



**Overview of the Proposed 400kV  
Overhead Transmission line near  
Beauly, Scotland**

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## **1. Executive Summary**

This report has been prepared at the request of Heritage Solutions. Its main purpose is to assist in reviewing the proposals made by Scottish & Southern Energy (SSE) for a new 400kV overhead transmission line between Beaully and Denny. It specifically looks at the Kiltarlity area and the Yellow route option (called the Indicative Proposed Route or IPR). SSE has selected it over seven proposed routes in the Interim Report it recently published.

In situations where new 400kV electricity transmission lines have to be built selective undergrounding near large distribution points and areas of natural beauty is the only sensible way forward. We hope SSE will recommend this for the section of line near Beaully.

The UK Government has set a target that 10% of electricity supplies within the UK should be generated from renewable sources by 2010. This could require up to 10 GW of additional renewable generation, most of which is expected to come from wind energy. In addition, the Scottish Executive has set a target of 40% of electricity supplies in Scotland should come from renewable sources. The DTI is keen to see that appropriate transmission infrastructure is put in place to enable the electricity generated from renewable sources, particularly in remote regions of Great Britain, to be transmitted to centres of demand.

The proposal to construct the 400kV line forms part of Stage 1, which is to construct and connect up to 2 GW of wind farms in northern Scotland. Local communities, politicians and landowners need to be aware that further lines may be constructed into the Beaully area to complete Stages 2 and 3 (4GW and 6 GW) and even further lines may be needed bearing in mind the proposals announced by the Scottish Executive. While the focus of this report is on the Indicative Proposed Route it is worth noting that internationally, to date, wind energy has not yet proven to be a reliable nor economic source of energy for the scale of supply being proposed for the Scottish Highlands.

Undergrounding of the entire proposed line on land has been rejected by the DTI due to its high cost. Undergrounding by sub-sea cable off the west coast of Scotland (either 200km or 700km) was also examined and it has been recommended that the sub-sea cable option remain on the table for the future and to be reconsidered if there are difficulties in obtaining the necessary consents to build the overhead lines.

SSE estimates the cost of constructing the 220km line to be approximately £190m. At £863,000/km, this is around TWICE the cost of comparable networks in EU countries with a comparable geography and climate. Modest improvements in this ratio could generate savings on the overall construction costs that would more than offset the modest incremental cost of an underground spur near Beaully. The cost multiples for undergrounding in the UK are also considered very high when compared to similar projects in Europe. Whilst transmission companies in the UK maintain that an underground 400kV cable is 15-25 more times expensive than an equivalent overhead line, a recent 140km project in Denmark, where 10% of the line was put underground, revealed that undergrounding

was only 4-5 times more expensive. This new technology is environmentally friendly and other European countries and the European Commission are also favouring the greater use of underground cables particularly if it facilitates and speeds up the construction of transmission networks.

Given that at least nine major transmission lines already converge on Beaully with more on the horizon; given its natural beauty and given the desire to enhance tourism based upon, in part, its environmental sensitivity, this report recommends a short five kilometre spur from the Beaully sub-station be built underground replacing the existing 132kV route. Two specific options for the route are suggested in this report following close to the line of the existing 132kV route before joining up with aerial routes proposed by SSE.

Based on SSE's costing, a 5km above ground stretch of line in the area of Kiltarlity would cost of the order £4.3 million. Given that an underground cable built in the same area would be almost entirely through fields and would avoid the extra cost of a switching station on one end as well as be very close to existing roads and access points with existing rights of way assured, its cost should be closer to the five times experience in Europe. The incremental cost, therefore, of around £17 million would only add approximately £1million to SSE's annual transmission costs; this is only 0.8% of the existing transmission and distribution cost base in Scotland. Other savings in network design and construction methods should more than offset even this cost.

Ofgem is due to release its own report and list of priorities for the funding of new transmission lines to accommodate renewable investments later this month. Certain of the network costs that are incurred to permit new private power generating companies to transmit their product to their customers should be borne by these private companies. Solving bottleneck points and reducing unacceptable wirescape issues near Beaully should be top priorities for all parties.

In any event the IPR in the Hughton area should be reconsidered and rejected. On balance it does NOT cause the least disturbance for the environment nor the people of the area. In fact, it would cause significant and proscribed disturbances in the Ruttle Wood that conflict with the UK and EU laws and Directives protecting four specific endangered birds of prey. Such an attempt to build will inevitably lead to lengthy delays as all legal remedies are pursued. The IPR contravenes its own guidelines by placing towers at one of the highest points possible in the entire area. Some towers will rise from existing ground levels of 100 metres to levels of more than 200 metres above ground. Such new landmarks will be visible for miles in all directions.

The IPR also claims to solve one pinch point at Hughton by simply moving it to the west and creating another one on a home that was approved by planning prior to any of this route being published. Finally it causes more public disturbance and backlash by going into the Ruttle Wood directly over and onto a footpath the local Community Council has requested a landowner to privately fund and build. Ultimately, if it is decided undergrounding is not possible, then SSE should revert to a line within 50

metres of the 132kV existing line. SSE are already proposing this approach for the line from the Beaully substation to the river Beaully and this is, on balance, the least worst above ground option on the land to the west of the river. SSE should also use towers of less height and width and take into account some of the innovative designs and cost savings being used in Denmark and Sweden.

However, it is the conclusion of this report that undergrounding a short distance of around 5 km through fields is cost effective and an appropriate policy for the future in areas such as Beaully. This policy decision is especially critical at this stage before additional lines come marching into and across more of this beautiful landscape. Savings in design and construction technology will more than offset the real incremental costs. Local councils and landowners and those who enjoy and protect the environment will support SSE and the project will, instead of being delayed for years in frustrating disputes, be successfully completed.

## **2. Rationale for the new 400kV line**

The UK Government has set a target that 10% of electricity supplies within the UK should be generated from renewable sources by 2010. This could require up to 10,000 MW (10 GW) of additional renewable generation, most of which is expected to come from wind energy. Also, the Scottish Executive has set a target of 40% of electricity supplies in Scotland should come from renewable sources. The Department of Trade and Industry (DTI) has stated in its June 2003 report of the GB Transmission Issues Working Group (TIWG) that “appropriate infrastructure must be in place to enable the electricity generated from renewable sources, particularly in remote regions of Great Britain, to be transmitted to centres of demand if lack of transmission capacity is not to act as a barrier to meeting the Government’s 10% target”.

Over the last couple of years, a number of studies and reports have been commissioned to examine this issue including:

- A high level investigation by PB Power (February 2002) into the feasibility of developing an offshore high voltage cable along the western coast of Scotland and northern England;
- A Renewable Energy Transmission (RET) study in 2003 by SSE, Scottish Power (SP) and National Grid Transco (NGT), (the 3 GB Transmission System Owners-TSOs) that looked at transmission options for accommodating levels of 2GW, 4GW and 6GW by 2010;
- A report prepared in June 2003 by the DTI established by TIWG, which included the 3 TSOs and representatives from Ofgem, the Scottish and UK governments and an independent expert.

The PB Power study of February 2002 examined the cost of providing up to 2GW of new renewable capacity by laying an offshore HVDC cable with a length of either 200km or 700km from a location in Scotland down the west coast of Britain. The estimated cost was £790m for the 200km link and £1,700m for the 700km link.

The RET study for 2GW of power to be transmitted by overhead line through the regions of SSE, SP and NGT gave a cost estimate for grid

reinforcement of £ 520m which included an estimate of £ 190m for the SSE section of the line from Beaulay to Denny. Costs estimates were also made for two further stages for the addition of 4GW and 6GW. In SSE's area, these were £ 160m and £ 70m respectively, although no details of the possible line routes were provided in the reports.

The recommendation in the DTI report was that "in order to give confidence to the wind energy sector that transmission capacity would be available for their projects in line with the Government's targets, detailed preparatory work on Stage 1 2GW reinforcement should begin as soon as possible". It was also agreed that the sub-sea cable option should remain on the table for the future and "would be reconsidered particularly if the RET Stage 2 was not feasible because of difficulties in obtaining the necessary planning consents". This latter sentence is important in that the current plan put forward by SSE for the Beaulay to Denny 400kV line is to accommodate only Stage 1 (2GW of power). If the wind energy sector in Scotland is to be encouraged to meet Stage 2 (4GW) and Stage 3 (6GW) requirements (and the Scottish Executive's plan for 40% of electricity to be generated from renewables), significantly more enhancements to the existing transmission infrastructure in the local area will be needed to put on the table by SSE. Given the importance of the Beaulay switching station to the transmission grid in north Scotland, more 400kV lines could be built within the local area and the local communities need to be aware of this possibility.

In the report by PB Power, there is reference to the existing 132kV and 275kV transmission network in the north of Scotland. It states that the existing 132kV network may only be able to accept a few hundred MWs of new wind power, although they did report to Ofgem during 2001 that up to 2 GW of additional plant could connect in the north of SSE's area without requiring major reinforcement of the main 275kV network. In relation to the ability to deliver up to 2 GW of additional power, it states that due to economies of scale, there would be little incentive to adopt voltage levels that will deliver lesser amounts of power, which in effect is saying that if the 132kV line needs to be replaced, build a 400kV rather than a 275kV line.

### **3. Undergrounding as an option**

An overview of the technical, economic, environmental, political and regulatory Issues associated with undergrounding of 400kV lines is provided below.

#### Technical

Up until the last ten years, the majority of high voltage cables in the UK were of an oil-filled design including the 5.7km stretch of underground cable that forms part of the North Yorkshire 400kV line that links with the 2<sup>nd</sup> Scottish interconnector. Early oil-filled cables had a history of problems. The trench has to be very flat to allow the oil to flow smoothly along the cable and the oil needs to be replaced periodically. Location of faults was also complex. Although there have been improvements in oil-filled cable design, most transmission companies in Europe have turned to the use of cross-linked polyethylene (XLPE), which is now in operation in Denmark, Germany and Spain. Usage in the UK has, however, been limited and the only current project using XLPE is a project involving two 400kV cables covering a distance of 20 km from the centre of London to a northern suburban area. The link is laid in a tunnel, which is a more expensive option than laying the cables in the ground.

Subject to a survey of the characteristics of the land, there would seem to be few technical barriers to prevent the undergrounding of a 6-10km section of the line west of Beaulay using XLPE cables. The land is not particularly rocky or hilly. If the cable started at the existing switching station at Beaulay, it would need to go under the river Beaulay but this should not represent a major barrier. In Denmark, for example, a 2.5 km section of underground cable was installed under a 700-metre wide seawater fjord. Alternatively the cable section could start on the south side of the river.

An easement would be required for the cable trench and some land either side of the trench (from 3 to 8 metres) to allow a safe working area for excavation and vehicle access. Access to the cables is essential to meet the requirements of possible maintenance and repair. Thus, it would be necessary to reserve a free ground area with no equipment set up and practically no vegetation other than superficial vegetation. The space requirement varies according to the voltage level and the type of circuit, but in rural areas, a width of 13-14 metres for a dual 400 kV link (i.e. the width of a secondary road) is considered adequate by ETSO (Association of European TSOs).

Should a section of the line be laid underground, the selected route would need to be laid over open terrain to avoid the clearance of trees. This would mean avoiding Balblair Wood, Ruttle Wood, Fanellan Wood, Eskadale Wood and Boblainy Forest. The cables could, however, be laid close to the existing 132kV line that goes close to Fanellan and Hughton as there would not be the same concern over a 50 metre clearance to allow safe access and for helicopters to string the conductors to towers. One route would be to place the cables close to the Fannellan Farm and then over the Eilean Aigas fields before passing in front of Eskadale House and then run them down the valley before meeting up with the proposed

red route. An alternative could be to place the cables from Hughton to the west of Culburnie and meet up with the proposed “green” line to the south of Eskadale Wood. The two suggested cable routes are shown in Appendix 1.

### Economic

Despite recent developments in design (e.g. through the use of materials such as XLPE and mechanised laying methods), undergrounding of electricity lines remains more expensive than overhead lines. The main reasons behind the extra costs are:

- Additional insulation is required because the cables are often only laid one metre below ground. Overhead conductors do not need to be insulated as the air acts as the insulator;
- Extra land (typically 2,000m<sup>2</sup>) is needed for the stations where the cables need to be connected to overhead lines. The transition from the underground to overhead technique requires very compact towers (due to mechanical stress) supporting specific electrical equipment;
- A compensation substation maybe required to be built along the route to provide for reactive power and to deal with matters related to impedance. This is usually necessary only if the length of the cable is more than 20km. Joint bays (junctions) are required every 600 to 900 metres to ensure the continuity of two shipping lengths of cable.

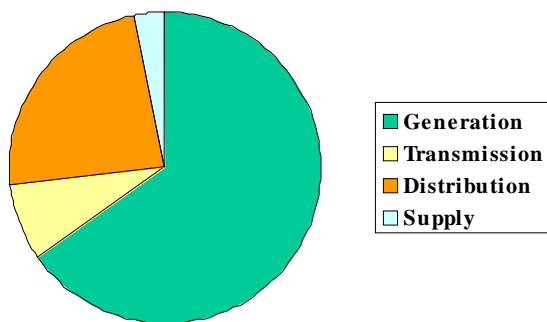
Actual costs will vary from project to project and the true market cost can only be established through a competitive tender, but the following factors should be taken into account:

- UK TSOs claim that undergrounding is 15-25 times more expensive than overhead lines and Ofgem has accepted a multiple of 14 times. ETSO quotes multiples of 10-12. However, the 14 km of 400kV underground cables being constructed by Eltra in Denmark as part of the 140 km link between Aarhus and Aalborg cost only 4.5 times that of the overhead line;
- UK TSOs also state that undergrounding adds a significant amount of time to the construction project. Evidence from the Eltra project shows that this is not the case. Once approved, that project took less than 4 years to complete and the preparation for the cable laying took between 6-9 months (15 months where the cable was laid below water);
- Evidence does show that once constructed, operating and maintenance costs for cables should be less than lines. Results in Australia indicate that overhead line maintenance is approximately £600/circuit-km/year compared to underground cable maintenance of £70/circuit-km/year;
- Underground cables are also less susceptible to storm and icing damage and are far less likely to cause death or injury to humans and wildlife due to accidental contact with the lines/cables. Information from France shows that there were 19 deaths due to

- contact with overhead lines in France in 2000 compared to no deaths for contact with underground cables;
- UK TSOs refer to the problem of faults on existing cables but all these relate to oil-filled design. The time taken to repair faults on underground cables is far longer than overhead lines and evidence of faults on XLPE cables remain largely untested as they have only recently been installed in Europe.

Evidence from the UK to date is that the long-term economic arguments for undergrounding are unlikely to find much favour with Ofgem, who as an “economic” regulator are unlikely to be persuaded that undergrounding small sections to preserve areas of natural beauty is a price worth paying. Ofgem’s final proposals on the funding of transmission investment to accommodate renewable investments are due to be published later this month. The report is expected to include an assessment by independent consultants into the plans put forward by the TSOs and the cost estimates associated with the proposed upgrades to the transmission network.

In terms of the overall impact on electricity prices, undergrounding has only a marginal impact on customer electricity bills. Transmission costs represent between 5-10% of the total cost of electricity (see chart below).



Based on the average domestic customer bill in the UK of approximately £280, transmission costs represent around £20 and the impact of undergrounding not only small sections of the Beaully to Denny line but significant amounts of the existing EHV network underground would have only a small impact on the customer bills.

Based on SSE’s costing, a 5km stretch of line west of Beaully around the area of Kiltarlity would cost of the order £4.3 million. If SSE were to accept that undergrounding should not cost more than 5 times the line, the incremental cost of around £17 million would only add approximately £1million to SSE’s annual transmission costs, which is only 0.8% of the existing transmission and distribution cost base in Scotland (see Appendix 2). The higher cost may still be difficult of justify to Ofgem, the regulator but they are due to the release their own report into the funding of new transmission lines to accommodate renewable investments later this month.

## Environmental

Over the past three decades, a significant amount of research has been carried out worldwide into examining whether electricity and in particular, the presence of electric and magnetic fields (EMFs) associated with the transmission of electricity have an adverse impact on health.

The European Union issued a recommendation in 1999 concerning restrictions on the exposure of the general public to electric and magnetic fields. These limits are 100 microteslas ( T) for magnetic fields and 5,000 volts per metre for electric fields. A large electricity pylon carrying a 400kV conductor produces around 5 - 10 T directly under the line and between 3,000 – 5,000 volts per metre. These levels fall with distance to the sides of the line. For example, approximately 25 metres to the side of the pylon, the magnetic field is estimated to be around 5 T and between 200 – 500 volts per metre. Underground cables can produce higher magnetic fields directly above them than an overhead line as the physical distance from the underground cable and the ground is smaller. For example, 400kV cables can produce over 30 T at ground level falling to 10 T at 2 metres above the ground. The field falls rapidly with distance to the side and the way the cable is constructed (with insulation material and concrete covers), they produce no electric field.

As recognised by the European Commission in their background paper *Undergrounding of Electricity Lines in Europe* – 10 December 2003, environmental considerations are now replacing engineering considerations as the main criterion for selection of new transmission networks. Rights of way permits are becoming increasingly difficult to obtain and the required right of way is very much smaller for a cable and once installed, the land above is generally used again for its original purpose, except for planting trees. This can result in a considerable saving, considering that in an overhead line little use can be made of the land that lies directly under the line or even some distance either side.

The indicative proposed aerial routes should also avoid conflict with the EU Directive on the Protection of Wild Birds of Prey. Plans to construct lines through the habitat of wild birds could lead to long delays in EU courts (see separate report prepared by Colin Crooke- The Highland Ornithology Ltd).

## Political/Regulatory

Unless the construction of the proposed Beauly to Denny transmission line goes to a Public Inquiry, there are few political or regulatory issues that relate specifically to the construction of aerial lines or underground cables in the UK.

In accordance with the Environmental Impact Assessment Directive, an EIA has to be carried out for all power lines with a voltage above 220kV and 15 km in length. SSE has announced that Gillespies LLP (who carried out the original routing study) will be carrying out the EIA. The specific requirements as what has to be included in an EIA are quite general, however, it would be expected that any proposal to construct a high voltage power line would address issues such alternative routes, impact

on wildlife and undergrounding. As undergrounding is considered to be a “permitted activity” for the utilities, neither an EIA nor planning consent is needed for installation of underground cables.

Apart from the EIA, construction of the line and substations would need planning consent from the various local authorities. Planning permission for the substations at Fort Augustus, Errochty and Braco is subject to the Town and Country Planning (Scotland) Act 1997, but it would seem that construction of the line can be approved by Scottish Ministers under Section 37 of the Electricity Act 1989. The requirements under section 9 of the Act are that the TSO should have regard to preserving natural beauty, flora and fauna and do what they reasonably can to mitigate any effect, which the proposals would have on the natural beauty. They are also required to avoid routes of technical difficulty and thus major additional expense. Local planning authorities may however raise objections to an application for Section 37 consent, which could lead to the convening of a Public Enquiry. Checks should also be made on the powers of local authorities in relation to the Town and Country Planning (Scotland) Act.

Should the UK government or Scottish Executive refer the project to a Public Inquiry, the project is likely to be subject to considerable delay. This is something the government will surely want to avoid, as it would put the whole commitment to renewable energy at risk. A Public Inquiry would, however, allow all parties to give representation and past experience in the UK and Denmark has shown that such procedures can force the TSOs to put some sections of the proposed line underground.

A recent Public Inquiry in the UK was the 75 km line between Middlesbrough and York. Significant public concern was raised over the decision to put overhead lines, rather than cables, through the Vale of York. An application to construct the line was made in 1991. Following several years of public inquiries and hearings it took 10 years for all consents and wayleaves to be put in place. National Grid was not in favour of an underground cable on the grounds of cost and the UK government took the view that the additional cost could not be justified. The aerial route was eventually given the go-ahead with the exception of a 5.7 km cable section.

In Denmark, detailed planning of the 400kV line between Aarhus and Aalborg began in 1989 but the Danish Energy Council only approved the line with three underground cable sections in 2001. The reasons for the decision to use underground cables were environmental (to reduce visual impact), closeness to urban areas (to increase the value of land near the line) and political (due to influence from politicians elected in the area and strong protest groups).

The time required obtaining the consents and approvals for major transmission projects in Europe has become a concern for the European Commission who issued a communication in December 2003 on “Energy Infrastructure and Security of Supply”. It recommends that to alleviate the impact of infrastructure to the environment and the people living close by, selective undergrounding of lines and use of less visible layouts such as new design pylons should be considered.

#### **4. Proposed overhead line - SSE approach**

SSE's initial proposals for the 400kV line between Beaully and Denny were set out in their January 2004 consultation document. It states that the conclusion of the three GB TSOs is that the required line between Beaully and Denny should go via Fort Augustus, Errochty and Braco. This would seem to imply that the option to take the line from Beaully on a route via the East Coast (via Aberdeen and Dundee) was not given significant consideration. SSE have since revised their proposals with the publication of their Interim Report on Consultations dated 29 June 2004.

SSE estimate that the cost of constructing the 220km of route is £190m, which equates to £863,000/km (approx Euro 1.3 million/km). By European standards, costs of constructing 400kV overhead lines in the UK are very high (see Appendix 3). For example, the total cost of the Danish 140km 400kV project equated to Euro 1 million/km (if it had all been overhead the cost would have been approx Euro 850,000/km). Part of the incremental cost is down to topography, as the line in Scotland will pass over hilly/mountainous ground (which is estimated to add around 20 percent to the cost). There are also other factors, including:

- Shorter distances between pylons (300-350 metres in the UK compared to around 400 metres in many European countries);
- Greater use of angle towers, where the line changes direction, which adds to stability;
- UK TSOs claim to construct lines to higher technical standards in terms of ability to withstand high winds and provide back up security in the event of a power failure.

The estimated costs of constructing a sub-sea cable on the west coast of Scotland also seem high by European standards. According to PB Power the 200km cable (2,000 MW HVDC link) would cost around £800m whereas Fingrid (the Finnish TSO) and Svenska Kraftnät (the Swedish TSO) have recently completed a feasibility study for a 200km sea cable (600-800 MW HVDC with power converters at each end to connect to the respective grids) between the two countries. They believe it can be constructed for around Euros 200m (approximately £140m). Although PB Power's estimates were based on transferring greater amounts of power than the Finnish/Swedish link, there is a significant difference between two cost estimates.

SSE state in their consultation document that they undertook a study of the options for the design of the towers. It re-affirmed that lattice steel towers, with a height of 45-50 metres, with three conductor bundles on each side of the tower remain the most appropriate structure for electricity lines "in the landscape to be crossed by the proposed line". An example of such a tower is shown on the following page. As shown in section 5, a number of European TSOs are erecting column rather than lattice towers with lower heights than those used in the UK.

A copy of the tower study was requested from SSE. According to an e-mail reply from Angus Gray (SSE), the study did look at current tower designs in many parts of the world including Europe, USA and Australia. According

to Mr. Gray, the report is not at present finalised as a public document and therefore could not be made available to ICF.



400kV tower and conductors

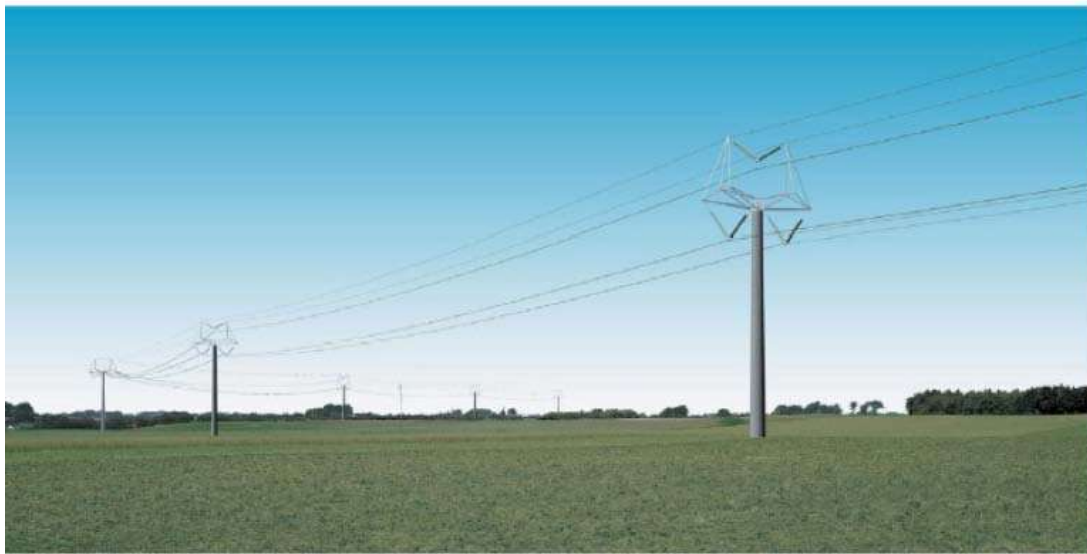
SSE also state that the 400kV line needs to be constructed at least 50 metres away from the existing 132kV line, which according to SSE has to remain live during construction to maintain supplies to the local communities. The 50 metres space is a “preference” rather than regulation and is to allow safe clearance for construction, in particular, clearance for helicopters that would be needed to string the lines to the towers.

Based on discussions with Dr Keith MacLean at SSE, they remain open to suggestions for the line route and are open to consider towers with a lower profile and height. They should continue to be pressed to release their tower study and focus on line routes crossing the lowest level of land in the area.

## 5. Examples of best practice for new overhead lines

Across Europe, TSOs and suppliers are working on projects that can reduce the future costs of constructing overhead lines and also develop new tower designs that can reduce the visible impact of the lines.

In Denmark, Eltra launched an open project competition for the design of a new high-voltage tower to be used between Haverslev and Mariager Fjord in Northern Jutland (which was part of the 140km line between Aalborg and Aarhus). The competition attracted 48 entries and the jury presented several financial prizes to the winner and others for good ideas. The winning design was a tower consisting of a column supporting a lattice, which in its turn supports the phases. For a 25km section of the new line, Eltra chose to use the new “design towers” (see below).



In Sweden, Svenska Kraftnät has been working with industrial designers in order to develop a new pylon for their 400kV lines. The aim is to produce a compact line that can allow the tower width to be reduced to about 6.5 metres (compared to around 14 metres for the standard UK design) and only 30-35 meters in height. The first photograph below shows the standard design and the second, the compact design.



As stated, without seeing SSE's study into the options examined for tower/conductor design, it is not clear whether they have looked into any of the designs shown above.

SSE does, however, according to their Environment Annual Report 2003 take "active responsibility towards current and future generations". Their statement of policy with regard to the environment states that they commit to "Complying with, and exceeding where appropriate, all statutory and regulatory environmental requirements and setting good standards where none exist". They also aim to "move towards a more sustainable and effective life cycle for processes, products and services". On the basis of the public documents related to the 400kV line, SSE do appear to be meeting this goal in relation to wind power but have not shown any significant desire to look at technological innovation or environmental responsibility in relation to the transmission of the electricity from this relatively new technology.

SSE maintains, however, that they are not against investing in new technologies, nor against investing in projects that increase the value of their regulated asset base. It is hoped that SSE will agree that the proposed undergrounding of a short distance of around 5 km principally through fields is a cost effective and appropriate policy for the future in areas such as Beaulieu when lifetime costs are taken into account. Savings in design and construction technology will more than offset the real costs. Local councils and landowners and those who enjoy and protect the environment will support SSE and the project will not be delayed for years in frustrating disputes.

## **Appendix 1      Potential route for underground cable**

Map not available in this copy of the report.

## Appendix 2      Impact of undergrounding on network charges

In the UK, transmission companies recover the cost of investing in new transmission assets through a capacity charge calculated on the following basis.

- Depreciation of 2.5 percent (representing 40 year asset life) of the gross asset value (GAV) indexed by a measure of the Consumer Price index;
- Return on capital (measured on net asset value), currently set at 6.25% percent real pre-tax;
- Transmission running costs (e.g. taxes, operational costs and overheads attributed to the connected assets). The cost factor is approximately 1.5% of the GAV;
- Maintenance costs. These are usually based on forecasts of site costs and expressed as a percentage of GAV (usually in the range of 0.5 to 1.5 percent).

If the costs of the proposed aerial route (£190m) are compared with a route that includes an approximate 8km of underground cable through Kiltarlity (£220m), the net impact of undergrounding as an annual charge can be shown.

£m	Aerial route	Partial undergrounding	Difference
Gross asset value	190	207	17
Annual costs			
Depreciation	4.75	5.18	0.43
Return on capital	11.87	12.94	1.07
Running costs	2.85	3.1	0.25
Maintenance at 1.5% for line and 1% for cable	2.85	2.07	(0.78)
Total annual costs	22.32	23.29	0.97

On the basis of the above assumptions, SSE would need to recover an additional £1m from its customers.

According to the 2004 Annual Report of SSE, their combined transmission and distribution businesses in Scotland had turnover of £243m, costs of £125m and an operating profit of £118m in the year to 31 March 2004.

If SSE has to recover an additional £1m, this would increase the overall cost base by approximately 0.8 percent per annum, which does not seem a significant cost to pay.

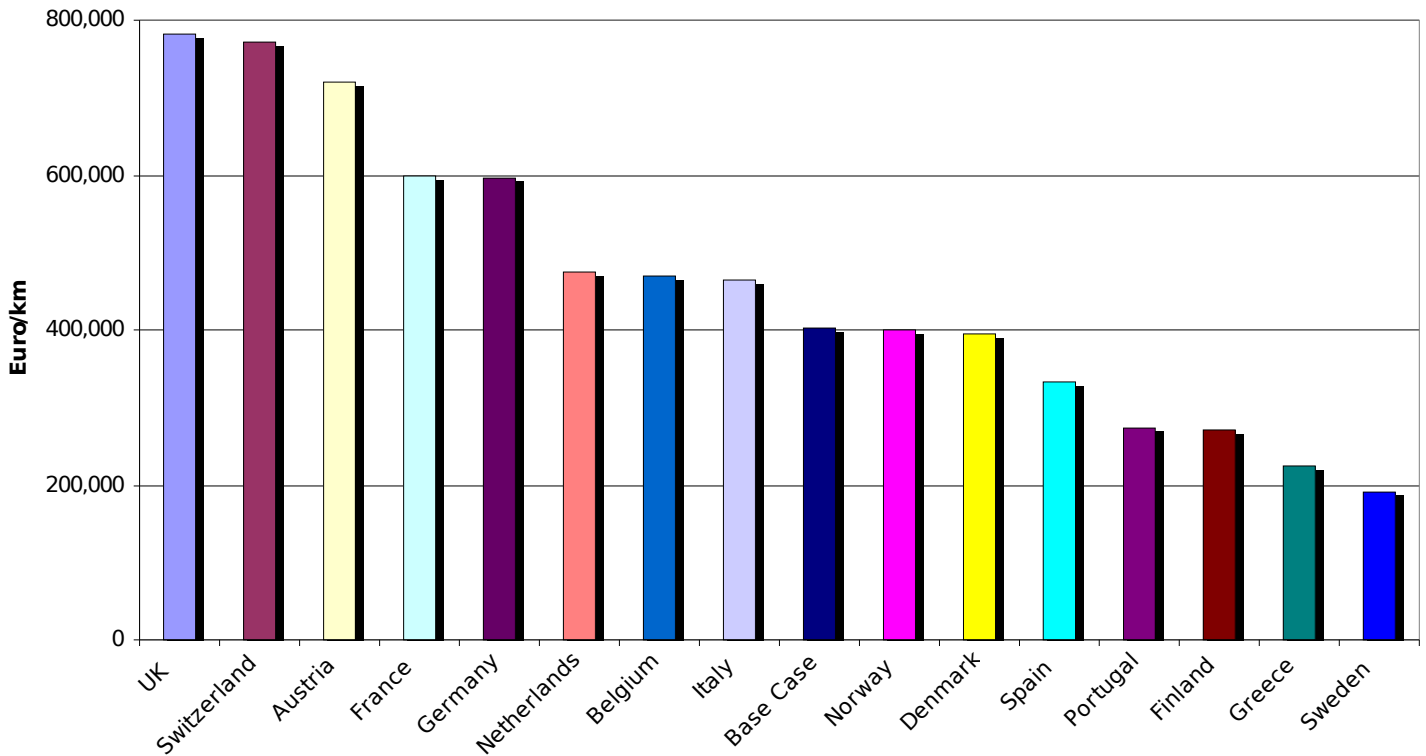
### **Appendix 3**

### **Glossary**

AC	Alternating electric current that reverses in direction and fluctuates in voltage requiring mechanisms to stabilize both voltage and frequency.
Conductor	Wire strung between towers for transmitting electricity
DC	Direct electric current that flows in one direction with little or no voltage fluctuation
DTI	Department of Trade and Industry
EHV	Extra high voltage (i.e.275 and 400kV networks)
EIA	Environmental Impact Assessment
EMF	Electronic and Magnetic Field
ETSO	European Transmission System Operators Association
Grid	A synchronized transmission network that delivers electricity from generating stations to local distributors and other users at high voltage.
GW	1,000 Megawatts (MW)
HV	High voltage network (usually 60 to 150kV)
IPR	Indicative Proposed Route
NGT	National Grid Transco
RET	Renewable Energy Transmission Study
SPT	Scottish Power
SSE	Scottish and Southern Energy
TSO	Transmission System Owner
Wayleave	Agreement granted by the landowner to the transmission company to permit the installation of equipment on, over or under the land in return for annual payments.
XLPE	Extruded cross-linked polyethylene

## Appendix 4 Unit cost of overhead lines

Unit cost - Double circuit 380 kV - flat land



Source: ICF Consulting Report for European Commission – Unit Costs of constructing new transmission assets at 380kV within the European Union, Norway and Switzerland.

Full report available at

[http://europa.eu.int/comm/energy/electricity/publications/doc/comp\\_cost\\_380kV\\_en.pdf](http://europa.eu.int/comm/energy/electricity/publications/doc/comp_cost_380kV_en.pdf)