

# Dunball Biomass Project

## Fuel Production – Findings to date

Sally Mills 05/03/20

### Brief

1. To explore opportunities around the production of common reed pellets as a fuel to enable a test burn to be completed in a boiler identified to be appropriate for the Dunball Depot. This burn will be undertaken so that emissions can be tested, and confirmation obtained that the standards set for UK's Renewable Heat Incentive (RHI) for particulates (PM10's) and nitrogen oxides (NOx) can be met. The current oxides of Nitrogen (NOx) and Particulate Matter (PM) concentration allowable limits under the RHI are 30 grams of PM and 150g NOx per gigajoule net heat input.

2. To explore the opportunities, logistics and feasibility, and where possible costings of setting up a pelleting operation in the SL&Ms to enable common reed to be utilised as a fuel.

### 1. Test burn and analysis

#### 1.1 Previous findings

Previous test burns in an ETA SH30 log burner and laboratory tests using common reed briquettes have demonstrated positive results and have fallen well within the limits needed to qualify for RHI.

Emissions	RHI Standards grams per gigajoule	Briquette trial – heat up phase * grams per gigajoule	Briquette trial – normal heating phase grams per gigajoule
PM10s (particulate/dust)	30	33	2
NOx (nitrogen oxides)	150	175	117

*Note \* Any readings taken during the heat up phase before the boiler is up to temperature are disregarded and not relevant to RHI accreditation, results are only used from the normal heating phase.*

The only high reading recorded was in relation to ash percentage levels in the Tay reed, (see table below), which after consultation with the testing laboratory together with Aberystwyth University it was concluded these were probably down to levels of silt on the reed stem (from the tidal Tay Estuary). However, this was not perceived as a problem as a high ash content would not affect the emissions and if present in the briquetted/pelleted material would only cause increased ash levels in the appliance.

When the results recorded from the laboratory are set out against previous test results for common reed and soft rush samples from the Somerset Levels, the standards set by the EN Plus and ISO British standard parameters for non woody briquettes, it can be seen from this that the results recorded fall between those required for the ISO British standards apart from the ash as mentioned above. These positive results indicate that trials using pellets (which in fact are miniature briquettes - should prove favourable.

Essential Properties	Unit	ENplus A2 pellets	ISO 17225 A	ISO 17225 B	Somerset Reed Briquettes	Somerset Rush Briquettes	Tay Reed Briquettes
Dimensions	mm	State diameter, width and length			175mm width x 80mm diameter		
Moisture	w-%	>15	<12	<15	5.3	3.8	3.8
Ash	w-% dry	<1.5	<6	<10	4.7	3.9	22.1
Particle density	g/cm <sup>3</sup>	>0.9	>0.9	>0.6	0.8 to 1.198	1.2	0.1
Additives	w-% dry	<2	<5	<5	N/A	N/A	N/A
Calorific Value	MJ/kg	>15.3	>14.5	>14.5	18	18.2	16.2
Nitrogen	w-% dry	<0.5	<1.5	<2.0	1.04	0.58	0.94
Sulphur	w-% dry	<0.04	<0.2	<0.3	<0.01	<0.01	0.06
Chlorine	w-% dry	<0.03	<0.10	<0.3	<0.01	<0.01	0.07
Surface Incl. Hole	cm <sup>2</sup>	Should be stated			140	140	

Trace Elements							
Arsenic	mg/kg dry	<1	<1	<1	0.3	0.3	0.8
Cadmium	mg/kg dry	<0.5	<0.5	<0.5	0.1	0.1	0.1
Chromium	mg/kg dry	<10	<50	<50	0.7	1	7.1
Copper	mg/kg dry	<10	<20	<20	1.9	1.1	4.5
Lead	mg/kg dry	<10	<10	<10	0.7	0.5	6.0
Mercury	mg/kg dry	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg dry	<10	<10	<10	<0.5	<0.5	3.9
Zinc	mg/kg dry	<100	<100	<100	16.8	17.9	87.5

Ash Softening temperatures	Deg c	Typically pine and straw over 1125	1340	1500	1300
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### 1.2 Biomass availability

For pelleting and completion of a test burn the common reed needs to be dry and ideally below a moisture content of 20%. Unfortunately, the current date of early March does not now permit harvesting of fresh material both due to unsuitability of material – common reed has already started generating green shoots, together with the need to respect breeding birds, bitterns particularly start to set up territory very early in the season. As a result, an alternative source of already harvested dry material needs to be found to enable any testing to be completed.

A supply of material has been sourced, currently located at Errol, Perthshire which has been harvested and collected over 2 years ago, by a Softrak 60 during the winter of 2017. This material was taken from the Tay reedbeds, which is currently cut for thatching bundles, and is made up of unwanted material that was either damaged, bundles which were of too poor a quality to be used or created from the cleaning of the bundles and has been stored in a dry environment since it's harvest.

The reed is below 10% moisture content and has been recorded as little as 5.7%. The material is currently in small rectangular bales, easy to transport, and there is more than sufficient quantity (over 400 bales available) to complete both a pelleting trail and a burn test in a boiler.

### 1.3 Pellet sizes

There are potentially a number of different sized pellets that could be used, the traditional small cylindrical animal feed type pellet at approximately 5mm in diameter, or a larger diameter 'puck' which can be between 30mm and 50mm - 40mm version shown in the photo opposite. There are pros and cons with each, but the larger sized puck may be more suitable as the machine that produces these are a little better at dealing with a higher moisture content. In addition, the material does not have to be ground up as small prior to pelleting and can be up to 10mm in length. Whereas for the small more traditional pellet the feed material has be ground a lot finer. This adds to the time, cost and energy needed for processing; however, this is the size which people are used to and familiar with. Both will travel through a boiler auger.



Common reed 40mm 'puck' briquettes

## **1.4 Getting material pelleted – current options identified**

1.4.1 A contractor in Scotland, who owns the reed is prepared to look at options for pelleting reed in Scotland and is more than happy to facilitate this, organise transport etc etc. He would charge a rate of £35 an hour +VAT. Not yet established whether there would be a cost associated with the pelleting.

1.4.2 I have a contact in Warwickshire, who runs an 'alternative' pelleting (traditional small size) operation (for other markets than the energy sector) and would be happy to trail pelleting reed for us (see Appendix 3) – but he would potentially not be able to do so for a month or two. This would probably be free of charge (except delivery) as he sees that there could be other opportunities in other markets for pelleted reed in addition to being used as a fuel.

1.4.3 An engineering company who produce small 'puck' making machines would be happy to produce reed pucks for us, enough for a test burn, however this would come at a cost, as estimated below:

To run approx. 1 ton of material through a C150 (@ 30kilos per hour) would take approx. 4 full days of processing and our hourly rate for this would be £58.00.

This would equate to approx 4 days x 8 hours x £58 per hour would be £1856.00 + VAT (without any shredding time if needed) and delivery costs.

## **1.5 Amounts of material needed for trials and testing**

For a burn trail it is anticipated that approximately a tonne of pellets would need to be supplied to the boiler manufacturer. For analysis a further Kg of pellets would need to be supplied.

Previous test boiler burns for testing have been conducted with ETA boilers through the supplier Innasol:

Andrew Archer, Area Sales Manager  
Innasol Ltd, Reigate Barn, Langford Road, Wickham Bishops, Essex CM8 3JG  
Tel: 01621 892 613  
Mobile: 07500 557 869  
Email: andrew.archer@innasol.com  
Web: www.innasol.com

Analysis also organised by Innasol/ETA and conducted by Bioenergy 2020+, based in Germany. Test burns were undertaken free of charge with the testing work at a cost of £1,500.

A second company for assistance with testing has been identified, who would test the material to RHI emission standards is BGI (Bio Global Industries), who test in KFM boilers at an estimated cost of between £750 and £1,000.

## **1.6 Sustainable Fuel Register**

Discussions with BGI also revealed that self-suppliers are in certain circumstances able to operate under an exemption or via a permit and as a result depending on the scale of approach, the fuel may not have to be listed on the Sustainable Fuel Register in order for it to be used. See details below:

### **1.6.1 Exemption**

Permit Exemption is available for small appliances burning less than 50kg/hr (0.4MW) where less than 5 tonnes of fuel are stored on site and where the operator is burning its own waste. EPR Schedule 3, Part 1, Chapter 2, Section 2 Burning of waste as a fuel in a small appliance (U4).

### **1.6.2 Part B Permit**

A permit for activities listed in Schedule 1 Part B of the EPA can be obtained from the Local Authority (LA) with a 3MWth thermal output limit and where the fuel material is excluded from Chapter IV.

Exclusions from chapter 4 also apply when treating the following types of biomass:

Vegetable waste from agriculture and forestry

Vegetable waste from the food processing industry, if the heat generated is recovered

Fibrous vegetable waste from virgin pulp production and from paper production from pulp, if it's co-incinerated at the place of production and the generated heat is recovered

Cork waste

Untreated sawdust, wood shavings or wood offcuts

Wood, particle board and facings – as long as they don't contain halogenated organic compounds or

Heavy metals from wood-preservative treatment or coating

BGI offers a permitting service and can assist with applications for permits and exemptions needed for alternative fuels, the costs of these services depend on which local authority is involved and size of system employed.

## 2. To explore the opportunities, logistics and feasibility

### 2.1 Amounts of material needed to fuel a biomass boiler at Dunball

Reedbeds are typically harvested on rotation, such as a 3 to 5-year time period, this means that there are different ages of reed present in the bed which is beneficial to the wildlife that relies on the habitat. The age of the reedbed will determine the amount of dry biomass that it will generate, the table below illustrates how this varies from 1-year to 15-year-old beds.

Vegetation Detail	Site	Location (County/ Country)	Dry matter tonnes/ha	Notes
1-yr old common reed	Ham Wall RSPB Reserve	Somerset, UK	6.2	Reed litter layer depth – no more than 20cm Average reed stem height - between 150 and 200cm Reed stem density percentage of reed coverage in a 2m <sup>2</sup> – 93%
3-yr old common reed			7	Reed litter layer depth – no more than 30cm Average reed stem height - between 175 and 270cm Stem density percentage of reed coverage in a 2m <sup>2</sup> – 90%
15-yr old common reed			8.76	Reed litter layer depth – 70 to 90cm Average reed stem height - between 250 and 300cm Reed stem density percentage of reed coverage in a 2m <sup>2</sup> - 86%

Based on the estimate annual requirement of 32 tonnes per year<sup>1</sup> of pellets for the proposed boiler at Dunball, it is estimated that a 4.5-hectare area of 3-year old reedbed would need to be harvested.

As an illustration, the current annual reedbed harvesting targets at RSPB Ham Wall Reserve alone, which is a 240ha in size, are:

- Annual 3ha reed cut for thatch / bundles
- Rejuvenate 15ha over the course of the 5-year management plan
- Annual summer cut 1ha
- Winter cut 7ha on 12-year rotation (but take into account any cutting done as part of rejuvenation)

So, at Ham Wall reserve alone more than enough reed is already currently generated to satisfy the proposed boiler at Dunball.

### 2.2 Harvesting

The biomass needs to be harvested in as dry a condition as possible and ideally below 30% moisture (maximum moisture permitted for G30 or G50 woodchips). The lower the moisture content the better the heat delivery. The form in which the material is harvested, e.g. as foraged material, in bales or bundles is not as significant, as the material can be processed accordingly before it is pelleted via shredding. However, foraged loose material would mean less processing, although potentially more trips in removal off site than baled or bundled material.

<sup>1</sup> Estimate from David Mason, Skanska, based on 155,000kWh of gas currently used annually

## 2.3 Machinery availability

The types of machinery required for harvesting and collection of the biomass, will in part be determined by the site itself and the degree to how wet it is and to what extent water levels can be controlled and drained to facilitate access. Any piece of farming equipment can be used as long as it can operate in wet conditions and take material off dry.

The specialist tracked machines developed through the DECC Wetland Biomass to Bioenergy Project unfortunately are no longer available via a contractor and are now not know operated in the UK. However, there are machines such as the tracked tractor currently operated by RSPB Ecological Services, which is rented out at £450 per day and includes an operator<sup>2</sup>. This machine does not currently operate the appropriate attachments and collection capabilities. However, Ecological Services would potentially be prepared to invest in machinery if there was a proven need and requirement to provide a service. There are tracked machines such as the Softrak developed by Loglogic which are available for purchase locally.<sup>3</sup>

## 2.4 Options for pelleting

There are potentially 3 main approaches to pelleting that could be considered:

### 2.4.1 Small scale single site plant

Where the size of the pelleting operation is only large enough to process the material that is generated from one site and produces the tonnages needed to power a small number of boilers. This could be delivered through a Weima C140 which has demonstrated will comfortably produce around 30 - 40kilos of 40mm briquettes using Ham Wall reed an hour as per the video referenced.<sup>4</sup> <sup>5</sup>Approximate cost of £12,000, without set up and 'add ons' such as shredders, etc.<sup>6</sup> At this throughput it would take approximately 80 days at 10-hours a day to pellet 32 tonnes of materials.

### 2.4.2 On farm pelleting plant servicing a larger area than the farm

This could be delivered via a containerised pelleting plant that was large enough with a suitable throughput to process material coming of a number of sites located within a defined radius around the farm and produce the tonnages that could service a number of boilers. An example of such as system has been developed by Ekokraft, (see Appendix 1 and 2), using a 40ft side opening shipping container for the housing of the material processing equipment, enabling mobile production of pellets/briquettes when loaded onto a suitable HGV trailer. It contains a full processing line to convert dried (less than 20% moisture) harvested reeds into 6mm or 8 mm pellets, (pellet size can be easily adjusted and can be from 6mm up to 40mm). The processing line consists of a coarse shredder unit to break down large material before depositing into a cutter mill which reduces particles further to <5mm in size. The cutter mill deposits material into 2 cubic metre hopper. This hopper gradually and automatically discharges fine grain material into the EcoKraft LP22 pellet mill. Pellets produced would be sieved and cooled in a conditioning unit before being deposited in perforated bags for further curing and cooling, ready for storage or use. Estimated throughput of this machine is 350kg an hour (exact through put can be established via a test by sending 100kg to Ekokraft in Germany), and purchase price at £156,646.<sup>7</sup> At this throughput it would take approximately 9 days at 10-hours a day to pellet 32 tonnes of materials.

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<sup>2</sup> Excluding haulage and any T&S

<sup>3</sup> <https://www.loglogic.co.uk/>

<sup>4</sup> Video Link C140: <https://youtu.be/PXmb1OTcxCc>

<sup>5</sup> <https://www.fercell.com/recycling/products/weima/compact-c-briquetter-series/>

<sup>6</sup> See Appendix for full specification

<sup>7</sup> See Appendix for quotation and drawing

### 2.4.3 A large pelleting operation operated by an experienced operative.

A central hub to where the material is harvested and processed from a large area, e.g. the levels north of the Poldens or the levels and moors to the south. Pellets from this scale of operation could be put utilised in a number of different applications: as a fuel, for equine markets or gardening applications by way of examples. Many consumers of pellets are looking for pellets made from sustainable materials, rather than timber, and alternative feedstocks are attractive to processors currently in this market. As a result, assistance in setting up such an operation can be sourced, preliminary conversations have been positive with companies such as Agripellets<sup>8</sup> (see Appendix 3), and individual contacts such as Paul Goriup from Fieldfare who predominately works in countries like Ukraine, harvesting reed for a variety of applications including the production of reed pellets for fuel. The throughput of this kind of system would be in the region of 2 tonnes and hour. At this rate it would take approximately 1.6 days at 10-hours a day to pellet 32 tonnes of materials.

There are obviously pros and cons of each approach, especially in relation to economies of scale and throughput of material, but also in relation to haulage and delivery of biomass, especially in the case of the larger operation, where material will have to be transported further. This obviously impacts on both cost and carbon.

However, the one of the biggest advantages of the large pelleting operation could be the diversification and wider application of the pelleted reed. This could present the possibility for the production of other high value products, especially to equine markets, which could then help support the costs of fuel production if necessary.

### 2.5 Storage for feedstock

Whether the feedstock is in its raw or processed state, it needs to be kept dry at all times, so that it performs at its best and delivers the maximum calorific value when used in the boiler. Using the proposed Dunball boiler requirement of 32 tonnes, if all the material was to be stored on a site at one time then this would require the following:

Material / Form	Amount needed	Bulk density	Estimated fuel store <sup>9</sup> capacity needed	Source / Reference
Chopped common reed	32 tonnes	60kg/m <sup>3</sup>	533m <sup>3</sup>	Ash, Wynne
Pelleted common reed	32 tonnes	666kg/m <sup>3</sup>	48m <sup>3</sup>	Ash

### 2.6 Costings

As an indication only, on previous calculations completed price per kWh using dry common reed burning loose material in a biomass boiler, worked out between 4p and 5p per kWh. However, these costs were derived using the following:

1. All material was utilised on the site it was harvested off through an onsite boiler – minimising time and transport costs.
2. Biomass was harvested and hauled using specialist tracked vehicles including a Pisten Bully Greentech, high powered Softrak and tracked dumpers, these are now unfortunately unavailable for hire and not operating via contractor in the UK anymore – but could be purchased, ref point re RSPB Ecological Services.
3. **Most significantly** – these costs per kWh were based on using loose material in the boilers – so no compaction costs in the form of pelleting or briquetting were factored in.

<sup>8</sup> <https://www.agripellets.com/>

<sup>9</sup> Typical fuel store size as at West Sedgemoor RSPB Reserve is 25m<sup>3</sup>

## Appendices

Appendix 1 - Quote for containerised pelleting system

Budget Quotation



Company Registration N<sup>o</sup> – 9420540  
 VAT Registration N<sup>o</sup> – 257 1292 02

Tiles Farm,  
 Asheridge,  
 Chesham,  
 Buckinghamshire  
 HP5 2XB

Ben Donaldson (Director) +44 (0) 7941 991165 ben@donaldsongroup.co.uk  
 Frances Donaldson (Company Secretary) + 44 (0) 7795 327131 frances@donaldsongroup.co.uk  
 Hugo Saffer (Business Development) +44 (0) 7483 862955 hugo@donaldsongroup.co.uk

<b>Customer Name:</b>	James Parry	<b>Quotation Date:</b>	04/03/2020
<b>Organisation:</b>	Bio Global Industries		Quote valid for 30 days
<b>Street Address:</b>	The Technology Centre, Hunters Oak	<b>Reference:</b>	
<b>City/Prov/Postal:</b>	Asheridge, Chesham, Buckinghamshire, HP5 2UU	<b>Quotation Number:</b>	DGBGI001-Q
<b>Phone:</b>	+44(0)1494 757055	<b>Customer VAT Number:</b>	
<b>Email Address:</b>	james@b-g-i.co.uk	<b>Customer PO Number:</b>	

**Quotation Details and Notes**

The following quotation is to provide a containerised pelleting solution for reed material on behalf of Somerset County Council. Donaldson Group, UK partners with EcoKraft AG is pleased to offer the following system, supporting equipment and services for this application:

- 40ft side opening shipping container for the installation of the material processing equipment, enabling mobile production of pellets/briquettes when loaded onto a suitable HGV trailer. Delivery to Somerset included.
- Full processing line to convert dried (less than 20% moisture) harvested reeds into 6mm or 8mm pellets. The processing line consists of a coarse shredder unit to break down large material before depositing into a cutter mill which reduces particles further to <5mm in size. The Cutter mill deposits material into 2 cubic meter hopper. This hopper gradually and automatically discharges fine grain material into the EcoKraft LP22 pellet mill. Pellets produced would be sieved and cooled in a conditioning unit before being deposited in perforated bags for further curing and cooling, ready for storage or use. A full detailed description of all equipment, parts and spares that is included in the listed price can be provided on request.
- Installation and commissioning of the above equipment into the container is currently excluded from the quotation

**Exclusions:**

- Modifications to the supplied container, including but not limited to access ports/holes for cabling and material handling.
- Any trailer for the movement of the container.
- Any other equipment - lighting/extraction needed for the container to benefit operation.

System is supplied Ex-works Pletting, Germany. Budget prices listed subject to change following detailed discussions.

**Quotation Costs**

	Unit Cost	Quantity	Net Cost	VAT	Gross Total
Full pellet production line as listed above, Inc delivery	£141,810	1	£ 141,810.00	£	141,810.00
40ft Side Opening Shipping Container, Inc delivery	£14,836	1	£ 14,836.00	£	14,836.00
				£	-
				£	-
<b>Quotation Total (Excluding VAT)</b>				<b>£</b>	<b>156,646.00</b>

NB: Quotation valid for 30 days | Total due within 30 days of invoice | Overdue accounts subject to a service charge of 2% per month.

Customer Approval Signature: \_\_\_\_\_  
 Invoices may be subject to the EU VAT reverse charging mechanism.

Bank Details: Donaldson Energy Ltd. IBAN - GB50NW852212724436577 BIC - NW8KGB2L  
 Account no 24436577 Sort 52-21-27 Cheques payable to Donaldson Energy Ltd.



### Appendix 3 – Email from Agripellets.

**From:** David Thompson <davidt@agripellets.com>  
**Sent:** 05 March 2020 14:26  
**To:** Sally Mills <Sally.Mills@rspb.org.uk>  
**Subject:** RE: Pelleting common reed

Hi Sally

Further to our conversations we would be very interesting in exploring alternative uses for reed in a pellet form.

Through our companies we are involved with adding value to agricultural residues, primarily straw and currently producing animal bedding as well as a range of garden products such as mulch, compost and an organic slug control, all in a convenient, easy to use pellet form. We are still involved in fuel pellet production although to a lesser extent.

Over the last few years we have concentrated on further increasing value and are working closely with a number of university spin outs on preparing products for pyrolysis and using straw in carbon capture and utilization (CCU)

Our current pelleting production is 2tonnes per hour and we are in the process of increasing this to 4tonnes per hour

We would be very interesting in trailing some reed to convert into pellets and then explore its potential higher value uses.

Please feel free to contact me and keep me informed of your efforts.

Regards,

David

David Thompson

Agripellets

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Office 01789 761333

Minerva Mill,  
Alcester  
Warwickshire  
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B49 5ET