Programme Area: Energy Storage and Distribution

Project: Transportable Storage

Title: Final Report

Abstract:

With increasing utilisation of renewable energy sources there are many cases where the ability to site generation within easy reach of demand becomes more limited. In these situations, how the energy is moved from where it is generated to where it is needed becomes a more critical aspect of the overall energy system. More remote locations are more costly to connect to transmission lines, be they electricity networks or pipelines. At the same time the intermittency of renewable energy sources places a greater emphasis on the use of energy storage to balance the different variations in supply and demand over time. Transporting stored energy is one possible way to address both of these concerns simultaneously.

Context:

With increasing utilisation of renewable energy sources, there are many cases where the ability to site generation of electricity within easy reach of demand becomes more limited (e.g. offshore wind farms). More remote locations are more costly to connect to electricity networks or pipelines. Additionally, intermittency of renewable energy sources places a greater emphasis on the use of energy storage to balance the different variations in supply and demand over time. Transporting stored energy is one possible way to address these concerns simultaneously. The aim of the project was to understand and quantify transporting energy for a number of different scenarios. Cases were developed for offshore wind farms located off the UK and concentrated solar in the Sahara. A range of options were then analysed for transporting and transmitting energy from source to demand with the different approached quantified and compared.

ETI Executive Summary

Programme: Energy Storage and Distribution

Project Name: Transportable Energy Storage (FRP)

Deliverable: FR/Final Report

Introduction

With increasing utilisation of renewable energy sources there are many cases where the ability to site generation within easy reach of demand becomes more limited. In these situations, how the energy is moved from where it is generated to where it is needed becomes a more critical aspect of the overall energy system.

More remote locations are more costly to connect to transmission lines, be they electricity networks or pipelines. At the same time the intermittency of renewable energy sources places a greater emphasis on the use of energy storage to balance the different variations in supply and demand over time. Transporting stored energy is one possible way to address both of these concerns simultaneously.

Project

In deciding whether to support the development of transportable energy storage technologies, the ETI needed access to a thoughtful and factual analysis that considers all the relevant factors and identifies where transportable energy storage is most likely to be beneficial and what cost and performance targets would need to be met to justify the development of potential technologies to deliver transmission scale transportable storage.

Three sources of generation were considered within this project:

- Concentrated Solar Power (CSP) generated in the Sahara to be imported to the UK;
- Wind energy generated in the Outer Hebrides to be imported to the UK; and
- Wind energy generated in the Orkney Islands to be exported to Norway

This project within the Energy Storage and Distribution programme has been delivered by EA Technology Ltd, consultancy supported by:

- University of Strathclyde
- University of St Andrews

The contact value was 99k delivered with no cost variations in November 2011.

Three detailed project reviews took place during the course of this project. All SAG members were invited to attend; Shell and Caterpillar representatives attended the reviews.

Key findings

Key findings of the study are:

- Electricity transmission represents the least cost solution if electrical energy is required at the demand site
- Chemical energy carriers do however compare favourably with electricity transmission where they can be used directly

In terms of the levelised costs per unit of energy delivered to the UK, the analysis demonstrates that electricity transmission represents the least cost solution if electrical energy is required at the demand site.

This is true for all of the three generating site scenarios. For example, the cost associated with transferring electrical energy via a transmission network from the Outer Hebrides to the UK mainland is just over £70/MWh and from the Sahara £139/MWh compared to between £232/MWh and £281/MWh using chemical storage media.

The chemical energy carriers do however compare favourably with electricity transmission where they can be used directly. If energy can be supplied as a fuel rather than electricity, the case for the chemical energy storage media becomes economically viable. For example, hydrogen can be delivered to the UK from the Sahara at a cost of £124/MWh by ship or £120/MWh by pipeline, which is less than that for direct transmission (i.e. £139/MWh).

The results also indicate that using electro-chemical energy storage media (i.e. a Zinc-Air Battery ship concept) is unlikely to represent an economically viable concept. The overall costs are dominated by the cost of the batteries themselves. Even assuming an extremely ambitious cost target for a transportable battery the levelised cost per unit of electricity delivered is over six times that of the baseline transmission option.

Further work

There are no further projects planned as a result of the findings of this project but the recommendations propose that consideration of future project areas and projects should be informed from the results that suggest a number of potential focus areas:

- the development of DC Transmission technology; improving efficiencies and lifetime of AC to DC converters and reducing costs

- developing Hydrogen and Hydrocarbon fuels as alternatives to electricity for transport end uses
- the potential to relocate Ammonia (and fertilizer) production from mainland UK to remote generation sites;
- the potential for the generation sites to be used for the production of Aluminium;
- the development of long distance fuel pipelines;
- the development of key harbours and ports to act as key hubs for the transport of energy into the UK.

At this stage the ETI intend to use the output from the report to inform its strategic view and development of the UK energy system for 2050 and beyond.