Background

The Wetland Biomass to Bioenergy Competition was born out of the Department of Energy and Climate Change’s (DECC) UK Bio-energy Strategy (April 2012). This strategy identified the need to source new feedstocks for bioenergy, which sat within the limits outlined in DECC’s sustainability criteria. This specifically states feedstock production must not pose a threat to food security, in the UK or internationally, or present risks to biodiversity and ecosystems.

What did the project aim to achieve?

Funded by DECC, the Wetland Biomass to Bioenergy Competition aimed to demonstrate the untapped potential of using existing biomass produced on wetland nature reserves generated from habitat management, as a new energy feedstock. It was designed to encourage business and academia to develop a solution for the end-to-end delivery. To design, build and procure the technology needed to create and deliver the complete process from harvesting through to energy production from wetland biomass in an energy efficient way.

Biomass generated from conservation management can be a challenge for many land managers, often limiting the management work undertaken or compromising what can be achieved, and in some instances resulting in the need for sites to have sacrificial areas, where the material is left to rot down.

The competition was delivered in three phases; Phase 1 commenced January 2013 and concluded March 2013. Phase 2 ran between May 2013 and March 2014, with Phase 3 from April 2014 to March 2015 concluding the project.

The project was undertaken in three geographical wetland areas which were selected based on habitat diversity, scale and complexity, they were:

- The Somerset Levels and Moors.
- The Broads, Fens and Suffolk coast.
- Northern and Eastern Scotland.

Within each of these areas there were consortiums of conservation land managers who provided the sites and biomass needed for the trials and demonstrations undertaken throughout Phase 2 and Phase 3.

What were the results?

Initially 14 applications were submitted for Phase 1 of the project, a large percentage of these were consortiums of applicants, with a wide range of expertise from academics to engineers. From the 14, seven were selected to proceed to the feasibility stage and were provided with funding to undertake this work. From these seven, three applicants were chosen to receive funding for Phase 2. During this phase, the competition element was removed by DECC and the same three applicants continued through to complete the project to the end of March 2015.
The **three successful applicants**, **AB Systems (UK) Ltd**, **AMW-IBERS** and Natural Synergies Ltd employed a diverse range of approaches that have now provided land managers with a portfolio of techniques for the conversion of conservation biomass into bioenergy. These include specialist harvesters, drying and storage systems, together with energy conversion processes such as pyrolysis, anaerobic digestion and combustion.

**Harvesting** material off wetland sites in a suitable condition is essential in its utilisation; through the project new specialist tracked harvesters capable of dealing with challenging wet conditions, were developed. The large 300hp Pisten Bully equipped with a precision chop forager was both effective and efficient for the removal of thick vegetation in large areas with good access and ground not considered as exceptionally sensitive. In comparison the design of the smaller 120hp Softrak operating a double chop forager, was more manoeuvrable, with a lighter footprint, but with a slower work rate.

Once cut, **haulage** of the material off site was either achieved via the harvesters’ collection bins or through adapted tracked haulage vehicles and the newly developed sledge cableway system. This cableway could transport 1,000kg of biomass up to a distance of 1,000m with a footprint of 0.2 psi when hauled over wetland areas, significantly reducing the impact of vehicle movements on sensitive ground.

**Storage** of the cut material was dealt with through conventional means such as wrapped bales and silaging using existing farm structures for wet materials, or via the AgBag system which was capable of storing biomass in both dry and wet condition. To reduce the moisture content of the biomass to be used for combustion, **drying** was undertaken in two ways: through the use of a pyrolysis kiln, which dried small amounts of material quickly and through the AgBag system using perforated pipes and solar panels, bringing the potential to dry larger volumes over a longer period - which is still to be trialled.

A **pyrolysis** kiln was developed as part of the project to produce biochar, (in addition to drying) which was successfully achieved using rush, reed and scrub. This process proved excellent for reducing the volume of materials (conversion rate of 3 to 1 for reed), whilst increasing their energy density, producing a high calorific value additive which was mixed with other materials during the briquetting process.

Both small and medium scale **anaerobic digestion** were trialled during the project, each with satisfactory results. The small scale 7kW system utilised liquid produced from the screw-pressing of wetland biomass, this provided the energy needed to power processing the remaining solid fraction into briquettes at a feed rate of 500 litres a day. The pilot medium scale system explored cell disruption techniques to process whole crop foraged material and
achieved a biogas composition of between 54 to 56% bio-methane. Further trials and investment are needed to progress this system beyond pilot stage and to the desired 150kW scale, with significant changes needed on the design of the feed mechanism.

Combustion of the wetland materials was achieved successfully through the production of briquettes, with emissions results displaying that each of the wetland biomass briquettes performed satisfactorily to be burned as an alternative to pine. Although briquette composition, density and production efficiency would benefit from further trials. Loose material and briquette wafers were trialled in a biomass boiler and performed effectively, however further emissions testing is needed to achieve RHI accreditation.

The efficiency of each process was monitored and life cycle analysis revealed the following results:

<table>
<thead>
<tr>
<th>Participant</th>
<th>Energy Conversion Technology</th>
<th>Greenhouse gas savings (MJ/a)</th>
<th>Biomass Energy Efficiency (MJ/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB Systems</td>
<td>Briquette production</td>
<td>89.8%</td>
<td>65.0%</td>
</tr>
<tr>
<td>AMW-IBERS</td>
<td>Briquette production</td>
<td>84.1%</td>
<td>68.7%</td>
</tr>
<tr>
<td>Natural Synergies</td>
<td>Anaerobic Digestion</td>
<td>73.4%</td>
<td>58.9%</td>
</tr>
</tbody>
</table>

What’s happening now?

Next steps are to progress the areas already mentioned and to identify opportunities to utilise this range of techniques on the ground, to both maximise conservation management whilst providing a new bioenergy feedstock. Exploration in to the application of knowledge and experience into other habitats has also been initiated, with heathland as the next priority.

The project has illustrated that this approach has immense potential and could range from small scale briquette production on a site by site basis to replace fossil fuels, up to operating at a landscape scale to deliver a complete community energy system. The options are now being explored further using the mechanisms identified in the Energy for Nature project which looked to develop a PES based model for delivery¹. Through this project, linked with the DECC research it has been demonstrated that the idea of ‘conservation biomass to bioenergy’ can form a sustainable means of financing essential management of key habitats for biodiversity whilst providing an environmentally sound alternative energy feedstock.

Thanks must go to the many organisations who allowed their sites to be used as guinea pigs and biomass donators without which the project wouldn’t have been possible. They also showed much appreciated patience when trials didn’t always go to plan!!

Where can I find more information?

The applicants’ reports have been published by DECC and can be accessed online through the following link under the section Wetland Biomass to Bioenergy Competition.

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¹ Energy for Nature project report