communities and the natural environment, notably in sections of projects which have:

- Densely populated urban areas;
- Areas where land is unavailable or planning consent is difficult to obtain within an acceptable timeframe;
- Waterways and other natural obstacles;
- Land with outstanding natural or environmental heritage or vulnerable eco-systems;
- Historically or culturally important sites/buildings;
- Areas of significant or prestigious infrastructural development; and
- Land whose value must be maintained for future urban expansion and rural development.

Each project is unique and requires its own careful analysis and specific solution. However, as the voice of European manufacturers of underground cables, we adhere to the view that unless an acceptable overhead route can be found, underground cables are an appropriate solution.

In particular, Europacable also notes that partial undergrounding of a line can, for controversial projects, provide a compromise to allow a project, which might otherwise be blocked for many years, to move forward. In such cases, the lifecycle cost analysis can be extended to compare the "cost of non-cable" (including lost revenues, bottleneck costs, etc) to the marginal installation costs associated with the use of underground cables.

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ANNEX I: LINE & LIFE COST CALCULATIONS

Comparing costs of OHLs and UGCs is not an easy issue. The technical solutions are different, the ways the lines can be operated are different and the costs of a project will depend on the demand/power rating and the geographic surroundings (urban, rural, normal soil, wet soil, rock etc).

Comparisons between the capital costs of OHLs and UGCs are often quoted based upon studies and past projects. In many cases comparisons are made solely on the capital costs of the equipment together with the costs of installation and accommodation works and in other cases, respective life costs are considered that take into account transmission losses, maintenance costs, availability (and associated outage related costs) and decommissioning.

The eventual cost will depend on several factors including:

- length of cable, where section lengths of up to 50km are now technically possible for AC circuits without providing compensation;
- number of joints and the method of bonding the metallic sheaths;
- type of cable (XLPE or fluid filled);
- size of cable (anything from 800 to 3200mm² depending on capacity rating);
- width and depth of cable trench;
- method of laying cables (trefoil or flat), the type of backfill used in the trench and whether the cables are direct buried, laid in ducts, pipes or tunnels.

The extra cost can vary significantly and on XLPE projects completed in Europe over the past 10 years carrying voltages between 380-420kV, the range of investment cost has generally been between 3 and 10 times. When all costs are considered over the estimated life of the cable, these multiples fall to between 3 and 7 times. In many cases, this represents a cost effective solution when the reduction or elimination of planning delays are considered.

For the transmission system owners, the increased investment cost will need to be recovered from customers over the life of the assets but as the cost of transmission represents less than 5 percent of the total cost of electricity (between 2 and 3 percent according to Ofgem), the impact on customer bills should only be marginal, particularly when compared to the subsidies being recovered from customers for renewable energy generation.

A recent study[1] in Scotland of an XLPE cable project produced the following calculations:

Cabled section length (km)	5	10
Capex/km XLPE cable £k[2]	6,675	6,100
Capex/km OHL £k	1,050	1,050
Cost ratio	6.4	5.8

When life cycle costs were considered the following cost ratios were arrived at (based on a 5km section of OHL/UGC)

	XLPE/OHL
Discounted present cost (DPC)at 3% discount rate	6.4
DPC including maintenance & decommissioning	6.1
DPC including maintenance, decommissioning & losses	4.0

[1] Undergrounding of Extra High Voltage Transmission Lines by Jacobs Babtie for the Highland Council, Cairngorms National Park Authority & Scottish Natural Heritage, March 2005

In the study accurate outage data for XLPE cables could not be obtained as many installations are relatively new and were installed after CIGRE (International Council on Large Electric Systems) carried out its most recent survey in 1996. If outage statistics gathered by CIGRE in 1996 for older fluid filled cables are applied (non-availability of 3.2hours/circuit km/year compared to 0.126hrs per OHL), the cost ratio rises to 7.6, but based on recent research, Europacable believes that outages on modern XLPE cables are around 0.2hrs/circuit km/year, which is far lower than fluid filled cables and is close to the level of outages experienced on OHL. (CIGRE is currently updating its work in this area and results of a new survey are due to be released later this year).

A recent study[2] in France for a proposed 150km 400kV transmission line in Normandy looked into 10 different technologies for completing the link, including AC and DC links, partial and full undergrounding. The "life cost" summary for the principal alternatives was as follows:

150km link	Power rating MVA	Number of lines/cables	Cost €m	Cost multiple to OHL
Overhead line	4000	6	200	-
XLPE underground cable	2000	6	598	3:1
XLPE underground cable	3000	9	832	4:1
XLPE underground cable	4000	12	990	5:1
Partial cable/OHL 30/120km	2000	6/6	305	1.5:1
Partial cable/OHL 30/120km	4000	6/12	358	1.8:1

The report indicates that even the most expensive solution (involving 12 cables for the full 150km) was only estimated to be 5 times more expensive.

The French report also underlines the importance of the power rating in determining the cost differentials. A recent example of this can be shown when a comparison is made from a new cable project in Italy (where an 8.4km section of a 40km link was put underground) and discussions into the potential cabling of sections of the proposed 220km line between Beauly and Denny in Scotland.

	Beauly-Denny	Turbigo-Rho
Maximum Rating Winter	4,050A	4,080A
Maximum Rating Summer	3,620A	3,400A
Number of cables proposed/actual	12 fluid filled	6 XLPE
Size of cable proposed/actual	2,500mm2	2,000mm2

The comparison above would indicate that the a more effective cable solution has been adopted in Italy for power lines carrying a similar amount of electricity (between GW 2.2 and 2.3) and therefore cabling in Scotland may not be as expensive as some initial reports suggest.

Since their introduction in Europe in 1997, 400kV XLPE systems have had an excellent service record and new installations have or are being installed in/around Berlin, London, Madrid, Milan, Rotterdam and Vienna and in rural areas of Denmark and Italy. At voltages of 220-275kV, XLPE cable systems have been installed since the 1960s in various locations such as Barcelona, Dublin, Lisbon, Paris and Stockholm. There has also been a significant expansion of EHV cable systems elsewhere in the world including the Middle East and the USA. The UK, however, has been comparatively slow in endorsing XLPE cables. There are currently no manufacturers of XLPE cables in the UK (only fluid filled) and it has been only in recent months that National Grid has announced that XLPE cables will be preferred to fluid filled for future cabling projects. The most recent example in the UK of cabling in a non urban area was the Vale of York, but in Europacable's view, cabling technology has moved forward and that there is now a more compelling case for cables that meet the requirements for a secure electricity supply within an acceptable time frame.

[2] "Audit of the alternatives to the proposed overhead line between Cotentin and Maine" – CESI, December 2005

A further factor which is also used frequently by those opposed to UGCs is that the economic life of a cable is much shorter than that of an OHL and therefore the asset has to be replaced more frequently. Some evidence contained within in a recent report[3] for the European Commission demonstrates that this is not the case.

Equipment	Asset life	Factors affecting asset life
Aluminium Conductor Steel Reinforced "ACSR" – normal environment	54	Climate, environment, creep, mechanical fatigue, insulator failures, weather (wind, rain, ice loading), pollution levels
ACSR – polluted environment	46	Degradation of material, high temperatures due to loading, joints
Steel lattice tower	63	Climate, environment, corrosion, maintenance, ground condition, concrete splitting, steel/concrete junctions
Cables (fluid filled)	51	Environment concerns (oil leaks), sheath, corrosion, electrical/thermo-mechanical stress, loading

Europacable believes that XLPE cables should be able to match the asset life of fluid filled, with the added advantage that the environmental concern of leaking oil is not relevant.

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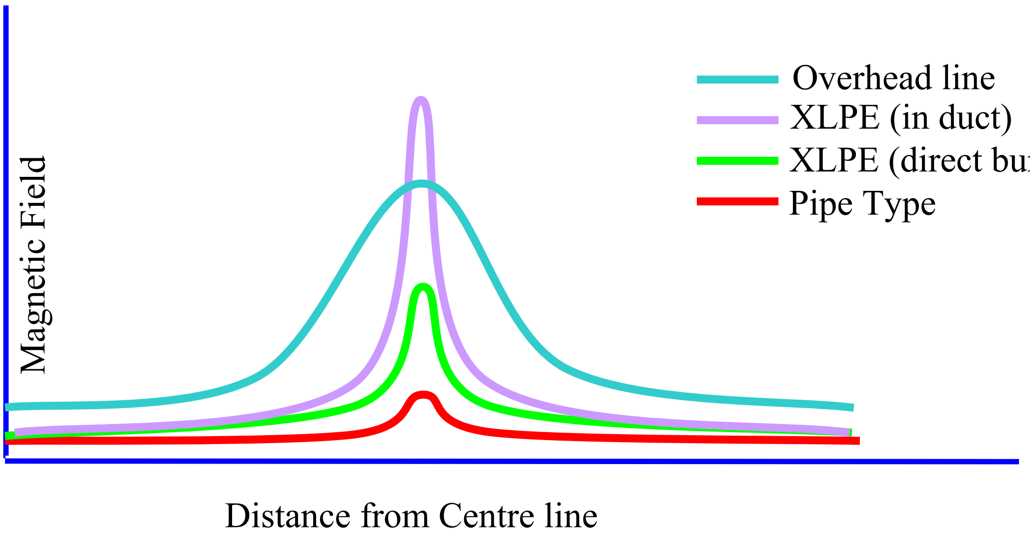
[3] Study for the European Commission - Energy Infrastructure Costs between 1996 and 2023 on the TENS network with emphasis on renewable energy, CESI, IIT, ME & Ramboll, October 2005

ANNEX II: ENVIRONMENTAL CONSIDERATIONS

As part of the European Union's energy strategy, there is a commitment to reducing the social and environmental risks associated with the transmission of energy and in this respect cables can provide benefits as they have been shown to be more effective in mitigating potential health impacts.

With cables, the electric field is eliminated whereas for OHLs, the maximum exposure under a line is around 5000V/m falling to around 50V/m at 100 metre distance. Both OHLs and underground cables produce a magnetic field. The magnetic strength at 1 metre above ground directly under a 400kV OHL is approximately 30 µT (microteslas) at normal load and up to 70 µT at maximum load. At 100 metres distance these rates fall to around 0.2 µT and 0.4 µT respectively. Although underground cables can produce higher magnetic fields directly above them than an OHL these fall rapidly such that 10 metres either side of the cable the magnetic field is negligible. For OHLs, the magnetic field is not negligible until some 150-200 metres away from the line.



The European Union issued Directives in 1999 and 2004 concerning restrictions on the exposure of the general public to electric and magnetic fields and the current limits are 100 µT for magnetic fields and 5000V/m for electric fields. A number of European States though, including Sweden and Switzerland and three autonomous regions in Italy, have recently imposed much tighter exposure limits (in effect an exposure of less than 0.5 µT) in certain locations. The impact of this is that OHLs in those countries are generally not being built within at least 150 metres (and often 200 metres) from existing properties.

The UK government has recently established Stakeholder Advisory Group (SAGE) to examine EMF issues surrounding existing and new homes near existing and new power lines. A report is expected later this year but unofficial indications are that some limit for the siting of OHLs from new and existing properties (possibly around 80-100 metres) will be recommended and this will need to be taken into consideration by all stakeholders.