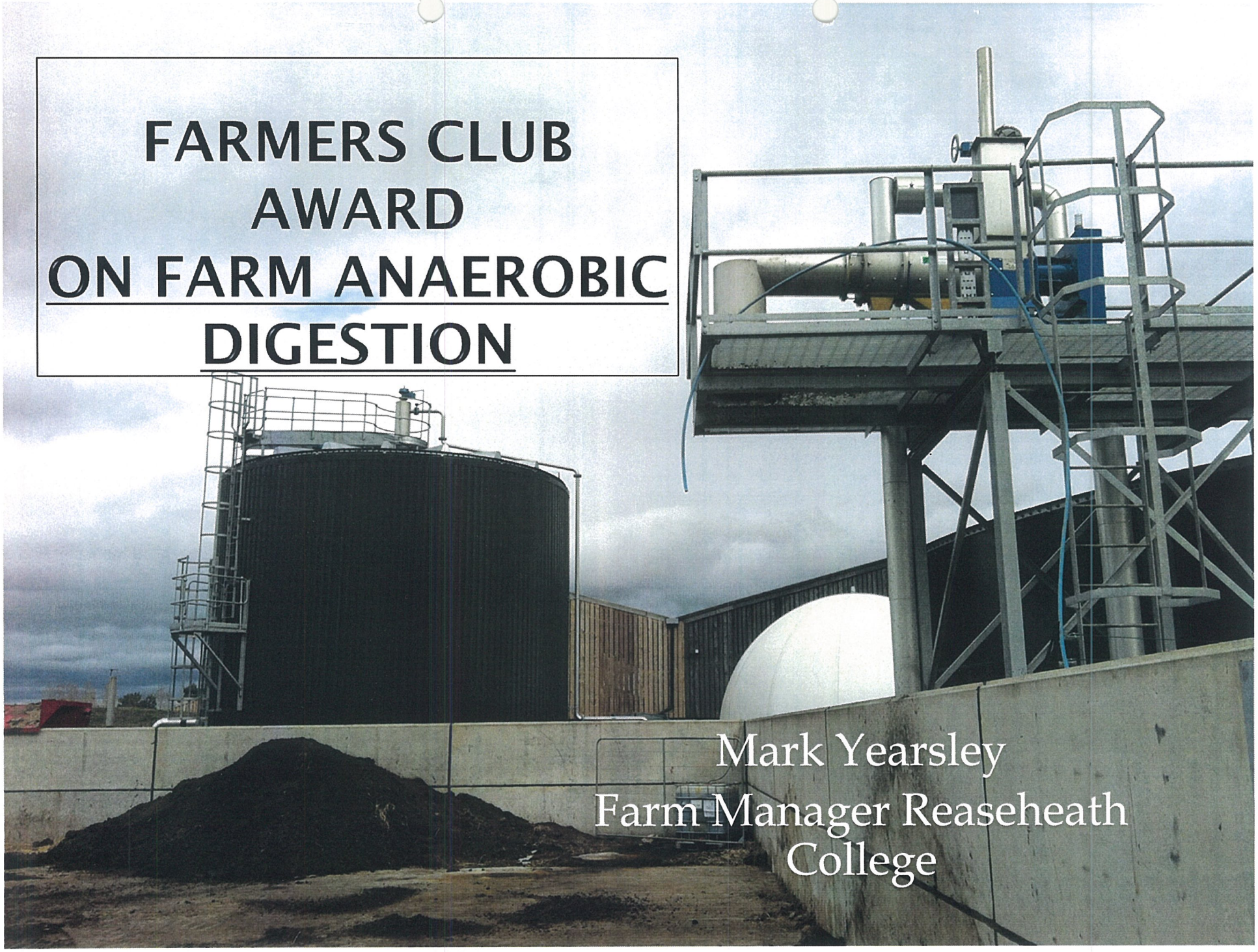
FARMERS CLUB AWARD ON FARM ANAEROBIC DIGESTION



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I was given the opportunity to explore further experiences and practices that farmers who have committed to installing Anaerobic Digesters (AD) on farm looking at how they have integrated the process in their business's and why they went down this road.

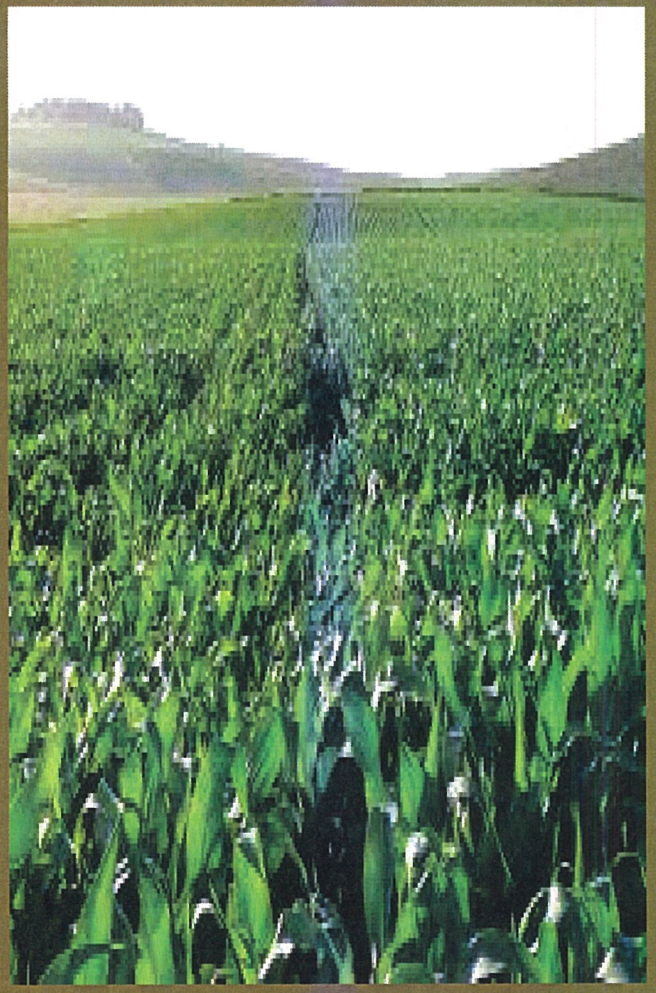
I travelled around 8 different farms in the UK and 8 in Wisconsin to compare the 2 .

- I also attended workshops run by Royal Agricultural Society (RASE) and The National Skills Academy (NSA) to improve my understanding on methane production and what makes a digester tick.
- Attended the Anaerobic Digestion & Biogas Association (ABDA) annual conference to listen to a number of key speakers sharing their experience and thoughts on which direction the industry is going in the UK.

Preview

The commitment in the UK was quite different to that in the States, although the primary reason in the UK is to produce renewable energy and maximise feed in tariffs (FITS). The States are focusing more on reducing their carbon footprint and utilising on farm waste streams to become self sufficient in localised energy production.

UK – 2 Approaches to on farm AD



Commercial

Large Scale investment to run as a independent cost centre – maximising gas production by utilising energy crops grown on farm or on contract by surrounding neighbours.

The disadvantages –

- competition with livestock farmers who rely on buying in forage cannot compete
- Land for growing food to feed the increasing world population is taken up to produce energy

Small Scale

Focusing on saving costs and utilising home produced waste streams i.e. Slurry!

Advantages are –

- Less impact on crop production
- Recycling
- Farmers become more focused on valuable low cost feed stocks

Disadvantage –

- Longer payback on investment
- Continual supply of feedstock throughout the year

UK Large Scale AD

A number of farms I visited in the UK were either already chicken/arable producers investing in AD or arable producers that were investing in chickens and AD. The combination of broiler muck and energy crops has a high calorific value that produces good quality methane levels in biogas. Feeding 20% broiler muck with maize and or fodder beet which also fits into the arable rotation. Running and Combined Heat and Power unit (CHP) selling power back to the grid and utilising the excess heat from the plant to heat the broiler houses is very sustainable. Running the digestate through a separator gives the farmer two valuable bio-fertilisers which can be utilised on the farm.

Top Left – Broiler Muck storage

Bottom Left – Semi plug Flow Digester under construction

Top Right – Diet mixer, quick mix and macerators

This producer was feeding his digesters a mixture of fodder beet, maize silage and grass silage, using hydrolysis to help break down the structure of the crops before feeding into his digesters. He was running a 1 Megawatt CHP into the grid and utilising all the excess heat in the farm house and buildings. He was installing a third digester to produce gas for the grid. His whole farm was geared up for AD and had ceased arable production

The same producer is installing a second digestate lagoon with a sealed top to capture any excess biogas that is produced after digestion

UK Small Scale AD

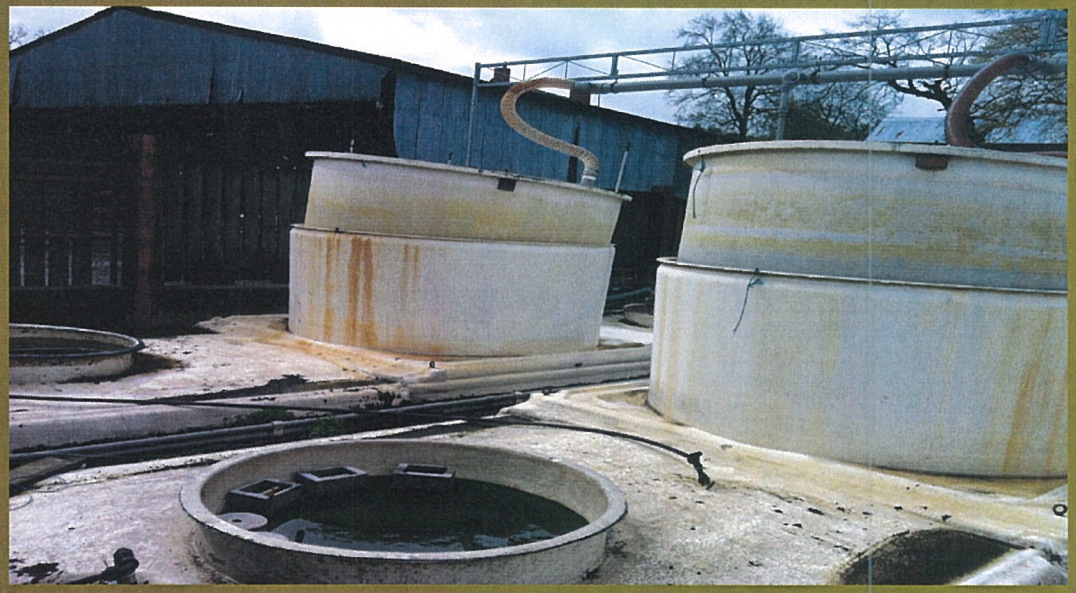
The whole concept of small scale AD on livestock farms has yet to be properly promoted, although the government are starting to look at incentives to encourage 250 kW or less installations by providing funds for feasibility studies and low cost loans. The digester on the right is an new low cost concept designed by Marches Biogas which is focused on slurry based enterprises called a Plug & Play, which is exactly what it is. It is constructed in the factory and delivered to the farm on the back of a lorry. It can be placed on a concrete pad or below ground level. The design concept is to provide a simple robust solution to small scale AD. The digester is a cylindrical glass reinforced plastic insulated tank with an internal heat exchanger and mixing is carried out by gas injection.

This digester has a volume of 100 m3 and would suit a 150 head dairy farm. Currently it is being fed 3 cubic meters of slurry over a 24 hour period and producing around 65 cubic meters of biogas. This gas could be used to run a small CHP unit or feed a gas boiler to heat water for parlour washing, under

floor heating in a pig or calf unit household heating to name a few. Some milk buyers are focusing more on the carbon footprints of their producers. One avenue is purchase these digesters and hire them to their producers. The beauty is they can be moved from farm to farm if a producer decides to move companies or ceases milk production

This installation has been in operation for 25 years, There are 2 small digesters on this farm which take slurry from the 140 dairy cows. During the summer 1 digester is used then the other become operational during the winter when cows are housed. The word "simple" comes to mind, there is a second hand boiler which heats both digesters up using biogas with the excess being piped to 2 farmhouses where it is used to heat and cook on a daily bases. It also supplies hot water to the parlour for washing. I did ask the farmer if he knew how much money he was saving and his reply was he had no idea. After 25 years of service I would say the investment has paid back 3 times over. The digestate is separated once the discharge pit is full to storage and applied to the land. No bought in fertiliser is used!

This producer is slightly larger scale running a semi plug flow digester with a cover over the discharge tank. He is a beef producer and is feeding yard muck plus some food waste through the digester, again the installation was over 20 years old very simple running a 125 kW CHP into the grid. Same principle separating and utilizing the digestates on farm without any brought in fertiliser costs.



USA Large Scale AD

In Wisconsin the dairy producers are focusing on the "Simple Approach" but at a very much larger scale. The incentive for them is they are given a Carbon Credit score for the farm and paid accordingly. There are no FITS payments therefore no incentive to sell the power back to the energy companies, the price per kW was the same either way so most producers were utilising the power on farm with either a back up generator or a grid connection.

Most producers I visited were running a minimum of 3000 head and were able to utilise all slurry produced.

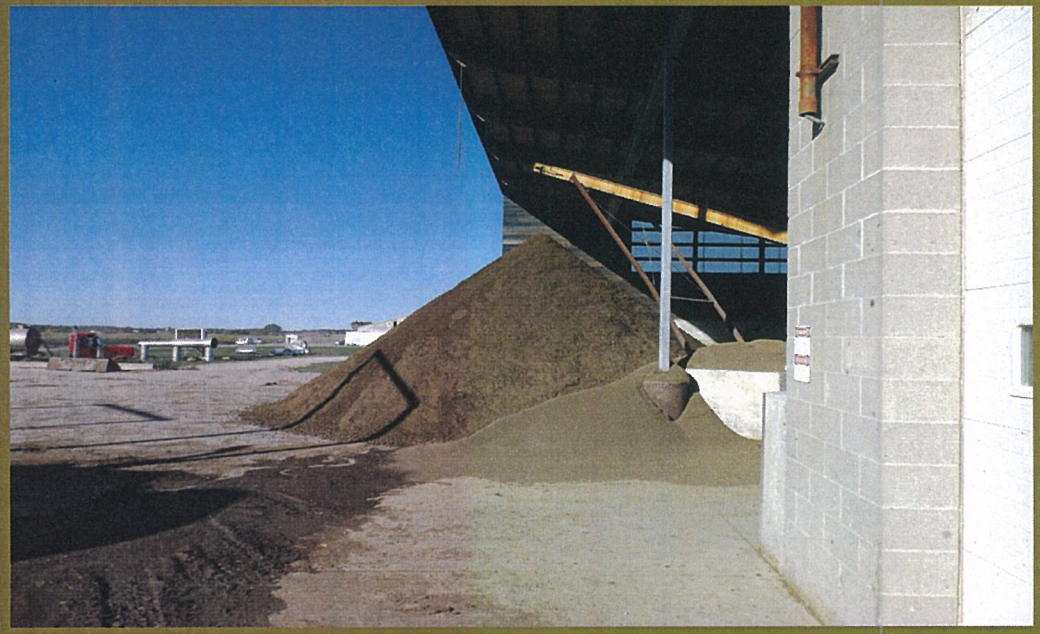
This is a typical digester, it is a Continuous Flow Reactor (CFR)

The design is a simple underground channel configuration constructed of concrete with an internal heat exchanger and because it continually flows no mixing is needed. The lid are concrete panels insulated with spray on foam. This one covered a hectare in area and was coping with 3500 cows worth of slurry which equates to 175000litres per day. It takes about 2 weeks to travel through the digester, retention times were not important, a happy medium was to extract 80% of the gas before discharge.

The bottom picture shows the discharge weir.

This farmer was actually selling to the grid as he was producing more power than he could handle

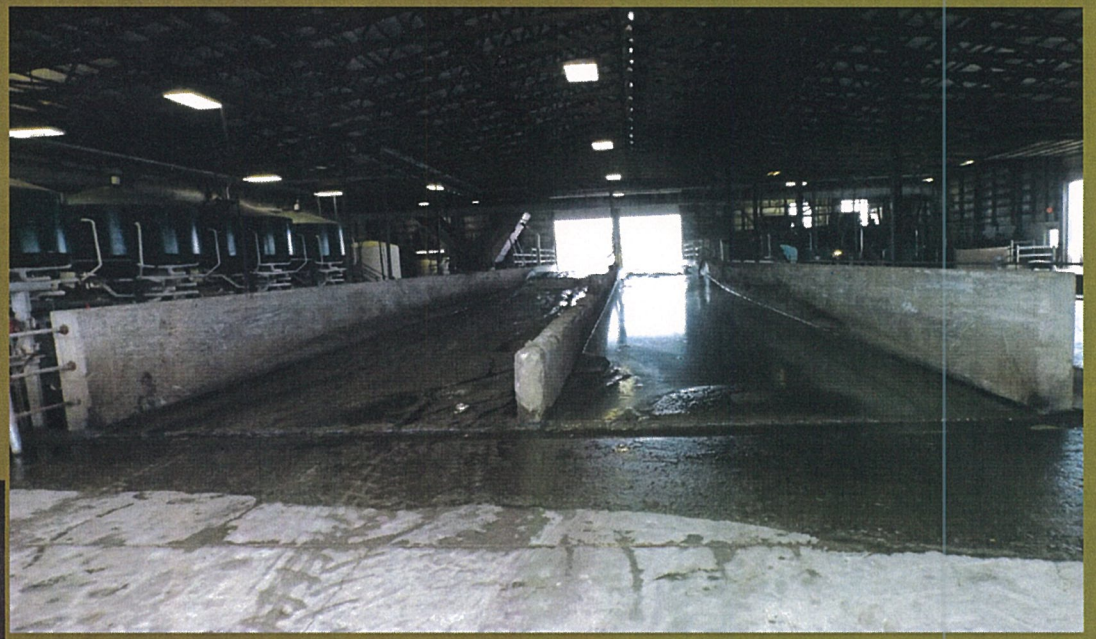
2 500 kW CHP units, digestate was separated then the fibre was put through a drier utilising excess heat from the CHP units and was reused as bedding for the cows

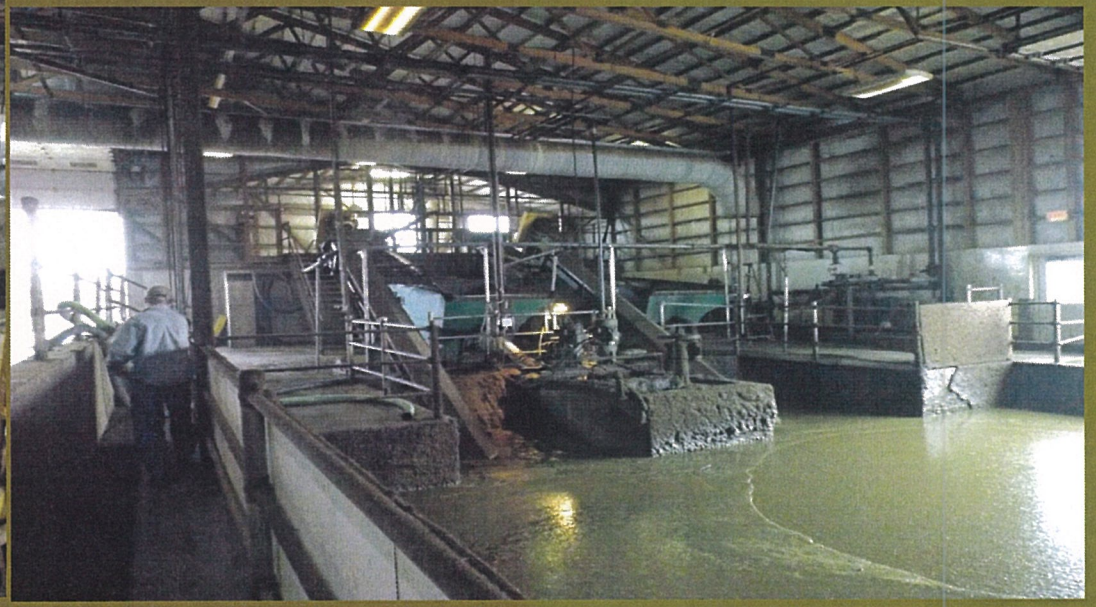


AD & Sand Bedding

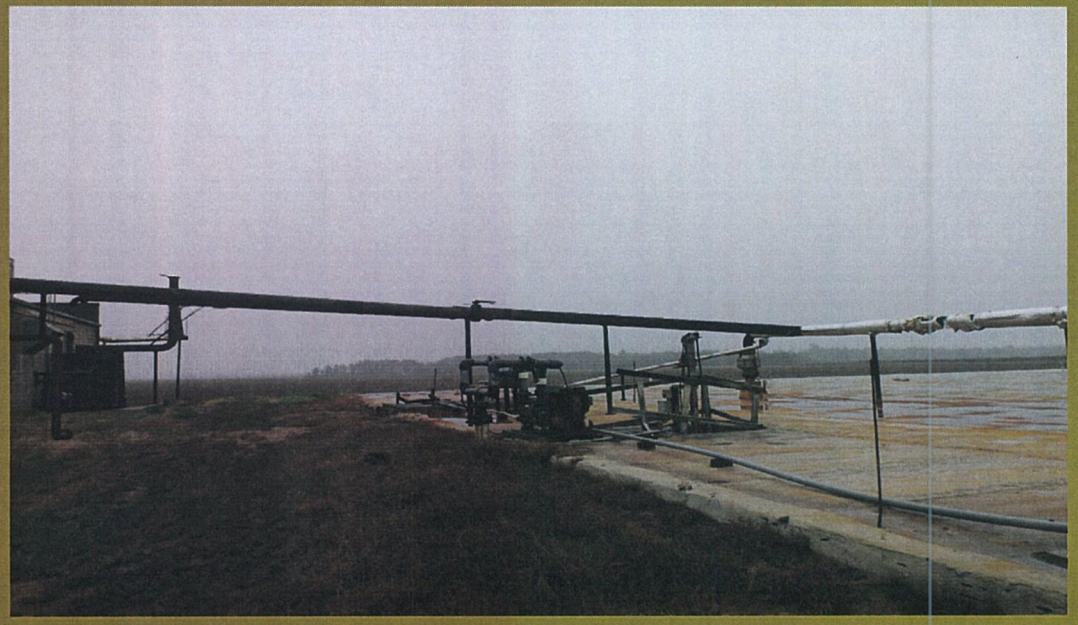
Ingenious method of scraping passages, this vacuum tanker had a V shaped rubber blade on the front and sucked the slurry up leaving the floor clean.

The slurry was emptied down into these channels that sloped to the centre sand would start settling . Down the centre It was then augured up to 2 Parabolic screens, some of the liquid separated as it travelled and ended up back in the tank.

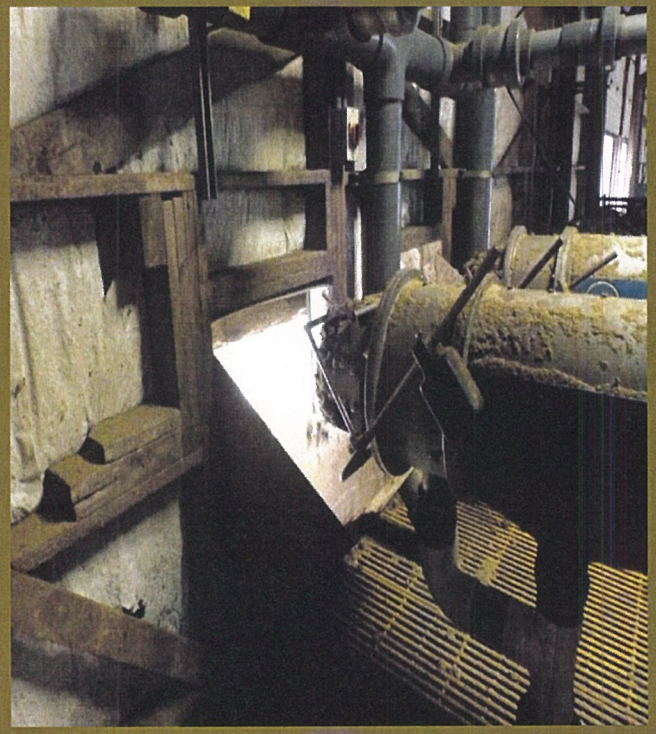


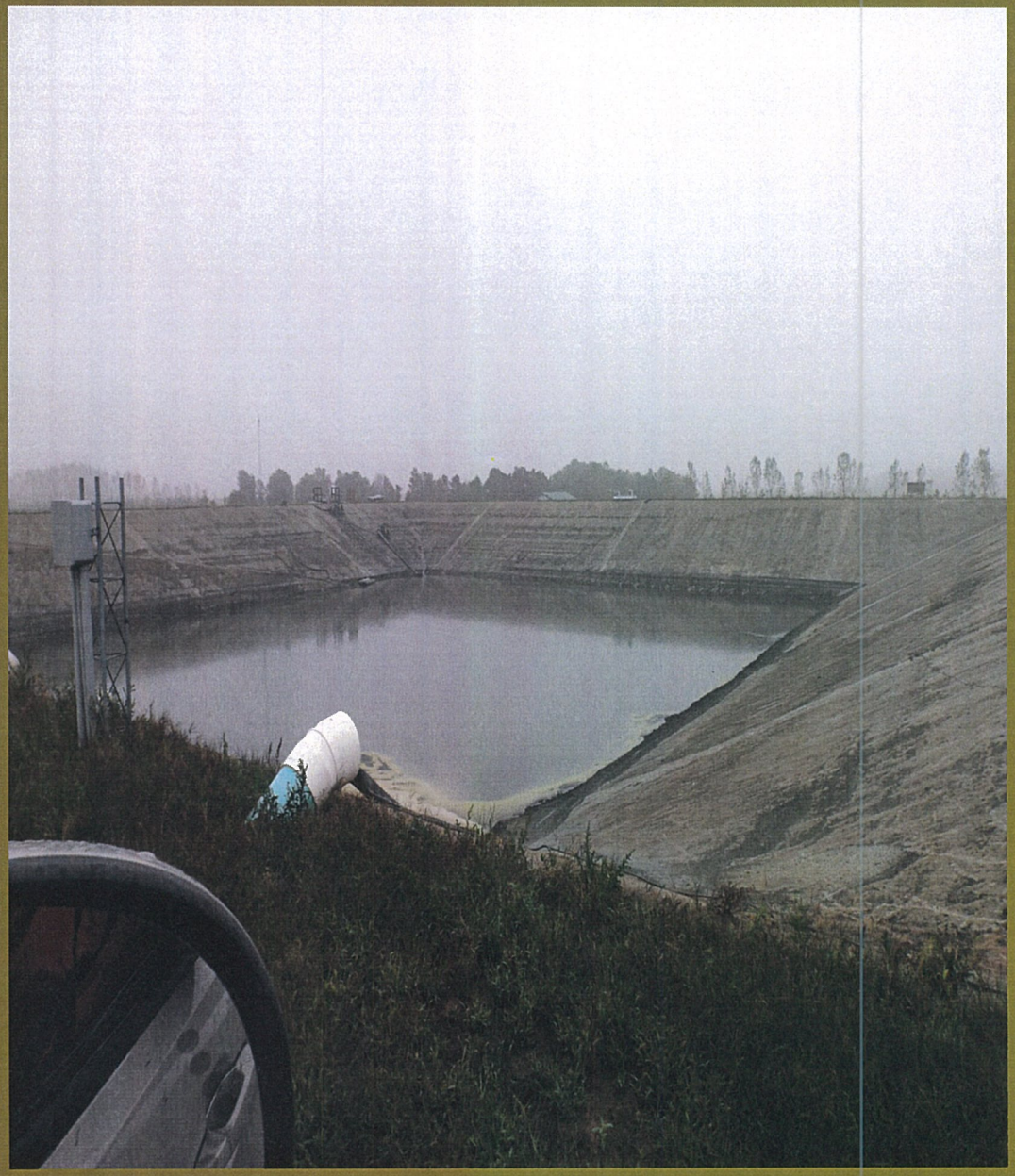


The sand was piled to re use the slurry had less than 2% sand fraction and was then pumped on to the digester with no problem of settlement. Digester Design CFR which was common on all farms I visited. The farm was utilising all the generated power on site, milking took 22 hours a day and servicing of the 500kW CHP was done in the 2 hours down time. A back up generator was onsite for emergencies.



Digestate is passed through 2 screw press separators, the solid fraction is exported to the local vegetable growers and the liquid is stored in this very impressive lagoon which covered 2 hectares. They were irrigating up to 8 miles away

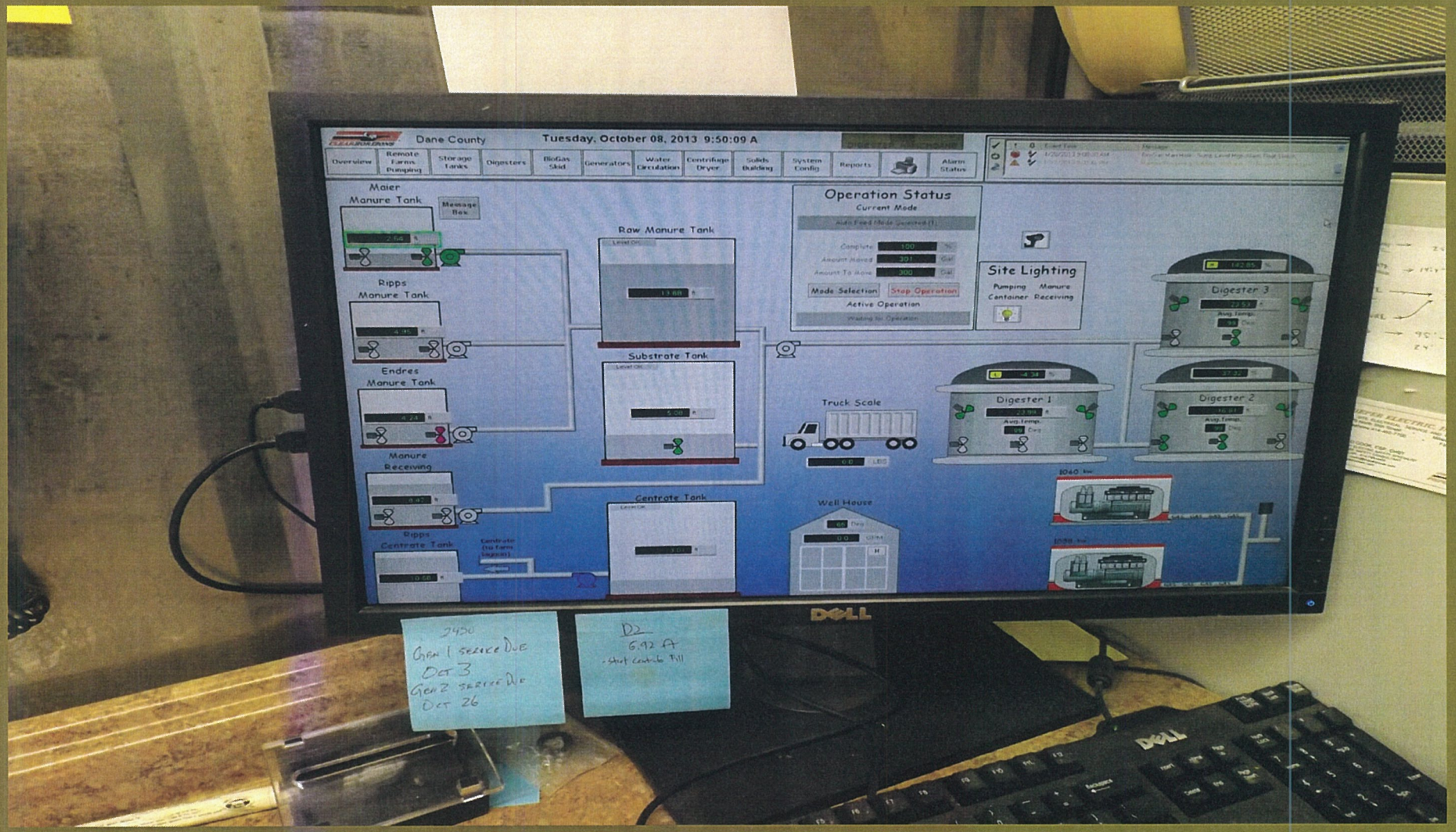




Municipal Approach

- This plant was situated between 3 dairy farm in Dane County Wisconsin (8000 cows). All slurry was pumped through underground mains to the buffer tanks.
- The site was running 2 x 1Megawatt CHP's feeding the grid.
- Also taking in pre processed food waste.
- No money changed hands, the site supplied dried bedding and valuable bio fertiliser back to the farms.

Typical Flow Diagram for monitoring AD site



Typical Records

Measurment per Week		1	2	3	4	5	6	7	8
Week commencing	Units	04/03/2013	11/03/2013	18/03/2013	25/03/2013	01/04/2013	08/04/2013	15/04/2013	22/04/2013
CSTR Slurry Feed rate	m3/day	13.86	12.57	20.14	17.00	17.29	19.71	16.43	5.17
CSTR Solid Feed Rate	m3/day	1.09	0.56	0.47	0.56	0.71	0.51	0.56	0.91
CSTR biogas flow	m3/hour	461.43	359.00	403.71	442.57	474.71	449.29	472.43	347.83
CSTR biogas / feed	m3/m3	30.88	27.34	19.58	25.21	26.37	22.21	27.81	57.24
P&P Slurry Feed rate	m3/day	2.00	2.14	2.14	2.00	1.85	3.28	2.00	2.00
P&P biogas flow	m3/hour	70.00	67.43	63.00	65.86	73.14	70.14	72.00	71.17
P&P biogas / feed	m3/m3	35.00	31.51	29.44	32.93	39.54	21.39	36.00	35.58
H2S	ppm	322.77	319.00	293.00	203.57	334.71	300.29	318.71	333.00
CH4	%	53.12	51.57	56.57	45.66	56.00	53.71	54.29	51.50
Total Eletrical Production	kWh/week	4387	5033	5558	3821	5626	5090	5103	2905
Total Parasidic	kWh/week	107	90	25	66	20	61	89	142
Net Electrical Production	kWh/week	4280	4943	5533	3755	5606	5029	5014	2763
Water heat energy produced CHP	Kw/hr	15.36	21.00	27	32.6	41.7	45.46	60.25	60.74
Excess Heat	Oc			44	59	55	49	60.0	50

Points of Interest

- Slurry is such a versatile feed for AD, it contains all the right bacteria to breakdown the feed to produce biogas of a reasonable quality.
- The key is to keep the DM as high as possible, so keep parlour washings out of the slurry system
- Cow rations don't have an impact on gas produced it is how efficiently the animals have utilised the ingredients bad animal utilisation is good for the digester!
- pH and volatile fatty acids (VFA's) should be monitored, this can be done by regular analysis of feed stocks. High VFA's will impact PH and cause Acidosis within the digester. This is less likely to happen feeding slurry as the main ingredient. PH wants to be in the region of 6.5 to 8.5
- Carbon to Nitrogen ratio ideally needs to be 25:1

Comparison

Slurry			Digestate
Fresh Weight per M3	Units	Result	Result
pH		8.02	8.32
Total Solids	%	59.5	77.6
Total N	%	2.6	3.6
Ammonium N	Kg/T	1.57	2.39
Total P	Kg/T	.48	.88
Total K	Kg/T	3.08	4.58
Total Sulphur	Kg/T	2.2	.75
Total Calcium	Kg/T	2.04	2.62

The table above shows a typical comparison between slurry & digestate derived from slurry

Although very similar on analysis in practice the nutrients are 15 to 20% more available in the separated digested. The benefits are –

- Quicker up take by the growing crop
- Reduction in Artificial Fertiliser
- Cost saving benefit
- Less hazardous Material
- Reduction in odour
- Less worm kill post application
- Healthier soils

Guidance should always be included in your Nutrient Management Plan

On Farm AD – The Way Forward

- Government Strategy needs to look more closely on how to incentivise farmers to look at AD, surely we should take a leaf out of Wisconsin's book? Simplify the way to attract farmers to look at renewables through a payment scheme based on reducing their carbon footprint rather than through feed in tariffs.
- Focus on cutting red tape on planning, councils and government bodies need to work in partnership to provide clear understanding to the general public and local environment groups.
- Look how Municipal AD can work for farmers and supply them with safe uniform waste streams for AD
- To much reliance on fossil fuels and the detriment they are having to the environment renewables are more cost effective.
- Excess Nitrogen and phosphates are having an impact on the environment, AD can help minimise the threat.

Conclusion

On Farm AD in the UK has great potential, I hope that the industry develops and all industry linked groups work together to provide a clear path to encourage farmers look at AD.

As a farm manager of an education establishment I am in an ideal position to encourage and promote AD to the next generation, it needs to be included in curriculum as I'm sure it will be integrated into farming business's of the future.

As AD grows it is important that we provide training to supply the industry with the technical support needed from planning, design, installation to competent individuals that can manage and maintain plants. Working with current experts we can achieve tailor made programmes to satisfy these points .

Aknowledgments

I would like to thank the following people for their time and support in making my travel award a success.

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