Business Plan for the 250kW on-farm AD

at *SITE X*

owned by *the Client*

Prepared by the Alpha-Financials Environmental team

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TABLE OF CONTENTS

1. SUMMARY OF THE *SITE X* 250KW ON FARM AD PLANT 3

2. ASSESSMENT OF CURRENT BUSINESS STRUCTURE AND COMPETENCE TO CONSTRUCT AND OPERATE AN AD PLANT EFFICIENTLY. 6

3. TECHNOLOGY PROVISION ASSESSMENT 6

3.1. TECHNOLOGY PROVIDER 6
3.2. FEEDSTOCK 7
3.3. POTENTIAL METHANE PRODUCTION 8
3.4. FEEDER 9
3.5. DIGESTER 9
3.6. DIGESTATE 10
3.7. ENGINE SCHNELL 250KW / BOILER 90KW 12

4. FINANCIAL ANALYSIS 14

4.1. SUMMARY OF THE EXISTING BUSINESS 14
4.2. PROJECT CAPEX 14
4.3. MAIN ASSUMPTIONS IN FINANCIAL ANALYSIS 14
4.4. FINANCIAL RESULTS 16
4.5. SENSITIVITY ANALYSIS 17
4.6. FINANCIAL VIABILITY OF THE PROJECT 18

5. CONCLUSION 19

APPENDIX 1: CURRENT AND FUTURE ENERGY SUPPLY AND USE 20

APPENDIX 2: GRID CONNECTION 21

APPENDIX 3: PLANNING AND EA 22

APPENDIX 4: TECHNOLOGY PROVIDER: *AD TECH PROVIDER #1* 24

APPENDIX 5: FEEDER 25

APPENDIX 6: DRYER 26

APPENDIX 7: PPA POWER PURCHASE AGREEMENT 28

APPENDIX 8: CURRENT BUSINESS OVERVIEW 29

APPENDIX 9: BASE CASE FINANCIAL STATEMENTS 31

APPENDIX 10: SENSITIVITY ANALYSIS 34

APPENDIX 11: ENVIRONMENTAL BENEFITS 35

APPENDIX 12: SOCIAL BENEFITS 40

1. Summary of the *SITE X* 250kW on farm AD plant

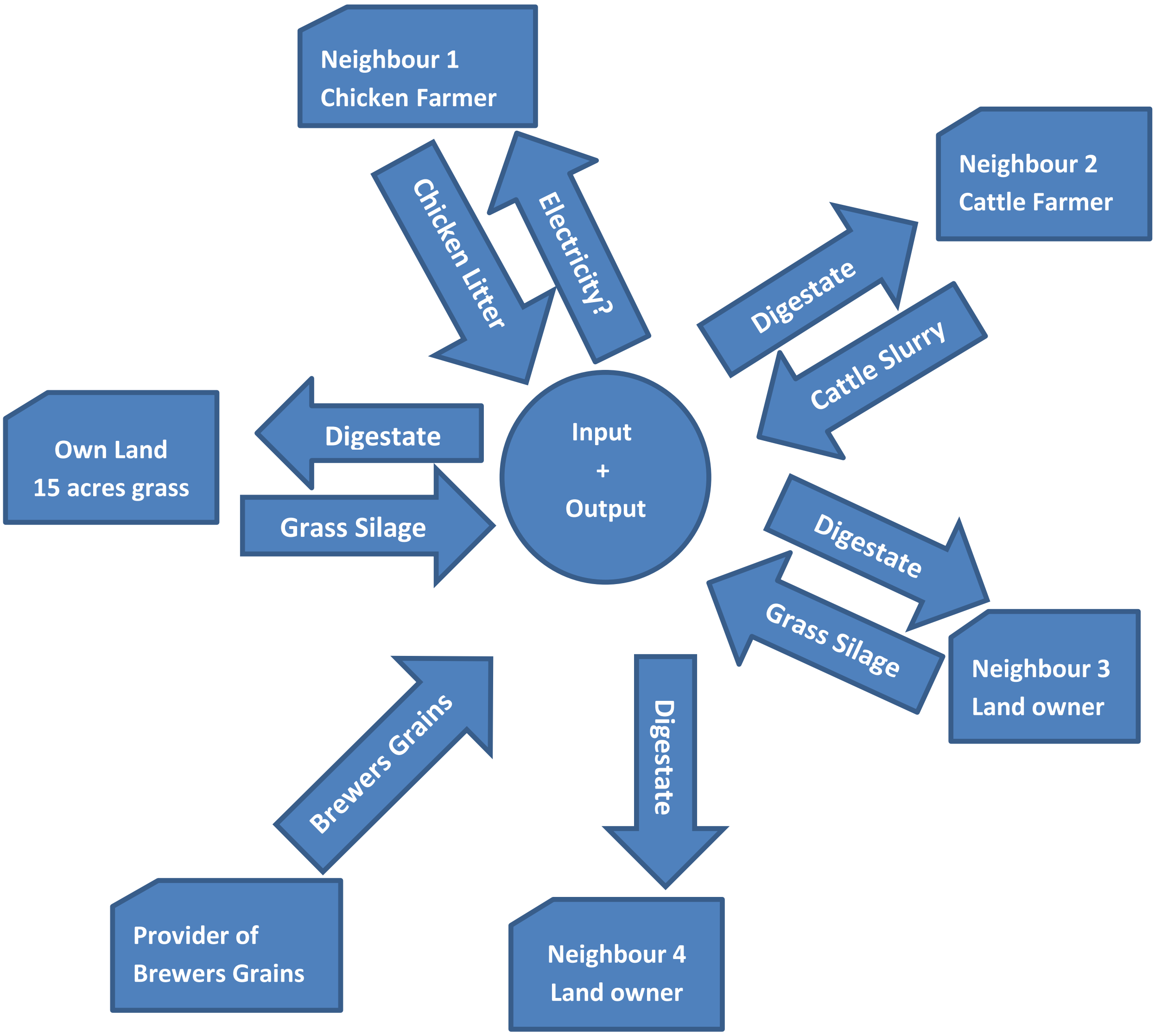
The 250kW on farm AD plant is seeking funding for 100% of the total amount required of £1.984mm. As detailed in this business plan, this amount is a most inclusive number where all capex has been chosen for its high quality, durability and low maintenance, whilst the operational expenditure reflects the risk-averse approach taken to this entire project. This business plan indicates that due to detailed planning, this project will reduce waste, improve GHG emissions (Appendix 11), bring social benefits (Appendix 12), export low carbon electricity into the national grid and use the heat produced, whilst providing an appealing return.

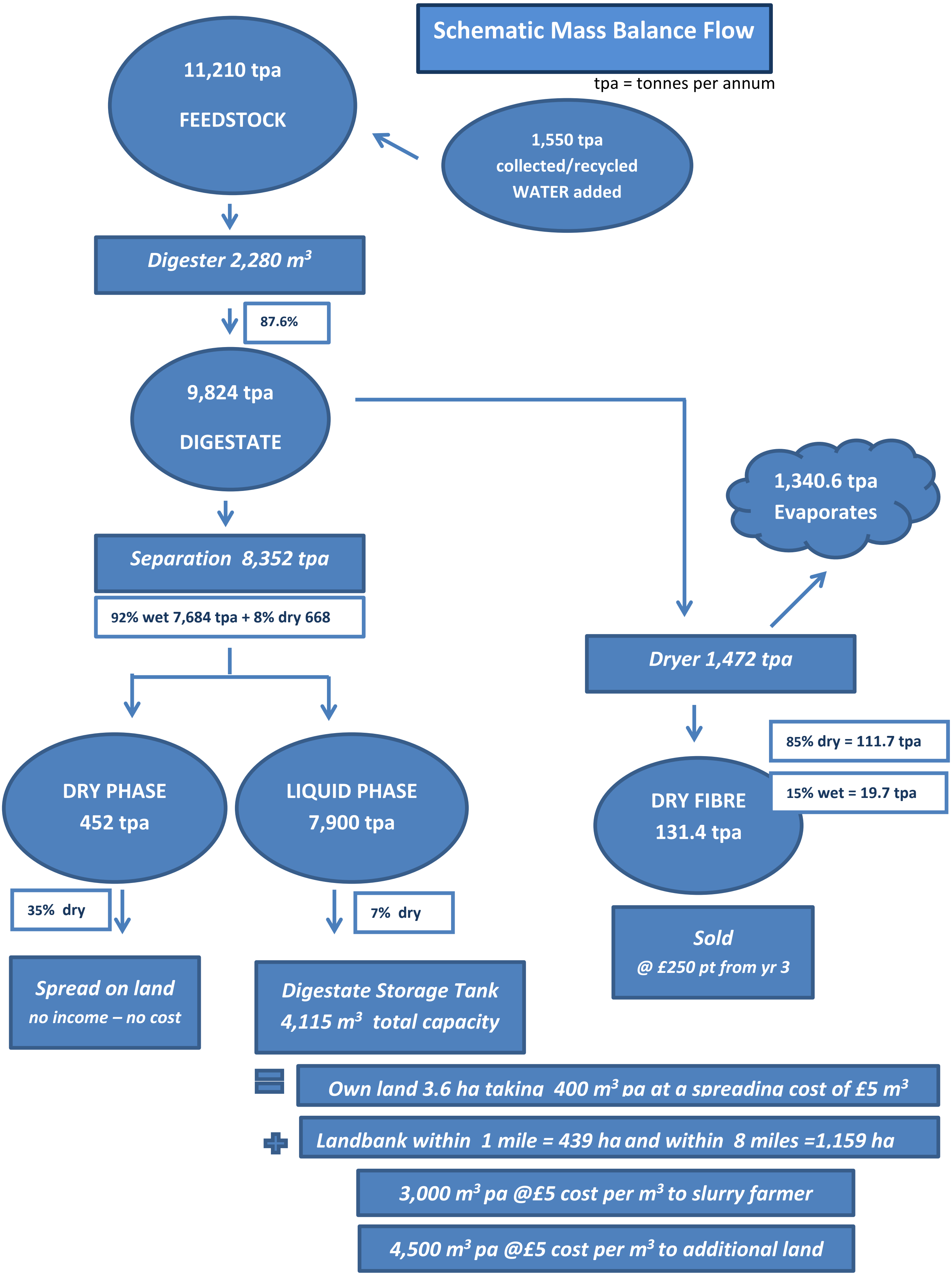
The table below provides an overview of the key components of the proposal. A conservative approach has been taken combined with risk mitigation to the maximum extent possible.

Key Characteristics of the *SITE X* AD		
Owners	*The Client*	*Contact details*
Land	Owned	100%
Location	*SITE X*	*Postcode*
Planning	Approved	No special T&Cs
Grid Connection	Secured	No special T&Cs
Feedstock total	11,210 tpa (tonnes per annum)	+ back-up available
FYM	2,000 tpa (£6/t)	Own
Grass Silage	300 tpa (£24/t)	Own
	1,300 tpa (£24/t)	Contract intended 3~5 yrs
Poultry Litter	1,260 tpa (£10/t)	Contract intended 3~5 yrs
Cattle Slurry	4,000 tpa (£10/t)	Contract intended 3~5 yrs
Water	1,550 tpa (£0/t)	Own
Brewers grain	800 tpa (£40/t)	Contract intended 3~5 yrs
FiTs	12.46p/kWh	Pre-accredited to 30/09/2015
RHI	5.9p/kWh	Rate from 1/4/2015
CHP	Schnell	$250kW_{el}$ and $220kW_{th}$
Availability	93%	- service incl. in main service contract
Service contract	Yes	Included in AD tech.
Technology Provider	*AD Tech Provider #1 - Germany*	300⁺ plants + UK service team
Methane Production pa	588,526 m^3 CH_4	
Electricity output total	2,028,553 kW_e pa	Includes 9% parasitic
Heat output total	2,211,100 kW_{th} pa	Includes 15% parasitic
Digestate total	9,824 tpa	
to separation	1,100 tpa (optional)	
- dry phase out	452 tpa	
- wet phase out	7,900 tpa	
to dryer	1,472 tpa	$250kW_{th}$ Dorset Dryer
- dried fibre	131 tpa	- service incl. in main service contract
Landbank	1,600 ha in total availability	439 ha within 1 mile
Payback Period	**7 years**	
NPV (@8%)	**£ 0.6**	
IRR (20 year project)	**12%**	

For details on Current and future energy usage, Planning and Grid connection please refer to Appendices 1, 2 and 3 respectively.

Schematic overview of the project




Schematic Mass Balance Flow
tpa = tonnes per annum
11,210 tpa
FEEDSTOCK
1,550 tpa
collected/recycled
WATER added
Digester 2,280 m^3
87.6%
9,824 tpa
DIGESTATE
Separation 8,352 tpa
92% wet 7,684 tpa + 8% dry 668
1,340.6 tpa
Evaporates
Dryer 1,472 tpa
DRY PHASE
452 tpa
LIQUID PHASE
7,900 tpa
85% dry = 111.7 tpa
15% wet = 19.7 tpa
DRY FIBRE
131.4 tpa
35% dry
7% dry
Spread on land
no income – no cost
Digestate Storage Tank
4,115 m^3 total capacity
Sold
@ £250 pt from yr 3
Own land 3.6 ha taking 400 m^3 pa at a spreading cost of £5 m^3
Landbank within 1 mile = 439 ha and within 8 miles =1,159 ha
3,000 m^3 pa @£5 cost per m^3 to slurry farmer
4,500 m^3 pa @£5 cost per m^3 to additional land

2. Assessment of Current Business Structure and Competence to Construct and Operate an AD Plant Efficiently.

The current business, without the AD plant, is described in section 4.1 with the financial analysis in Appendix 8. *The Client* is extremely committed to this project, which he considers as his pension, and his hard working ethic is witnessed by him:

> *Original contains examples of the hard work of the client.*

The Client has a healthy, realistic view on the needs to operate an AD plant. He employs two farm labourers, who will go through the entire training program in order to guarantee continuation and cover for the operations.
As future AD operators, he combines their formal training and an additional small budget to get further training on existing plants with his curiosity and intense desire to make this plant work. It was agreed that a full service contract will be taken out which includes 5 working days of training, 24/7 service during commissioning and full after sales support. In addition, the service contract will include 100% online off-site monitoring by the AD supplier and it was noticed that within the circle of current *AD Tech Provider #1* plant owners/operators there is a great sense of common interest and desire to share experiences. *The Client* is a very sociable, likeable person who values relationships with a mutual benefit.

Whilst *the Client*'s time commitment is commendable, he has also put all his limited financial means available into applying for the planning and securing the grid connection.

3. Technology Provision Assessment

3.1. Technology Provider

Logo of *AD Tech Provider #1*

Whilst the full proposal and additional *AD Tech Provider #1* financial information are available upon request, Appendix 4 contains further details and references on *AD Tech Provider #1*, one of the top five providers of AD plants in the world, having a combined installed capacity of 133,928kW$_{el.}$

Besides their huge experience with AD in general in Germany and in the UK, it was its experience with our particular feedstock (including the brewer's grains - see below) combined with the presence of an excellent biological service and the inclusion of the entire process (including dryer and CHP) into the service contract that made them the supplier of choice out of several others that were considered in tremendous detail. *AD Tech Provider #1* was recommended by several other large AD providers as well as contacts in the industry such as the International Biogas Association (IBBK).

The following sections explain the link between the technology provider on the one hand and feedstock, biogas production, pre-treatment, digester, digestate, engine and other issues on the other hand.

3.2.Feedstock

Since *the Client* supplies only a portion of the feedstock itself, securing the rest is of paramount importance to the project's success. Hence, the project is structured around combining feedstock providers and output off-takers (electricity/heat/digestate) to the maximum extent possible, whilst contracts for 3~5 years minimum will be a condition of the project going forward.

To ensure the correct and optimum mixture of feedstock several routes have been pursued. The biological analysis is based on *AD Tech Provider #1*'s own experience (since the head of the biological department runs her own AD plant with comparable feedstock) as well as on their lab analysis. Since we previously also considered other technology providers, the expected biogas production had also been cross checked with *AD Tech Provider #2*'s own in-house analysis and *AD Tech Provider #3*, where possible. In addition the KTBL international list for biomethane production potential confirms that the figures used are within the boundaries of realistic expectations

The total feedstock for the plant will be 11,210 tonnes per annum, consisting of:

(i) 2,000 tpa of *SITE X*'s own FYM waste, from corn fed, straw bedded pigs, which impacts on the composition of this waste and results in the need for a pre-treatment (see RotaCrex under 'Feeder' below).

(ii) 1,600 tonnes of grass silage per year (14% of total). A neighbouring farmer, *Neighbour 3*, will provide 1,300 tonnes per year at a price of £22/tonne with the remaining 300 tonnes harvested from *the Client*'s own 3.6ha land as several cuttings per year can be taken.

(iii) 1,260 tpa of poultry manure deliverable from *Neighbour 1*'s 200,000 broiler chickens, 600 meters from *SITE X*, which are currently heated by a 900kW biomass boiler. As the chicken litter stems from broilers, the litter is less gritty, has a lower DM and has less N (20% as against 25%) compared with layers. If kept dry, the chicken litter can be stored for a long time. Chicken manure is particularly high in nitrogen and should hence not exceed 30% of total feedstock (IBBK). This plan keeps the chicken litter at 11.2% of total feedstock.
Neighbour 1 will sign a contract for the delivery of the feedstock. A cost of £6 per tonne of chicken litter is assumed. This neighbour is interested in further collaboration and several options have been analysed, one of which is a private wire electricity supply which is considered as a sensitivity, but does not make part of the base case (See below).

(iv) 4,000 tpa of cattle slurry (cows housed in-door all year – so consistent and continued supply) will be provided by *Neighbour 2* under contract for at least 3 to 5 years. The business plan incorporates a cost of £5 per tonnes for haulage of the cattle slurry since this feedstock will be exchanged for liquid digestate. This farmer is very knowledgeable about AD and he will take 3,000m^3 of liquid digestate onto his land for which a cost of £5 per m^3 for spreading is assumed. A raw waste buffer tank with a capacity of $159m^3$, representing just over two weeks of storage time is included.

(v) 1,550 tonnes of water which is the waste water collected from the pig farm in a 25,000 litres underground storage system. This not only substantially improves the management of this waste stream but also saves a cost of £ 3,600 for its removal per annum. It also reduces the need to add fresh water. In addition, rain water will be collected and used if required. The budget foresees for an additional drainage tank costing £10K, for collection of rain water, which will eliminate the need for fresh water.

(vi) 800 tonnes of brewers' grains will be purchased at £38 pt from the *Provider of Brewers Grains*. The alternative of growing maize or whole crop on 40 acres which a neighbour made available was dismissed on the basis of higher costs of maize or whole crop as against an equal expected methane potential. The use of brewers' grains eliminates the need for silage clamps, which reduces capex by at least £70,000, since the brewers' grain will be delivered on demand. A contract for 3 or 5 years will be a condition precedent.

Note on the *Provider of Brewers Grains*:

Logo of *the Provider of Brewers Grains*

Original contains specific information on the Brewer, removed to preserve confidentiality.

Note that there are several alternatives for feedstock available and that since no other AD plants in the county exist or are currently planned, there is no immediate competition for the feedstock.

3.3.Potential Methane Production

5 different AD technology providers have provided estimates on the expected CH_4 production of the feedstock. *AD Tech Provider #1* and *AD Tech Provider #2* have analysed the feedstock in more details in their respective laboratories and used their experience in other (and their own) plants to confirm the final number used in our BP of 588,526 m^3 of CH_4 pa.

The values used for the purpose of the business plan are:

Feedstock	% of total	CH_4 production in m^3 per tonne	Annual Production of CH_4
FYM	**18**	**48.8**	**97,636**
Grass Silage	**14**	**127.0**	**203,200**
Poultry Litter	**11**	**126.2**	**158,962**
Cattle Slurry	**36**	**13.5**	**54,000**
Water	**14**	**0.0**	**0**
Brewery grains	**7**	**93.4**	**74,729**
Total	***100***	**-**	***588,526***

3.4. Feeder

The choice is made for the low energy consuming, low maintenance, adapted micro-crusher, the MultiRotor Vario 38m^3, including the RotaCrex. It is specially designed to convey chopped renewable energies and suitable substances include silage of maize, grass, elephant grass and so on up to length of 50mm as well as up to 20% manure from cattle, pigs, turkeys or chicken. Dry matter content can be between 25% and 40%. Although this adds £106K, to the overall capex, the anticipated benefits warrant the investment due to the following positive impacts: slightly improved methane production (due to increased surface area), making the digestate better suited to the drying process at a later stage, reduced number of blockages, reduced HRT needed, reduced crust formation and reduced overall amount of feedstock required. Details: Appendix 5.

3.5.Digester

The feedstock to hand significantly impacts on the choice of technology provider and *AD Tech Provider #1* has ample experience with all the feedstock utilised even the less usual Brewers Grain.

The single tank, continuous flow, wet digester of 2,280 m^3, degrades organic material by bacteria under anaerobic conditions and with a temperature of between 38 and 42^{0}C it is operating as a mesophilic digestion process, with an average HRT of 69 days. The digester is equipped with all necessary heating, agitation and sulphur removal technology to guarantee a stable and reliable process, well proven in 300+ similar installations. The conical base of the digester with base drain allows extraction of sediments, and the heating pipes embedded in the wall and the base allow evenly heating of the complete digester content. The agitation technology is always tailor-made, depending upon substrate and tank size, and the netting cover in the tanks allows a biological sulphur removal of the biogas.

Each component is selected carefully to guarantee durability and low energy consumption. The overall design of the digester and the position of the different components are based upon years of experience and are optimised to maximise the efficiency of the biogas plant.

The plant will be built inclusive of all the latest health and safety requirements as well by using durable low maintenance components.

→ Full details are available upon request.

3.6.Digestate

The 11, 210 tonnes of feedstock will result in 9,824m^3 of digestate per annum. This digestate will follow one of two different routes, which run in parallel; either it will be **dried** or it will be **separated**. In the latter case it will end up as a liquid phase or a semi-solid phase (see schematic overview on page 4 for the full mass balance flow and all the % DM). All three end products are described below. The entire process is driven by the maximum capacity of the drier which is 250kW$_{th}$ which will 'demand' the digestate up to its maximum capacity. If the digestate is not 'requested' by the dryer it will go to separation. This configuration results in the full utilisation of the heat, without wastage. Notice that Ofgem confirmed that drying of digestate is a RHI receptive process.

3.6.1. Drying → output = fertiliser

The Dorset 220kWt$_h$ dryer can process 1,472 tonnes of digestate pa, and will deliver an output of 131.4 tpa of dried material. This nutrient rich material is a perfect fertiliser, comparable to that used in the agricultural world today with a market value of £350 per tonnes. For the purpose of the BP it is anticipated that familiarising neighbouring farmers with this material will take some time, as experience by AD operators throughout the UK, and hence no income is assumed until year 4 at a conservative price of £250 per tonnes. In addition, a small amount of £5,000 is budgeted for the purpose of assisting the familiarisation of the neighbouring farmers on the benefits of digestate.

RHI will be claimed for this operation, although at the moment of composing this BP no applications have been approved by Ofgem, due to the legislation being very new. However, several AD plants are in the process of applying and a 1MW plant, Singleton Birch Ltd with a similar configuration to *the Client*s has been informed by Ofgem that they will look favourably upon their application.

Note that the dryer makes an integral part of the AD operation and its operations and maintenance will be covered by one *AD Tech Provider #1* service contract.

All assumptions used in this business plan regarding the drying of the digestate result from extensive meetings with senior people in both the mentioned drying companies as well as a site visit as detailed in Appendix 6.

3.6.2. Separation → output = liquid phase fertiliser

All the digestate that is not dried, being 8,352 tpa, will go through a separation process which will leave 7,900 tpa in liquid digestate, a valuable fertiliser. This will be collected in the 4,115m^3 digester tank.

The cost of spreading will hugely depend on the method used.

> An umbilical pumping system costs £100 to set-up per day followed by a £100 cost per hour, whilst 80 tonnes of digestate can be spread per hour. Assuming a 10 hour working day, this equates to a total cost of roughly £1.3 per tonnes.
>
> If a 13 tonnes tanker is required at a cost of £60, the cost of spreading will reach £4.6 per tonnes.

One of the neighbouring farmers, *Neighbour 2*, recognises the value of this fertiliser and he will take 3,000m^3 at the cost of haulage @ £5 per tonne. The remainder of the digestate 0r 4,500 m^3 is assumed to be spread a the cost of haulage but after 3years this spreading should no longer be a cost nor an income which is very conservative as it is hoped that good digestate management will turn this into an income stream.

The Client, who is not in an NVZ, can take a maximum 250 tpa of digestate onto his own grass land. In addition, this land will take 400m^{3}of liquid digestate per annum at the cost of the haulage of £5pt (not consistent). However, there is plenty of potential additional landbank available. *Neighbour 5* is physically the nearest with 350ha of arable land which is also not classified as a NVZ. *Neighbour 5* is unfamiliar with digestate, and as a result negotiations are currently underway with *Neighbour 5*'s agronomist, with the aim of finding support in convincing him of the benefits of the digestate. The agronomist reviewed the lab analysis of comparable digestate and commented on the positive impact which he anticipates.

The table below provides an overview of the available landbank options.

Name	**Landbank In ha**	**Distance from *SITE X***	**Crop (C) / Grass (G)**	**NVZ Yes / No**	**Familiar with digestate**
The Client	6.2	-	G	No	Yes
Neighbour 5	350	adjacent	C	No	No
Neighbour 4	747	1.5 ~ 7miles	C (some G)	?	Yes
Neighbour 2	145	7 miles	G (some C)	Surface Water No	Yes
Neighbour 3	83	1 miles	C / G (30%)	No	?
Neighbour 6	270	3~8 miles	C (some G)	50/50	Yes
Total	***1,601.2***				

The exact composition of the digestate will need to be taken into account but assuming as an average that 30m^3 (which is pessimistic compared to the going average rate of 40m^3) can be spread per ha and with a total amount of liquid digestate of 7,900m^3 we have a coverage of roughly 6 times.

Whilst further analysis as to the exact fertiliser replacement that can be achieved is required , a rule of thumb of 200kg per annum per acre of a standard fertilizer (blended 20-10-10), at a cost of roughly £260 per tonne, can be used as a guideline. This equates to about £52 per acre or £125 per hectare.

SITE X currently exchanges the straw required to bed the pigs for the 2,000 tpa of FYM. If this exchange did not take place, there would be an additional cost of £17,500 to the pig farm. In the future, this arrangement could stand with the straw being exchanged for digestate.

A liquid digester storage tank with a content of 4,115m^3 represents 180 days of storage or just over 6 months.

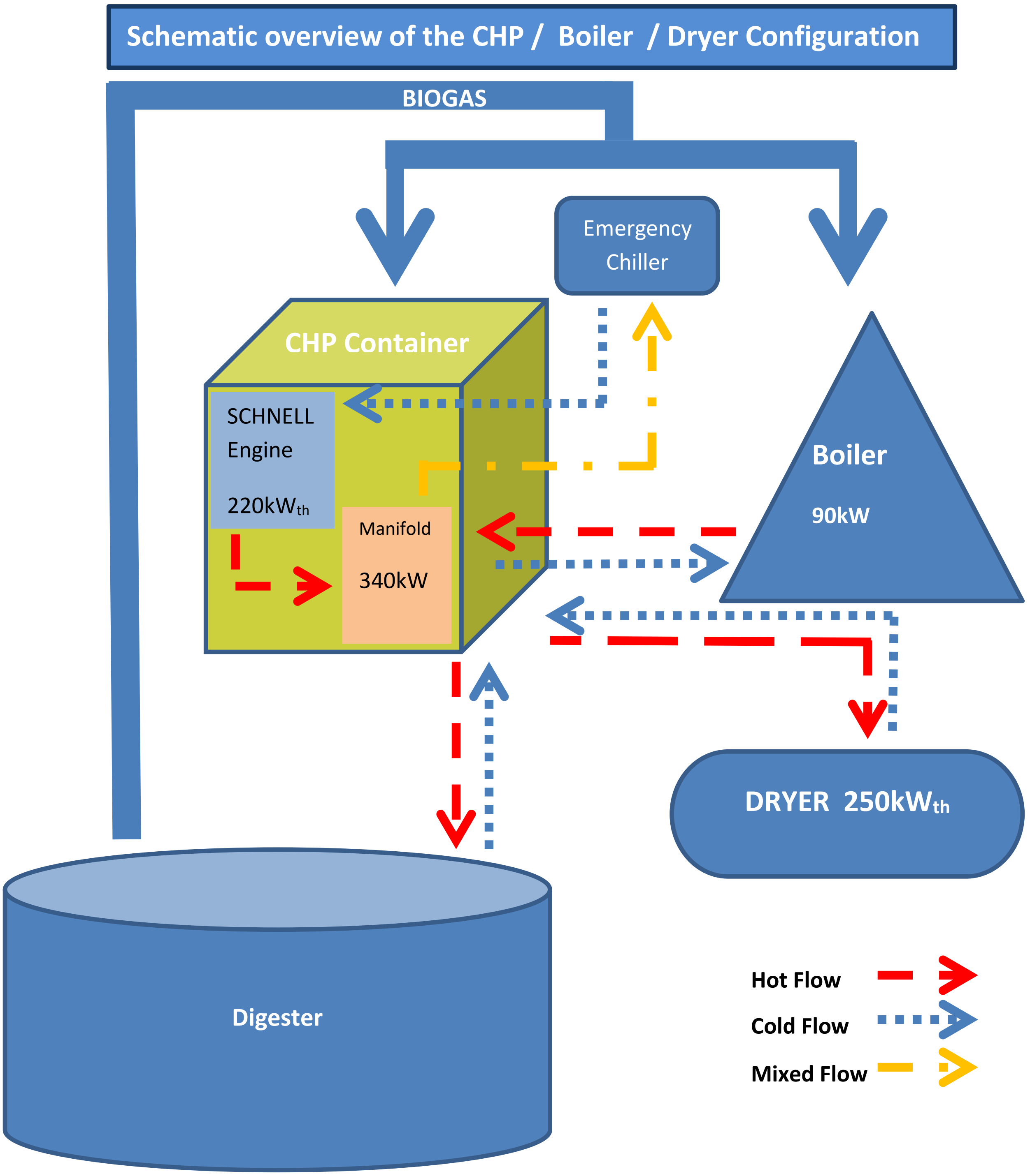
3.6.3. Separation output = solid phase digestate

The separation process results in the production of 452m^{3}tpa of semi-dry digestate. This dry phase of the output of the separator is assumed to be spread on land at no income – no cost for the duration of the project.

3.7. Engine Schnell 250kW / Boiler 90kW

During normal plant operation, biogas will be utilised by the CHP unit to generate electricity and heat. A 249/250kW$_{el}$ Schnell CHP unit has been specified to accommodate the proposed level of biogas production, for which a 93% availability is assumed in our business case despite some of their existing plants exceeding 95%. Originally, the G2 engine was selected but visits to Germany revealed the higher reliability of the Schnell engine. The manufacturers only recently requested and received insertion onto the list of Ofgem's approved engines, and the engine is hence new to the UK market, but approved for FiTs and RHI. The CHP will be covered by a full maintenance contract.

Refer to the Schematic Overview below for the configuration of the CHP, Boiler and Dryer, which indicates how an additional boiler can be used for those short periods of unavailability of the CHP, to heat the digester. As indicated there, the boiler also functions as top-up supply of heat to allow the dryer to reach full potential in both summer and winter conditions RHI will be claimed on the production of the heat in these limited periods. This boiler will not be used to heat the seed digestate since a decision was taken to buy in heated digestate to speed up the biological process.



1. Both the CHP and the Boiler receive biogas
2. The Schnell CHP at $250kW_{el}$ has a maximum capacity of $220kW_{th}$
3. The Dorset dryer has a capacity of $250Kw_{th}$
4. In summer the dryer is fed by $220kW_{th}$ from the CHP and $30kW_{th}$ from the boiler = $250kW_{th}$
5. In the winter the digester has an increased demand for heat of 60 kW_{th}
6. In the winter the dyer is fed by $160kW_{th}$ from the CHP and $90kW_{th}$ from the boiler = $250kW_{th}$
7. The manifold has a capacity of $340kW_{th}$ but will never utilise more than maximum $220kW_{th}$ from the CHP and $90kW_{th}$ from the boiler = $310kW_{th}$

4. Financial Analysis

4.1.Summary of the existing business

For the past three years, *the Client* has run a high welfare, straw based pig fattening unit over a 20 week cycle, which has restricted both the income stream and the manure output; the latter in two ways as the composition altered with the age of the pigs and the availability of the manure was 20 weeks on and 2 weeks off. In recognition of their effort, in July 2015 they won a more profitable contract from *a livestock rearing organisation* to rear 2,000 piglets. The pigs stay at *the Clients* farm for 18 to 20 weeks, at which stage they are moved on to another farm and then replaced by a new batch of piglets. This change positively impacts AD operations by increasing income and providing a more consistent and continuous FYM waste stream.

The latest accounts to 04/15, exclude the impact of this new contract, so we have created an underlying, current business scenario to evaluate the financial health of the business.

At this stage we have focussed on the cash generating potential of the current business and its robustness, particularly to increasing interest rates, in what remains a highly leveraged entity. The breakdown of the financial analysis is included in appendix 8 and the key results and conclusions are as follows:

- Commencing in late 2011 as a heavily indebted start-up, gearing has steadily declined from 72% to 67%. With the new rearing contract in place, the rate of decrease will increase slightly.
- With a net cashflow generation of just over £30k pa, or twice the current interest payments, there is headroom to cover any likely increase in interest rates in the medium term.
- Overall, there is not sufficient strength to provide financial support for the AD plant which needs to be financially justified on a stand-alone basis.

4.2.Project Capex

The total capital costs amount to £1.8m and are based on the following firm quotes:

- £1.4m *AD Tech Provider #1* (09/14) for the main AD plant plus Dorset dryer
- £0.2m from a local contractor (05/14) for the civils work
- £0.1m grid connection (06/14)
- £0.1m for miscellaneous items
- £0.1m for contingency

Note that all formal quotes for the capex items have been increased by 2.5% to allow for inflation increases due to the inevitable delays in securing finance.

4.3.Main Assumptions in Financial Analysis

The main assumptions underpinning the financial analysis are as follows:

- All financial forecasts based on a 20 year analysis with a 6 month construction period commencing in September 2015
- All capital costs are based on supplier quotes and throughputs utilise the mass balance calculations provided by *AD Tech Provider #1*

- A general inflation rate of 2.5% has been applied to all capex, opex and revenue items other than the subsidies.
- A 5% contingency has been applied to all capex and opex costs
- The full £0.2m Annual Investment Allowance, which terminates on 31/12/2016, is allocated to the project, but no ECAs are assumed (the latter may be available for the dryer)
- Seed digestate (i.e. digestate bought in from an existing plant mixed with slurry to start the plant up) and initial heating costs £25K
- Feedstock prices are based on indicative rates agreed with suppliers which in due course will be converted into 3-5 year contracts. The rates are as follows:
  - Cattle slurry £10/tonne (haulage only)
  - Pig FYW £6/tonne
  - Brewers Grains £40/tonne
  - Chicken Litter £10/tonne
  - Grass silage £24/tonne
  - Water free (from on-site bore hole)
- A spend of £5k pa for the first 2 years has been made for marketing the benefits of digestate and its disposal is assumed to be cost neutral due to its inherent worth.
- Parasitic loads of 9% and 15% for electricity and heat respectively are rounded up from the manufacturer's specification.
- The CHP plant operates at an average utilisation rate of 93% with the dryer utilisation set at 91% throughout the analysis period.
- Operating at this rate means that just under 14% of the electricity and 24% of the heat potential of the feedstock is either lost or provides for contingency in the event that feedstock yields are lower than expected
- Maintenance costs are based on *AD Tech Provider #1*'s basic service scenario 2 meaning a high level of feedstock contamination and accelerated activated carbon replacement
- *AD Tech Provider #1* callouts have been set at 4 per year including the first year which only has 3 months of operation.
- It is further assumed that *the Client*s will from year 3 onwards undertake some of the *AD Tech Provider #1* service contract obligations, although no savings have been included in the model for this
- RHI and FITs are based on current published rates for the period ending 31/3/16. For the first year of trading, no degression and no inflation adjustments are applied to either the RHI rate, or the pre-accredited FIT rate.
- All surplus electricity is exported at a rate of 5.6p per kWh
- No marginal business rates costs will arise from the new plant
- The financial structure assumes 60% equity and 40% debt funding, the latter at an interest rate of 5%. Due to the use of tax normalised cashflows, changing either the level of gearing or the cost of debt will not change the project IRR.
- The private wire scenario assumes £0.05m capex costs and a starting electricity sale price of 9p/kWh, escalated at a rate of 1% above RPI for 5 years as per DECC forecasts as per DECC forecasts at the end of 2015
- All available cash paid as dividends

- No EIS benefits are assumed, even though these will be applicable and can therefore enhance equity shareholder returns by up to a third of their starting value

4.4. Financial Results

The summary financial results from the base case comprising the project profit and loss, cashflows and balance sheet statements covering the 20 year analysis period are included in appendix 9, but the key results are as follows:

SCENARIO 1: Base case *AD Tech Provider #1* — All monetary amounts in £'000s unless otherwise stated

Total investment cost		1,804			
Project IRR		12%			
Project NPV (GBP millions @8.0% CoC)		0.6			
Payback period (years)		7.8			
Years of earnings dilution		1			
Year	1	2	3	4	5
Electricity produced (MW)	304	2,029	2,029	2,029	2,029
Heat Produced (MW)	300	2,000	2,000	2,000	2,000
Revenue	73.1	499.2	540.0	553.5	567.3
Operating costs	-87.0	-272.7	-268.8	-275.5	-282.4
EBITDA	-13.9	226.4	271.2	278.0	284.9
Depreciation	-89.0	-89.0	-89.0	-89.0	-89.0
Feedstock cost p/kWh	2.5	2.5	2.6	2.6	2.7
Total cost[1] p/kWh	29.1	9.0	8.9	9.0	9.2
Total feedstock costs	14.9	101.5	104.0	106.6	109.3

[1] Excluding financing costs

4.5.Sensitivity Analysis

In recognition of the volatility and uncertainty associated with the key assumptions, the following sensitivities have also been modelled. Appendix 10 details the changes in the major financial outcomes from all the sensitivities examined and in summary, these comprise the following:

Sensitivity	Probability	Project IRR change (from 12.1%)	Commentary
Downside scenarios			
RHI allowable volumes reduced by 15%	Low	-1.1%	Covers the potential risk that RHI won't be allowed on the grass silage, requiring the use of an alternative, more expensive, input
Opex costs increase by 5%	Low	-0.8%	Supported by quotes from supplier. Have 5% contingency already. Potential mitigation is an opportunity (below)
Inflation over the 20 year analysis falls from 3% to 2%	Low	-0.8%	Not previously occurring in the UK although in 09/14 annual inflation was 1.2%
Upside scenarios			
Reduce construction costs by 5%	High	+0.8%	Release of contingency, FX movements and ability to negotiate with supplier
Private wire agreement set-up with neighbour	Medium	+0.4%	Informal discussions indicate that both parties would benefit
Opex costs reduce by 5%	Medium	+0.8%	With sufficient training, owner has the opportunity to bring in house and significantly reduce cost. The contingency may also become available
Income (£2/tonne) secured for digestate from year 4	Low	+1.0%	Product has intrinsic worth, but significant marketing challenge to convince potential clients

The RHI downside scenario considers a potential legislation change relating to the sustainability criteria of the feedstock, which is currently in place for bio-methane, but which may come in to force in the years to come for CHP also (and may not be 'grandfathered'). Disallowing feedstocks not meeting the sustainability criteria might mean that in this case, the RHI would be reduced by the percentage that the grass silage represents of the total feedstock. Since plant flexibility allows the use of alternative but less cost effective feedstocks, we have assumed that the net impact would be equivalent to losing half of the grass silage heat content i.e. 17%.

The private wire scenario refers to selling 300,000kWh of electricity to an adjacent neighbour, *Neighbour 1*, by means of a private wire for approximately 800meters underground for which a quote was received by PowerSystemsUK after a visit to *SITE X*. In addition, a private purchase agreement would be required between *the Client* and *Neighbour 1*. The deal is financially interesting to *the Client*s (see result above) and *Neighbour 1* has expressed serious interest if he can undercut his current electricity costs of 10p per kWh. This is likely to be added at a later stage (Appendix 7).

4.6.Financial Viability of the project

With a base case IRR of 12% and relatively small adverse movements from it in all the downside scenarios, we consider that this project looks sufficiently profitable and robust to attract investors.

At least initially, and due to the lack of security, probably only an all equity financing solution will be possible. The owner has limited savings, but are prepared to invest what he has together with a small pension fund where this is possible.

Full utilisation of EIS tax benefits, would improve the equity investors returns by up to a 1/3 or, assuming all equity financing, be equivalent to increasing the project IRR about 17%.

Conclusion

This 250kW on-farm AD project for the *SITE X* farm aggregates the many different positives of AD in general; it reduces waste streams, creates renewable energy in the form of heat and electricity, produces a valuable fertiliser and biomass fuel and offers substantial social and environmental benefits.

The farm's own waste stream is put to great use whilst additional waste streams from neighbouring farms will be tied in contractually. Furthermore, all outputs, electricity, heat and the digestate (solid as well as dried and pelletized) are utilised and often linked to the suppliers of the feedstock making this a robust and coherent scheme.

AD Tech Provider #1 had built over 300 plants worldwide and counts a very successful operation amongst these in the UK which uses similar feedstock to *SITE X*. The presence of a sales, biological and a service team (for the AD technology, the dryer as well as the CHP), locally in the UK made this the technology provider of choice.

The Client, who has demonstrated great commitment to the project, will assume responsibility for the operations, under close guidance and initially with all the training required.
In addition to an attractive base case, financial viability remains robust under a number of relevant downside scenarios. Returns may in any event increase due to a number of potential upside options.

Every care has been taken to ensure accuracy of all the information provided, we can however not take any responsibility for its content.

Anne Laleman - Director

On behalf of the Alpha-Financials Environmental team, represented by Matt Cawley, Matt Lomax, Peter Harding and Anne Laleman. Please contact any one of our team for further details.
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Appendix 1: Current and future energy supply and use

Current Energy Assessment

- Off-grid site reliant on fossil fuels
- Imported diesel costing £6,400 pa to generate 50,000kWh of electricity using a generator and battery storage
- For heating and cooking, bottled propane is used at a cost of £1,000 per annum

Energy Use Projections

- *The Client*s use of 50,000kWh pa will increase by no more than 10% upon the changes to their current business operation.
- Parasitic electricity load of 9% used by AD
- Parasitic heat load of 15% used by AD

Electricity Supply

- The AD plant will generate approximately 240kW_e or 2,028,533kW_e pa from feedstock calculations
- A net export of 300,000kWh is possible to *Neighbour 1*
- Negotiations for the future arrangement of a PPA are under way (See the scoping table below)

Heat Supply

- The AD plant will generate approximately 2,211,100W_{th} pa, of which approx. 331,665 kW_{th} is included and required as the parasitic load for the AD plant at 15%
- In the base case scenario 1,879,435kW_{th} is used to dry the digestate.
- There is spare heat capacity and several options remain still open going forward.

Appendix 2: Grid Connection

Background

SITE X is currently off-grid, reliant on diesel generators for electricity

- HV grid connection is approx. 700m from site
- WPD screening identified suitable grid capacity in the local electricity grid

Current Status

- A formal connection offer was provided on XX/XX/2014 and remains valid until required with written letter of authority from WPD
- A deposit of 10% of work total has been submitted to secure the offer
- Total connection fees from WPD are £94,051.13 excl. VAT
- Contestable work totalled £83,821.59 and non-contestable work totalled £7,318.54.
- Written quotes from 3 independent connection providers (ICPs) are awaited.

Further Details

- The terms and conditions of this offer are standard classification: 12 weeks needed before commencement of works due to procurement, substation on customers land must have 24 hour access, and license is required from Street Works Act 1991 because of the roads involved.
- An analysis of Independent Connection providers (IPO) was carried out
- Alternative grid connection options are not available due to the dated grid infrastructure in adjacent dwellings
- Energy optimisation under G59 classification will also require further investigation if a private line option is chosen with *Neighbour 1*.

Risk Mitigation

- In view of the recent developments, and WP the grid connection poses no constraints on this project.
- There is no issue of financing this grid connection.
- 3 ICPs were chosen to provide comparable quotations and timeframes

Appendix 3: Planning and EA

Background

Planning

- Berry Bros Ltd were selected to provide planning consultancy and assist with submission following their experience with on-farm AD developments
- Comparable quotes for planning consultancy were also supplied by Pegasus Group, who provided *the Client* with a favourable pre-feasibility planning report, but who turned out to be more expensive
- On March XX/XX/2015, a site visit by chartered surveyors and planners Berry Bros Ltd advised that submission of a pre-planning application to the relevant County Council was required
- Berry Bros Ltd identified that the application would be considered by county level judgment rather than parish or district authorities
- Feedback for the pre-planning application was received on the XX/XX/2015 and identified there to be few insurmountable barriers to successful planning permission

Environment Agency

- Initial screening of the site was carried out by an EA representative
- Following advice given by Berry Bros Ltd and findings of a desk based analysis, it was deemed appropriate to pursue written confirmation of necessary permitting and/or waste transfer licenses associated with the proposed feedstock

Current Status

Planning

- A full planning acceptance was unanimously granted XX/XX/2015 with non-detrimental conditions
- Consent was granted with full support of key consultants at the county level
- Further details can be provided upon request

Further Details

Environment Agency

- No objections subject to conditions being imposed to protect the land based water environment on site
- Site layout map on next page
- Full access to the planning decision and associated comments can be found using the address below

Address removed to preserve confidentiality.

Site layout removed to preserve confidentiality

Appendix 4: Technology provider: *AD Tech Provider #1*

Full appendix on the chosen AD energy technology provider.

Appendix 5: Feeder

Example of a MultiRotor Vario

The solid feeding system Vario has proven itself at many installations in Germany and at biogas plants in England. With the Vario you can directly charge your digester with chopped energy crops, cattle and poultry manure, agricultural residues and solid co-substrates like old bread. The modular system offers holding containers with capacities between 11 m³ and 74 m³. It also allows supplementary extension of the container. The units operate with particularly low power consumption and wear due to the Vario conveying technology. The conveying units are manufactured completely of stainless steel, each with a separate drive and equipped with hinged flaps to allow efficient conveying of the substrate. A loosening auger is mounted to the head wall to avoid bridging of substrate. The solids charging system offers great feedstock flexibility.

Advantages at a glance:
- Reliable, robust and proven technology
- Complete conveying system in the substrate zone made of stainless steel
- Future-proof investment — easily expandable and flexible due to modular system
- Low power consumption through adjusted motors and drivers
- Base element made of stainless steel, optional all modules in stainless steel
- Upgrade to more fibrous material
- Maintenance-friendly; single conveying strings can be switched off for maintenance
- Consistent discharge, therefore good filling level of charging auger

→ Full specifications available upon demand

Appendix 6: Dryer

Background

- An initial analysis of dryer options identified a use for a 250kW containerised belt-dryer, capable of processing 270kg/h of digestate
- The team visited two comparable digestate drying facilities for means of review at AD sites processing similar feedstock's to *SITE X*
- Interviews with operations managers and AD owners were added to an internal comparison of suitable equipment

Current

- A Dorset Piccolo RM9 250KW dryer was chosen to be the most suitable machine given operational features associated with *SITE X*, performance data from other sites and feedstock suitability
- The Piccolo RM9 was deemed to provide the best fit for proposed mass balance data by utilising the most appropriate use of heat generated by the CHP
- A variable speed belt allows for multiple digestate outputs including optional pelletizing equipment to be added to the process at a later stage if required
- Based on the information received from *AD Tech Provider #1* on the screw press and the Dorset Piccolo RM9, the dryer would remove 1,340.6 tpa of excess moisture utilising 1,879,435Kwth and claimable RHI (Please revert to the schedule on page 5 of this business plan for a schematic overview of the mass balance)
- It indicates that of the 1,472 tpa of wet fibre enters the dryer, 131.4 tpa leaves as dry fibre of which 85% is dry matter(111.7) with 15% wet (19.7tpa)
- Operation and maintenance arrangements with Dorset were also deemed appropriate for the longevity of the machine

The image below shows the proposed Dorset Piccolo RM9 250KW dryer

Technical Details

- Input: 1.545 t/a, 8% TS
- Output: approx. 145 t/a, 85% TS
- Expected operating hours: approx. 8.000 h/a
- Drying performance: 0,6 – 0,8 kg water per kWh subject to local conditions
- Heat requirement: approx. 250 kWth
- Maximum air flow dryer (hot): approx. 17.000 m³/h, 78°C
- Water input temperature: 90°C
- Design dryer capacity based on 20°C ambient temperature

Appendix 7: PPA Power Purchase Agreement

Background

- An initial scoping of five energy brokers, each with varying PPA arrangements was conducted in June 2014.
- A budget price per MW was provided by two of the largest PPA providers in the industry prior to planning consent.
- Provision for the most suitable PPA has identified a number of smaller brokers specialising in the relatively small scale of development associated with *SITE X* 250kW AD.

Current Status

- Negotiations for the future arrangement of a PPA are under way now planning and grid are secured (See the scoping table below).

Company	Price Per MW Winter 2015	Comments
Ineco	Estimate Winter 2015 is currently at £54.90/MWH	Embedded Benefits which vary due to location but can be worth up to £10 MWh
Opus Energy	Estimate Winter 2015 is currently £50 and £55/MWh	Inclusive of the Levy Exemption Certificates (LECs)
Centrica	Budget estimate requested	Budget estimate requested
Neas Energy Ltd.	Budget estimate requested	Budget estimate requested
Endco	Budget estimate requested	Budget estimate requested

- Opus Energy and Ineco Energy have identified an expected market value for Q3 2015.
- Under a PPA, both Opus and Ineco quoted that a market rate of £50-55MWH would be achievable using a fixed PPA scheme. Both brokers quoted the same price at this stage of development and at the current scale.
- It was also identified by Ineco, that a further £10MWH could be achievable under Embedded Benefits associated with the locale of the development.
- Specific consideration and scoping of PPA brokers whom deal with smaller <500KWh are in progress to ensure a competitive pricing arrangement.

Map showing the location of *SITE X*, removed to preserve confidentiality

Map showing the location of *SITE X*, removed to preserve confidentiality

Appendix 8: Current Business Overview

Year ending		Est current performance	05/04/2014	05/04/2013
Reported EBITDA		78,751	76,457	13,787
Additional sustainable contribution		35,000	0	0
Owner withdrawals		0	0	0
Underlying EBITDA		113,751	76,457	13,787
Depreciation		-43,950	-43,450	-8,536
EBIT		69,801	33,007	5,251
Interest		-38,696	-29,190	-15,972
PBT (ex disposals)		31,105	3,817	-10,721
Fixed assets		822,134	861,084	745,056
Current assets		19,602	19,031	7,200
Adjusted current liabilities		-2,188	-2,124	-14,252
Net operational assets		839,548	877,991	738,004
Long term loans		326,157	314,238	325,000
other debt (ST)		178,752	278,752	209,226
Total debt		504,909	592,990	534,226
Total equity		334,639	285,001	203,778
Total financing		839,548	877,991	738,004
Average debt		548,950	563,608	
Average equity		309,820	244,390	
Gearing (d/(d+e))		60%	68%	72%
Total return on assets		8.3%	3.8%	0.7%
Return on debt (avg)		7.0%	5.2%	
Return on equity (avg)		10.0%	1.6%	
PBT		31,105	3,817	
Normalised tax charge	20%	-6,221	-763	
Capex renewals		-5,000	-5,000	
Add back depreciation		43,950	43,450	
Underlying cash generation		**63,834**	**41,504**	

Appendix 9: Base Case Financial Statements

Output Project: *SITE X* AD 250 kW Project Statement of Cashflow: Scenario 1

	year ending	Mar 31	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	in GBP	000's	1	2	3	4	5	6	7	8	9	10
revenues total			73.1	499.2	540.0	553.5	567.3	581.5	596.0	610.9	626.2	641.9
capex total			(1,804.5)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
opex total			(87.0)	(272.7)	(268.8)	(275.5)	(282.4)	(289.5)	(296.7)	(304.1)	(311.7)	(319.5)
working capital (incr)/decr total			(0.7)	(34.7)	(5.4)	(1.0)	(1.0)	(1.1)	(1.1)	(1.1)	(1.2)	(1.2)
tax			0.0	0.0	0.0	0.0	0.0	0.0	(1.4)	(48.7)	(53.2)	(57.4)
CASHFLOW before FINANCING			**(1,819.1)**	**191.7**	**265.8**	**276.9**	**283.9**	**291.0**	**296.8**	**257.0**	**260.1**	**263.8**
equity injections			1,116.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
loan drawdowns			744.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overdraft drawdowns			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASHFLOW bef. DEBT SERVICE			**40.9**	**191.7**	**265.8**	**276.9**	**283.9**	**291.0**	**296.8**	**257.0**	**260.1**	**263.8**
loan repayments			0.0	(94.0)	(104.4)	(115.8)	(128.6)	(142.7)	(158.4)	0.0	0.0	0.0
overdraft repayments			0.0	0.0	0.0	(0.0)	(0.0)	(0.0)	(0.0)	0.0	0.0	0.0
capitalised interest			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
interest paid total			(40.9)	(81.8)	(71.5)	(60.0)	(47.3)	(33.1)	(17.4)	0.0	0.0	0.0
interest received total			0.0	0.1	0.6	1.6	2.6	3.8	5.0	7.5	11.2	15.0
CASHFLOW before DIVIDENDS			**(0.0)**	**15.9**	**90.5**	**102.7**	**110.6**	**118.9**	**126.0**	**264.4**	**271.3**	**278.8**
dividends			0.0	(15.9)	(90.5)	(102.7)	(110.6)	(118.9)	(126.0)	(264.4)	(271.3)	(278.8)
CHANGE IN CASH			**(0.0)**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Output Project: *SITE X* AD 250 kW Project Statement of Earnings: Scenario 1

	year ending	Mar 31	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	in GBP	000's	1	2	3	4	5	6	7	8	9	10
revenue			73.1	499.2	540.0	553.5	567.3	581.5	596.0	610.9	626.2	641.9
fees			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
cost of sales			(22.6)	(154.4)	(158.3)	(162.3)	(166.3)	(170.5)	(174.7)	(179.1)	(183.6)	(188.2)
Gross Margin			50.5	344.7	381.7	391.2	401.0	411.0	421.3	431.8	442.6	453.7
			69.1%	*69.1%*	*70.7%*	*70.7%*	*70.7%*	*70.7%*	*70.7%*	*70.7%*	*70.7%*	*70.7%*
Operating expenses			(64.4)	(118.3)	(110.5)	(113.3)	(116.1)	(119.0)	(122.0)	(125.0)	(128.1)	(131.3)
EBITDA			**(13.9)**	**226.4**	**271.2**	**278.0**	**284.9**	**292.0**	**299.3**	**306.8**	**314.5**	**322.3**
depreciation			(89.0)	(89.0)	(89.0)	(89.0)	(89.0)	(89.0)	(89.0)	(89.0)	(89.0)	(89.0)
PBIT			**(103.0)**	**137.4**	**182.1**	**188.9**	**195.9**	**203.0**	**210.3**	**217.8**	**225.5**	**233.3**
			-140.9%	*27.5%*	*33.7%*	*34.1%*	*34.5%*	*34.9%*	*35.3%*	*35.6%*	*36.0%*	*36.3%*
interest income			0.0	0.1	0.6	1.6	2.6	3.8	5.0	7.5	11.2	15.0
interest paid total			(40.9)	(81.8)	(71.5)	(60.0)	(47.3)	(33.1)	(17.4)	0.0	0.0	0.0
Profit Before Tax			**(143.9)**	**55.6**	**111.3**	**130.5**	**151.2**	**173.7**	**197.9**	**225.3**	**236.6**	**248.4**
tax expense			28.8	(11.1)	(22.3)	(26.1)	(30.2)	(34.7)	(39.6)	(45.1)	(47.3)	(49.7)
PROFIT FOR THE YEAR			**(115.1)**	**44.5**	**89.0**	**104.4**	**121.0**	**138.9**	**158.3**	**180.2**	**189.3**	**198.7**
Other Comprehensive Income			**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
TOTAL COMPREHENSIVE INCOME FOR THE YEAR			**(115.1)**	**44.5**	**89.0**	**104.4**	**121.0**	**138.9**	**158.3**	**180.2**	**189.3**	**198.7**
dividends	constrained		0.0	(15.9)	(90.5)	(102.7)	(110.6)	(118.9)	(126.0)	(264.4)	(271.3)	(278.8)
RETAINED EARNINGS			**(115.1)**	**28.6**	**(1.5)**	**1.7**	**10.4**	**20.0**	**32.3**	**(84.2)**	**(82.0)**	**(80.1)**

Output Project: *SITE X* AD 250 kW Project Statement of Financial Position: Scenario 1

year ending in GBP	Mar 31 000's	2016 1	2017 2	2018 3	2019 4	2020 5	2021 6	2022 7	2023 8	2024 9	2025 10
cash		(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
work in progress		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
trade debtors		9.0	61.5	66.6	68.2	69.9	71.7	73.5	75.3	77.2	79.1
other debtors		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
stocks		2.4	7.5	7.4	7.5	7.7	7.9	8.1	8.3	8.5	8.8
tax asset		105.5	117.5	111.5	96.0	71.8	39.2	0.0	0.0	0.0	0.0
current assets		**116.9**	**186.5**	**185.4**	**171.8**	**149.4**	**118.8**	**81.6**	**83.7**	**85.7**	**87.9**
tangible and intangible assets		1,804.5	1,804.5	1,804.5	1,804.5	1,804.5	1,804.5	1,804.5	1,804.5	1,804.5	1,804.5
accumulated depreciation		(89.0)	(178.1)	(267.1)	(356.1)	(445.2)	(534.2)	(623.2)	(712.3)	(801.3)	(890.3)
non-current assets		**1,715.4**	**1,626.4**	**1,537.4**	**1,448.3**	**1,359.3**	**1,270.3**	**1,181.2**	**1,092.2**	**1,003.2**	**914.1**
Total Assets		**1,832.4**	**1,812.9**	**1,722.8**	**1,620.1**	**1,508.7**	**1,389.1**	**1,262.9**	**1,175.9**	**1,088.9**	**1,002.0**
trade creditors		10.7	33.6	33.1	34.0	34.8	35.7	36.6	37.5	38.4	39.4
other creditors		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overdraft		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
current liabilities		**10.7**	**33.6**	**33.1**	**34.0**	**34.8**	**35.7**	**36.6**	**37.5**	**38.4**	**39.4**
provisions		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
deferred tax		76.8	99.8	116.1	126.7	132.7	134.9	133.8	130.2	124.3	116.6
debt		744.0	650.0	545.6	429.8	301.2	158.4	0.0	0.0	0.0	0.0
non-current liabilities		**820.8**	**749.8**	**661.7**	**556.5**	**433.9**	**293.3**	**133.8**	**130.2**	**124.3**	**116.6**
Total Liabilities		**831.5**	**783.4**	**694.8**	**590.4**	**468.7**	**329.0**	**170.4**	**167.7**	**162.7**	**156.0**
NET ASSETS		**1,000.9**	**1,029.5**	**1,028.0**	**1,029.7**	**1,040.0**	**1,060.1**	**1,092.4**	**1,008.2**	**926.2**	**846.0**
equity		1,116.0	1,116.0	1,116.0	1,116.0	1,116.0	1,116.0	1,116.0	1,116.0	1,116.0	1,116.0
legal reserves		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
retained earnings		(115.1)	(86.5)	(88.0)	(86.3)	(75.9)	(55.9)	(23.6)	(107.8)	(189.8)	(270.0)
TOTAL SHAREHOLDERS' FUNDS		**1,000.9**	**1,029.5**	**1,028.0**	**1,029.7**	**1,040.0**	**1,060.1**	**1,092.4**	**1,008.2**	**926.2**	**846.0**

Appendix 10: Sensitivity Analysis

Project Level *SITE X* AD 250 kW GEP millions

Project / Company Valuation	Total Project Funding	Project Payback Period in yrs	Project % return on investment	return on investment with EIS	Average PBT Project Life	Average Operating Margin	Project Earn.Dilution in years	Average EBITDA Project Life
Base Case								
0.25	1.89	7.8	12.1%	17.4%	0.2	26%	1	0.31
Construction costs change by -5%								
0.33	1.77	7.5	12.9%	18.3%	0.2	27%	1	0.31
RHI allowable volumes reduced by 15%								
0.12	1.92	8.3	11.0%	16.1%	0.2	24%	1	0.29
Opex costs change by 5%								
0.15	1.91	8.1	11.3%	16.5%	0.2	24%	1	0.30
Opex costs change by -5%								
0.34	1.86	7.5	12.9%	18.3%	0.2	29%	1	0.33
Private Wire, DECC electricity forecast (RPI+3% pa, compound to yr 5)								
0.31	1.93	7.7	12.5%	17.9%	0.2	28%	1	0.33
Digestate income (2/t) after year 3								
0.37	1.86	7.5	13.1%	18.5%	0.2	29%	1	0.33
Inflation changes by -1% (costs) & -1% (revenue)								
0.15	1.86	8.0	11.3%	16.7%	0.2	25%	1	0.28

Appendix 11: Environmental Benefits

11.1. GHG Savings

The associated GHG savings have been calculated using data collected and DEFRA supported conversion factors. The GHG savings have been calculated by quantifying the environmental savings in kWh generated and miles transport reduced.

An estimated electricity generation of 2,000,000 kWh supports the equivelant of 425 homes per annum using DECCs average UK household consumption of 4,700kWh/year.

The next two tables identify the total energy production and impact of transport emissions resulting from the *SITE X* development, respectively.

Total Energy Production			**Convertible**	**CF Emission Factor**						
Electricity output	2,028,553	*kWh*		0.44548	*kgCO2e*	903680	*kgCO2e*	903.68	*TCO2e*	UK Electricity generated
Heat output	2,211,100	*kWth*								
Current Onsite Diesel Generators	50,000	*kWh*	12000 litre p.a	2.9343		146715		146.7		Fuels / Gas Oil / Volume (l) / kgCO2
Energy Usage										
Electricity										
On farm	50,000	*kWh*								
AD Plant will consume (9%)	18,900	*kWh*								
Private Wire to neighbouring farm	300,000	*kWh*		0.44548		133644		133.6		
Dryer (21kWh x 1100)	23,100	*kWh*								
Electricity consumed	392,000	*kWh*								
Grid exported	1,636,553	*kWh*		0.44548		701631				
Heat										
AD Plant (15%)	331,665	*kWth*								
Dryer	1,879,435	*kWth*								

Feedstock																		
Material	Volume tpa	Source	Curent disposal route	Current Milage per journey	Journeys p.a.	Total Mileage	Emission Factor	kg CO2e	t CO2e	Proposed Use	Proposed Mileage	Journeys p.a.	Total Mileage	Emission Factor	kg CO2e	t CO2e	Carbon Difference	
Farm Yard Muck	2000	On farm	Off site Spreading	5.5	166	913	1.820222	1661.8627	1.66	Feedstock	0	60	0	1.820222	0	0	1.66	
Waste Water	1550	On farm	Off site Spreading	6	60	360	1.820222	655.27992	0.66									
Poultry Manure	1260	Neighbour	Off site Power Statio	70	60	4200	1.820222	7644.9324	7.64	Feedstock	0.5	8.6	4.3	1.820222	7.83	0.01	7.64	
Cattle Slurry	4000	Neighbour	On farm Spreading	0	0	0				Feedstock	7	4	28	1.820222	50.97	0.05	-0.05	
Brewers Grain	800	Nearby farm	Feed	40	40	1600	1.820222	2912.3552	2.912	Feedstock	40	40	1600	1.820222	2912.355	2.912355	0.00	
Outputs																		
Fertilizer	5426																	
Current Fuel																		
Wood chip (75t/ 6wks)	650	Neighbour Farm		20	40	800	1.820222	1456.1776	1.46	Fuel for Ne Biomass boiler	20	40	800	1.820222	1456.178	1.46	-1.46	
																	7.79	t CO2e
				Assumed Freight Capacity					**Source: DEFRA/DECC UK Government Conversion factors for Company Reporting expires 31/5/2015**									
				Brewers grains 20 Tonnes per load max														
				Biomass Delivery 16 tonner per load max														
									Freighting goods / HGV (all diesel) / Rigids >17 tonnes / 100% Laden / Miles									

The table below provides a simple estimated net saving analysis of the GHG impacts at *SITE X* and qualitatively supports the two tables above.

Factor	Impact of Development	Summary	Net Savings tCO_2e
Renewable Energy	GHG Saving Non-renewable energy substitution	*SITE X* currently consumes 50,000 kWh per annum which equates to 12,000 litres of Gas Oil. The carbon emissions associated with consuming this volume of Gas Oil will be saved.	146 tCO_2e per annum
	GHG Reduction from future Energy Generation	The development would produce around 2,200,000 kWh which displaces grid electricity.	927 tCO_2e
	GHG Savings from *Neighbour 1*'s Farm	*Neighbour 1* consumes around 300,000 kWh per annum supplied by the grid. The development can displace import electricty.	133 tCO_2e
Transport	GHG Reduction in Transport of FYM	Onsite produced Farm Yard Muck is currently taken offsite 10 miles away. This will now be used in the AD Plant leading to avoided HGV transport of 800 miles per annum	1.46 tCO_2e per annum
	GHG savings of Transported Waste	Poultry manure from *Neighbour 1's* farm is currently transported 70 miles from the site to a power station.	7.64 tCO_2e per annum

11.2. Improved farm Waste Management

Direct

The use of the FYM as a feedstock directly reduces the risk of point source pollution and associated run off at *SITE X*. Currently the FYM is stored on adjacent land on concrete foundations at the farm and is susceptible to loss of nutrients and calorific value from precipitation and air source weathering (See Plate below). The development would remove this risk by recycling the FYM and converting it into a usable source of liquid and dry digestate for secondary use. Recycling the FYM at source also reduces the risk of spillage and contamination in the transport of the material. The existing FYM Storage at *SITE X* is pictured below.

Picture of *SITE X*

Indirect

At present there is a risk to loss of nutrients and spillage due to overcapacity at *Neighbour 2* farm. Development at *SITE X* would provide extra capacity to a dated storage system and improve slurry management at the farm by regulating the flow of accumulated slurry. The *SITE X* storage capacity 211.5 days will allow associated farmers greater flexibility given the short spreading period.

There are also considerable efficency savings associated with the development. By centralising the use of multiple farm yard waste streams and generating electricity; the need for additional storage facilities in the area is reduced. The waste streams also provide a local alternative to synthetic fertilizer and generate new revenue streams in the supply chain.

11.3. Fertiliser Replacement

Currently there is extensive use of synthetic fertilizer in the surrounding landbank of *SITE X*. From discussions with associated agricultural stakeholders, there is demand for a substitute source of nutrients. A soil analysis is required to estimate the amount of digestate that can be utilised on the land surrounding *SITE X* and further research is required to calculate the amount of fertiliser used at the moment as some of the surrounding farmers are not forthcoming with the level of costs they incur at the moment. It remains difficult to predict the amount of fertiliser that can be replaced but it was estimated that the NPK values alone, on an average digestate would amount to £6.5 per tonne and if other trace elements and a like are included, this would amount to £7.9 per tonnes (estimates received from detailed calculations undertaken at *Farm 1*).

Existing fertiliser application at the farms of *Neighbour 2* and *Neighbour 4* uses a plate based systems which is known for its ease with which to spread large volumes of fertiliser but is seen by DECC and WRAP as an inefficient means of N use.

Fertiliser replacement as a result of the development will also be accompanied by considering the use of shallow injection system and/or bandspreading equipment. This allows for a greater degree of accuracy and increases the number of spreading days, whilst reducing ammonia nitrate loses, compared to plate based systems. It is estimated using DECC and Bioresource guidance that the cost of this system would be £100per hour and capable of transferring 80 tonnes per hour.

Further research into the acceptability of digestate use by the identified farms is underway. An information pack detailing the nutritional value of digestate as an alternative to fertiliser is currently in progress. The use of similar success as identified by WRAP and DEFRA will be used to engage with the farming stakeholders and encouraging wider uptake.

Substitution and fertiliser replacement at *SITE X* has numerous socio-economic and environmental benefits and provides further evidence of contemporary farming change as well as dispel common concerns related to renewable energy in the sector.

11.4. Reduction in Energy Crop Substitution

With extensive debate regarding the environmental impacts of AD technology, the *SITE X* development acts as a model of success by utilising around 20% of its feedstock from its own waste stream. There is a significant reduction in the need for land intensive energy crops such as *miscanthus* and *Pennisetum purpureum* as utilised by similar on-farm developments and ensures that the land bank required to sustain the operation is kept to a minimum. This is also critically important with new EU policy starting in 2015. The land bank required to sustain the operation is kept to a minimum.

Appendix 12: Social Benefits

12.1. Creating Stakeholder Cohesion

Development at *SITE X* will require extensive cohesion amongst the stakeholders involved. As identified in similar on-farm AD developments, there is potential to bring a host of benefits to the local community and through network based operations. This has proven to help small scale farms to remain competitive and provide a long term future for the businesses involved in the AD process. A visual representation of these expected relationships can be seen below.

Graph removed to preserve confidentiality

The *SITE X* development also has the potential to generate secondary knowledge networks associated with AD technology and local feedstocks as well as wider associated commercial opportunities.

12.2. Transport Savings to the Community

At present there are over 200 energy and waste related journeys made on and off *SITE X*. Recycling FYM and the substitution of imported diesel removes this traffic loading on the local road infrastructure and reduces the risk of community related opposition.

The use of feedstock from farming stakeholders within a 10 mile radius limits the number of journeys traditionally associated with similar developments. The sourcing of local feedstock allows for the reduction in transport miles by the fact the plant will be closer than the current disposal location. Due to the feedstock locale, the use of agricutural machinery as opposed to HGV vehicles, can be implemented.

12.3. Educational Asset

The Client welcomes the idea of the AD development being used in demonstration based activities, which opens up possibilities for the community and local education authorities to engage with renewable energy and waste-to-energy technology.

The *SITE X* development will also provide an educational platform for local farmers interested in the technology and farm diversification. A working demonstration locale at *SITE X* will improve the awareness of digestate as a fertilizer replacement, with pelletizing options further aiding the closed loop credentials of a sustainable business practice. A working example of the growing renewable energy technologies and associated employment opportunities can inspire future generations considering the sector in the *SITE X* area.

12.4. Additional Employment and Skills

A host of additional employment and skill based benefits will be generated as a result of the *SITE X* development. These are summarised below.

<table>
<tr><th>Impact</th><th>Theme</th><th>Summary</th><th>Time Frame</th></tr>
<tr><td rowspan="4">Direct</td><td rowspan="3">Local Employment</td><td>The Client has opted to use local contractors for the construction of associated civil based workings at SITE X. This will require an estimated 3.5 employees.</td><td>1-2 Months</td></tr>
<tr><td>The development will generate a full time apprentice position as a result of the additional work load for AD and farm operations</td><td>Full Time</td></tr>
<tr><td>A part time position is also anticipated for the operation and maintenance of the pelletizing plant.</td><td>Part time</td></tr>
<tr><td>Up skilling</td><td>Substantial training by AD Tech Provider #2 will up skill the Client as full time AD operators. Part time farm employees will also been trained operators</td><td>On-going</td></tr>
<tr><td rowspan="2">Indirect</td><td>Educational</td><td>Inclusion with local schools and colleges has the potential to aid further understanding and engagement with energy from waste (EFW) and renewable energy.</td><td>On-going</td></tr>
<tr><td>Up skilling</td><td>Engagement with local farmers surrounding renewable energy, waste management and diversification has the potential to stimulate the AD sector and add value to the community knowledge.</td><td>On-going</td></tr>
</table>