SHE Transmission

Strategic Wider Works Project: CAITHNESS MORAY HVDC

ABOUT THIS PAPER

This paper considers the evidence and analysis presented by SHE Transmission to support the Strategic Wider Works project, Caithness Moray HVDC. This £1.24 billion transmission investment would be completed in 2018 and contribute to an increased capacity for accommodating renewable generation of over 1.5GW.

Following a comprehensive and robust assessment, SHE Transmission concludes that **the Caithness Moray HVDC project has strong net benefit to consumers of over £2.5 billion** (for the central case; see Table 3 below). Alternative reinforcement options demonstrate lower consumer benefit, lower welfare benefits and longer delivery timescales; hence delaying renewable generation connections.

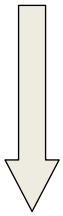
A STRONG NEED FOR REINFORCEMENT

Investment in the transmission system in the far north of Scotland is needed to accommodate current and future renewable generation (Table 1).

The transmission system is already 'full'. At 31 March 2014, 646 MW renewable generation is connected to the north of Inverness with a further 203 MW under construction or with planning consent. This exceeds the 'firm' capability of the transmission system under the GB network planning standards. To maintain system security, SHE Transmission currently runs the system to the north of Inverness under "connect and manage" derogation and 'non-firm' generation connection agreements.

In its April 2014 consultation on the case for the Caithness Moray reinforcement, Ofgem stated, "there is a need for a reinforcement of the transmission system in northern Scotland [...] existing transmission capacity is highly likely to be exceeded."

Table 1 Generation volumes and reinforcement triggers in the far north of Scotland

		Generation (MW)	*Cumulative generation (MW)*
CERTAIN	Connected	646	*646*
	Under construction	70	*716*
	With planning consent	133	*849*
	Contracted for grid connection – with planning consent application	739	*1,588*
	Contracted for grid connection – other	573	*2,161*
LESS CERTAIN	Not contracted for grid connection	853	*3,014*
	TOTAL	**3,014 MW**	

ALL REINFORCEMENT OPTIONS CONSIDERED

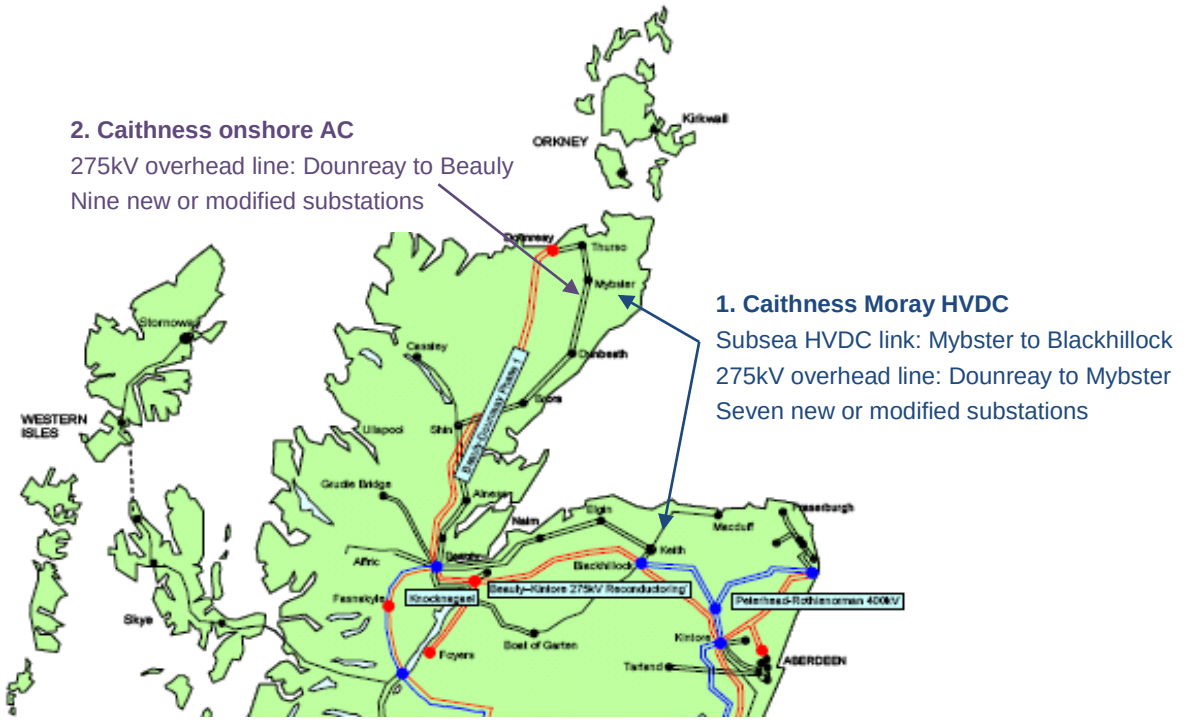
Over the past five years, SHE Transmission has extensively studied the options for reinforcement of the transmission system to the north of Inverness. This work has been undertaken in co-ordination with the Electricity Networks Strategy Group (ENSG), jointly chaired by DECC and Ofgem, and the conclusions reported in the ENSG 2020 Vision reports of 2009 and 2012.

Ten options were considered of different geographical and electrical configurations. Key criteria to assess the options included capital cost, planning and consenting risks, environmental impact, system benefits and technology risk. The results of the optioneering assessment were weighted across three categories: cost, technical and environmental. From this comprehensive analysis, **two options were taken forward** for detailed consideration (Figure 1):

1. **Caithness Moray HVDC** New subsea HVDC link from Caithness to Moray, with 26km 275kV overhead line in Caithness and associated works at seven new or existing substations.
2. **Caithness onshore AC** Full rebuild of the existing 190km 132kV overhead line between Beauly and Dounreay to 275kV capacity, and associated works at nine new or existing substations.

Each of these options was subject to full desktop analysis of route and site locations. Consideration was given to geological, environmental and public amenity concerns, and evidence-based adjustments made. This included the likelihood of a public inquiry for new overhead line build and mandated measures to mitigate the environmental impact. Engagement with statutory stakeholders has shown support for the assumptions made in this analysis.

Figure 1 Transmission system in the far north of Scotland and reinforcement options



Capital cost estimates for the two options were made following SHE Transmission's Large Capital Projects procedures (Table 2):

- The cost estimate for the Caithness Moray HVDC option was based on agreed contractual positions with the suppliers of the HVDC, overhead line and substation elements of the reinforcement. Residual cost uncertainties are uncontracted costs, contracted unknown costs and project risks (for example, weather). Independent benchmarking conducted by Jacobs Engineering Group demonstrates that HVDC cost forecasts are within +/-10% of a comparable global dataset.
  Cost estimate £1,236 million, accuracy +10% to -5% (Class 3)
- Although the Caithness onshore AC option has not been specifically tendered, SHE Transmission has recently concluded competitive market processes for framework overhead line and substation agreements. The cost estimate for the AC option was built up using these contract rates. An independent review of the costing exercise by Turner & Townsend concludes "this estimate represents a reasonable view of the likely out turn forecast of the works."
  Cost estimate £1,609 million, accuracy +25% to -15% (Class 2)

Annual operating costs for the two options were also estimated based on maintenance agreements with equipment suppliers, manufacturers' fault estimates, historic operating costs and cost allowances agreed in the RIIO-T1 price control settlement.

Stage 2 reinforcement

Completion of either the Caithness Moray HVDC or Caithness onshore AC reinforcement option would allow for the southwards transfer of renewable energy to Blackhillock or Beauly respectively. Because of the different entry points of this energy onto the wider transmission system, comparison of the benefits of two reinforcement options cannot necessarily be considered like-for-like. All such analysis shows that the positive net benefits of Caithness Moray HVDC are several orders of magnitude greater than Caithness onshore AC.

To strengthen the analysis, SHE Transmission has included the second stage of transmission reinforcement to the cost benefit analysis – full rebuild of the existing 275kV overhead line between Beauly and Blackhillock to 400kV capacity, and associated substation works.

Table 2 Cost estimates for detailed options analysis

£m, 2013 prices	**Capital cost – Stage 1**	**Capital cost – Stage 2**	**Operating costs pa.**
Caithness Moray HVDC	REDACTED: COMMERCIAL-IN-CONFIDENCE		
Caithness onshore AC			

ROBUST COST BENEFIT ANALYSIS

SHE Transmission has undertaken a thorough cost-benefit analysis of the two reinforcement options: Caithness Moray HVDC and Caithness onshore AC. The approach used follows the guidance issued by Ofgem in October 2013, and builds upon that used for previous Strategic Wider Works projects including Western HVDC 'bootstrap' and Kintyre Hunterston.

The aim of the cost-benefit analysis is to determine whether the economic benefits to consumers of alleviating system constraints outweigh the cost of investing in the growth of the transmission system. The key elements of the modelling are:

- **COSTS** Whole life costs (capital and operating) of the two stages of the Caithness Moray HVDC and Caithness onshore AC options, as described above, and converted into the actual annual cost to customers using the RIIO-T1 financial model and agreed regulatory finance parameters for SHE Transmission.
- **BENEFITS** Three elements:
  - Avoided system constraint volumes (GWh) are calculated using a dynamic dispatch model of the GB market, and converted into an annual avoided customer cost using a central estimate of £123/MWh.
  - Annual welfare benefits arising from the value of visual amenity to customers (based on the sustainable accounting methodology being developed in conjunction with PWC) and the social cost of carbon (following the approach adopted for Electricity Market Reform (EMR)).
  - Excluded from the analysis are unquantified welfare benefits that favour the Caithness Moray HVDC option such as costs of system outages, investor confidence, anticipatory investment in higher capacity and meeting 2020 renewables targets.
- **NET PRESENT VALUE (NPV)** Follows the modelling approach specified by Ofgem to determine the NPV of the two options when discounted over a 40-year period.

Cost benefit analyses have been undertaken for a wide range of sensitivities including in future generation scenarios (using the connection profiles established by National Grid for the ENSG) and constraint cost assumptions (for a credible range of £96-127/MWh). Notably, a wider range of downside sensitivities have been assessed than in previous Ofgem decisions to take account of, for example, revisions to future generation capacity allocations under EMR.

The results of cost benefits analyses for the four generation scenarios considered and range of constraint costs assessed are shown in Table 3 overleaf. For the central case scenario, Slow Progression generation (under which GB would not meet the Government's 2020 renewable targets) and £123/MWh constraint cost, **the Caithness Moray HVDC option has positive NPV benefit of over £2.5 billion**.

The benefits of Caithness Moray HVDC are £284 million (11%) higher than the equivalent central case analysis for the Caithness onshore AC option, and remain more highly positive for all scenarios considered.

Table 3 Results of cost benefit analysis

CENTRAL CASE £123/MWh constraint cost

NPV £m, 2013 prices	Slow Progression	Gone Green	Slower Slow Progression	Reduced Deployment
Caithness Moray HVDC	**2,527**	3,943	1,122	1,056
Caithness onshore AC	2,243	3,522	960	978

LOW SENSITIVITY £90/MWh constraint cost

NPV £m, 2013 prices	Slow Progression	Gone Green	Slower Slow Progression	Reduced Deployment
Caithness Moray HVDC	**1,338**	2,336	375	316
Caithness onshore AC	1,023	1,855	183	198

CONCLUSIONS AND OTHER CONSIDERATIONS

SHE Transmission has undertaken a comprehensive and thorough assessment of the need for reinforcement of the transmission system in the far north of Scotland, and to identify the reinforcement option that is of greatest value to the GB electricity consumer. **This analysis clearly and unequivocally demonstrates the Caithness Moray HVDC project has the highest consumer benefit, with strong net benefit to consumers of over £2.5 billion (for the central case).**

The Caithness Moray HVDC project is at a high state of readiness. All planning consents have been granted and key supply chain contracts have been agreed. The project has strong stakeholder support, with all statutory consultees and local communities expressing a preference for the project over the alternative Caithness onshore AC. Assuming timely approvals from Ofgem, project completion is forecast for 2018 allowing the connection of up to 1.5GW of renewable generation.

Over the past five years, SHE Transmission has established a strong track record in the delivery of large capital projects. All projects funded by under the Critical Investments programme have been, or are in the process of being, delivered on time and on budget; for example, Knocknagael, Beauly Dounreay and Beauly Mossford. Good progress is being made with the flagship Beauly Denny project. This delivery is a consequence of the experienced management team in SHE Transmission and the adoption of best practice Large Capital Projects business processes.