Wind to Agri Energy

Final Report - Local Energy Challenge Fund – Development Project

Project History

This project arose when the community of Shapinsay tasked Shapinsay Development Trust to address the severe curtailment experienced by its community owned turbine as a result of active network management and, to investigate methods by which curtailed capacity could be redeployed in an innovative manner. Given the level of agricultural activity within Shapinsay and the continuous demand for diesel fuel and fertiliser within the island this project offered a natural community fit.

Although unsuccessful for second round funding work completed and associations made during this development project did contribute to Shapinsay Development Trust becoming a member of the FCHJU funded BIG HIT project which will result in the deployment of a 1MW PEM electrolyser in Shapinsay and in the innovative reclamation of the lost (curtailed) capacity – albeit applied to different uses.

Local Energy Challenge Fund

A successful application for Phase 1 funding was made by Shapinsay Development Trust on behalf of a consortium involving:

Shapinsay Development Trust (SDT)
ITM Power plc (ITM)
The University of Sheffield (UoS)
Business Process Engineers (BPE)
Community Energy Scotland (CES)

It was anticipated that an additional partner, most likely a distillery, would be added as a supplier of CO2

The project aim was to produce synthetic diesel via the Fisher Tropsch (FT) process:

$37H_2 + 12CO_2 \rightarrow C_{12}H_{26} + 24H_2O$

or to create urea in a two stage process:

Converted into ammonia via the Haber-Bosch process:

$3H_2 + N_2 \rightarrow 2NH_3$

Then converted to urea:

$2NH_3 + CO_2 \rightarrow (NH_2)_2CO + H_2O$

Activities undertaken

ITM Power identified and applied design changes (including salt environment protection) which would be needed for any PEM electrolyser which might be deployed in an island environment where blown spray would be an issue.
ITM Power analysed flow modelling and then undertook more detailed project modelling to feed into an Aspen model for diesel production and undertook similar modelling for production of urea.
ITM Power also advised on design of the Urea reactor drawing upon previous project experience.
ITM Power investigated CO_2 capture from the air. The consortium engaged with Climeworks from Switzerland and Calvera from Spain with a view to them joining the project if this source of CO_2 was chosen.

BPE collaborated with ITM Power and UoS to determine and design the CapEx and OpEx models which might reasonably be expected in Phase 2 and obtained quotations for equipment and components needed prior to deployment. BPE identified specifications for compressors and N2 separators required for phase 2 development and deployment.

UoS worked with all partners to evolve their FT reactor design ready for deployment in an island location, offered technical support in other areas and disseminated the project at a number of academic conferences. UoS collaborated with ITM and BPE on upscaling both FT and Urea reactors for final use. UoS advised on the removal of impurities from distillery derived CO2 and identified methods to remove impurities based on information from industry sources.

SDT undertook studies and engaged with Orcadian, and other, distilleries as the preferred route to source a regular supply of CO2 for the project. They undertook a negative aspect study and liaised with local fertiliser suppliers to determine market reaction, and eagerness to become engaged with local Urea production. SDT also engaged with SEPA to determine the regulatory regime which would be applied to the project and with island farmers to ensure a ready market for any synthetic diesel and Urea which might be produced. SDT also worked with SAC (Scottish Agricultural College) to better understand fertiliser usage within Orkney.

CES liaised with Scottish and Southern Electricity (SSE) regarding electrolyser connection and determined response times between curtailment and activation of an electrolyser. CES offered advice on block exemption rules. CES provide advanced data derived from collated SCADA data which fed into project modelling undertaken by ITM Power and BPE.

All partners contributed to dissemination events during the course of their work on this project.

Summary of results –

1. Considerable progress was made on upscaling a Fisher Tropsch reactor for practical use and on upscaling previously deployed Urea reactors.

2. Regarding capture of CO_2 from distilleries – it became clear before this can be undertaken successfully a sub-project will necessary to determine the precise point at which CO_2 should be captured, the precise method of capture and storage which should be utilised (with special regard to space constraints at many whisky distilleries) and the method and extent of cleaning that is required to remove impurities prior to its use in any chemical reaction.

3. A study of direct capture of CO_2 from the air indicated that the life expectancy of equipment in an island environment would need particular attention

4. Engagement with local farmers and with fertiliser suppliers indicated that both are eager to engage in new methods of procuring (synthetic) diesel and fertiliser provided that costs are, at least, comparable with existing products and that efficacy and safety was proven. Locally the agricultural industry also appears eager to engage in testing.

5. SEPA engaged enthusiastically with the project and in principle indicated that exemptions granted to biodiesel might reasonably be extended to small scale community production of synthetic diesel, hydrogen and urea which individually fall below 200 tonnes per annum, thus negating the need for a full PPC Permit for local production at a small scale.

6. Enthusiastic public support for the aims of this project were evident at all dissemination events where its aims were presented.