WHOLE-LIFE COSTS AND ENVIRONMENTAL ASSESSMENT OF HIGH VOLTAGE POWER CABLE SYSTEMS

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ABSTRACT

This paper reports on a new whole-life cable model applied to a comparison of conventional XLPE and a novel high operating temperature thermoplastic cable system. It explores the whole life cycle including: manufacture, deployment, operation and end-of-life.

The new cable addresses a fundamental limitation inherent in existing electricity transmission and distribution networks by improving the capability of power cable system to tolerate increased peak demand whilst reducing whole-life environmental impact.

A new concept cable was successfully developed using new thermoplastic insulation materials that do not require cross-linking. This reduced the process energy required during manufacture and enabled recycling of the cable, further reducing the carbon footprint of the cable.

KEYWORDS

High voltage; cable systems; economic assessment; environmental assessment; whole-life; life cycle assessment; life cycle costs.

INTRODUCTION

There are many environmental drivers at a European level requiring the improvement of the design and deployment of power cable systems. These include the European Carbon Strategy, the EU Waste Framework Directive and the move to low carbon networks. Many of these do and will affect industry across the whole cable life cycle, not just manufacture but also deployment and end of life management.

Economics too is providing a force for change in the form of materials supply and the need for process energy reduction during manufacture. These environmental and economic drivers are becoming more and more important for efficient cable production and in meeting procurement requirements a number of which are increasingly reflecting green procurement policies.

Tools

In order to respond to these drivers, there are many methods for assessing the economic and environmental performance of products at production level, but few that deal with the whole life cycle. These methods include Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Total Cost Assessment (TCA) and a raft of technical approaches and studies. However, there hasn't been an approach to these assessments which aims to bring all aspects together in one methodology and tool.

LEETS

LEETS is a methodology and software tool [1] which brings together multiple assessments and enables them to be used to compare cable technologies, and their manufacture and deployment with account of the local environmental and end of life management options. As such it is ideally placed for carrying out assessments in response to the requirements of various stakeholders, be it the cable manufacturer or the utility using the cable.

LCC (derived from LEETS)

LCC is a new integrated life cycle cost and risk assessment methodology, which addresses whole life costs from original planning, to construction, operation and eventually the management of end-of-life of assets. The approach was developed to support asset investment and policy to enable optimum solutions to be identified, taking into account economic, environmental, health and safety and social costs, with explicit account of hazards and risks, including those arising from asset failure [2]. The use of LCC within the LEETS cable model is planned for subsequent projects.

HV Cables

High voltage cables typically use XLPE as the dielectric material. While this has excellent performance characteristics, it is energy intensive to produce, requires cross-linking and related degassing and is difficult to recycle.

New cable designs utilising new thermoplastic materials which are not crosslinked have been developed. These can operate at higher conductor temperatures if required; potentially up to 150℃. The materials used for so- called HTC cables are not cross-linked and offer both economic and environmental benefits. These were the subject of a recent UK Technology Strategy Board project [3].

METHODOLOGY

In order to meet the requirements of the project a number of methodologies, both laboratory and desk-based, were employed. Critically these included LCA studies, which was carried out and integrated into the LEETS-Cable model which included other environmental impacts and parallel economic and risk impacts.

Goal

The goal of the life cycle study was to evaluate the environmental impacts of the manufacturing, deployment, operation and end of life management phases of high voltage power cables. The benchmark scenario chosen was a typical XLPE cable technology for HVAC transmission which is currently employed by National Grid in the UK. The new thermoplastic cable used the same cable construction but with a thermoplastic replacement of the XLPE for the primary dielectric.