4th International Symposium on Anaerobic Digestion of Solid Waste Copenhagen 2005

Workshop on AD of Agricultural Residues

Seven Anaerobic Digesters on Cattle Farms in Scotland

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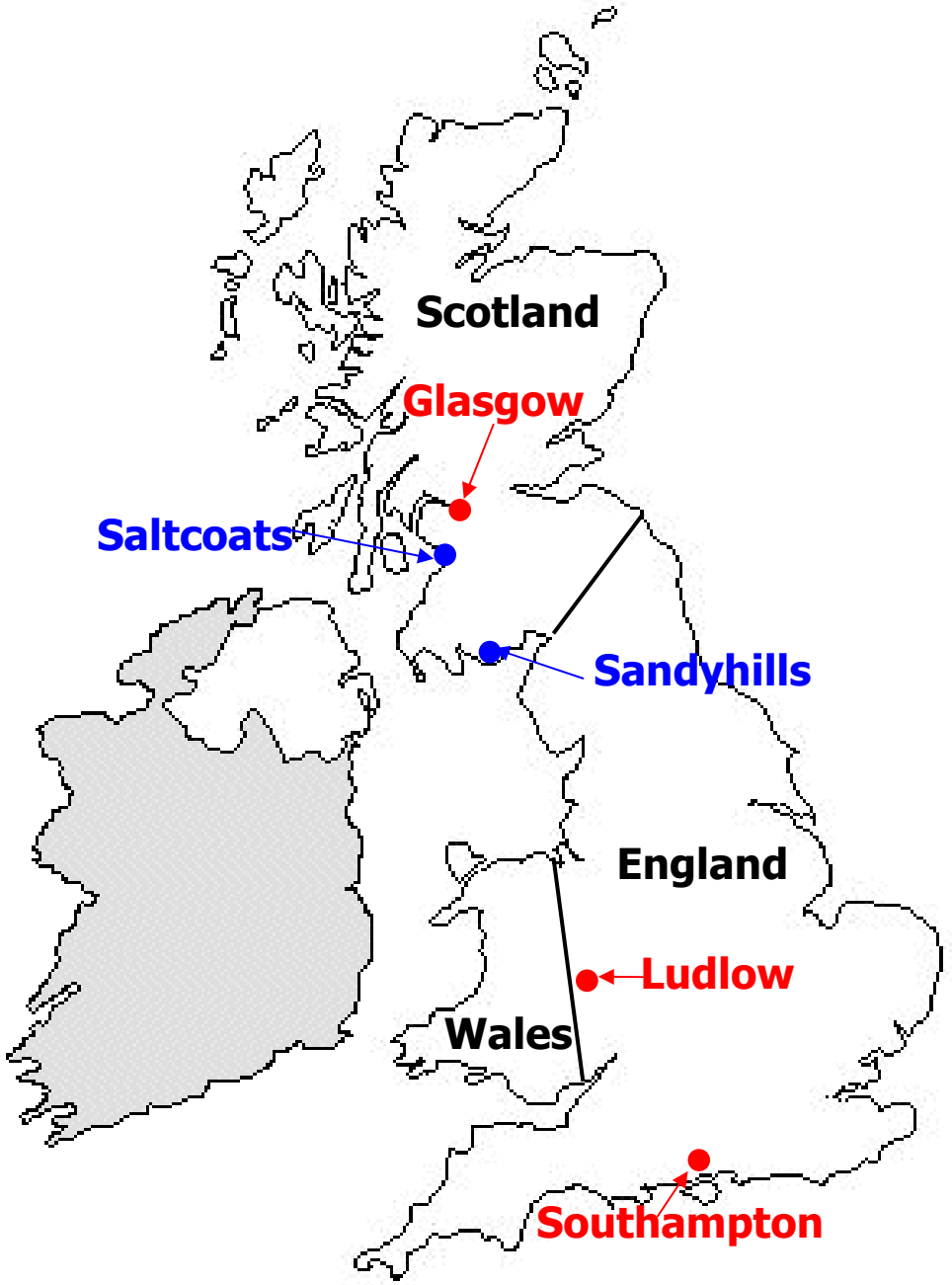
cropgen

Greenfinch

Scottish Executive Research Project into Diverse Pollution of Bathing Waters

- The Scottish Executive has identified bathing waters which are at risk of failing the EU standard due to the presence of high numbers of faecal indicator organisms (FIOs).
- In Southwest Scotland there is a particularly high risk of failure to meet the standard, possibly because of diffuse pollution from agriculture.
- The Scottish Executive commissioned a research project to investigate how full-scale on-farm biogas and composting plants might reduce the risk of diffuse pollution from agriculture.


Scotland
Glasgow
Saltcoats
Sandyhills
England
Ludlow
Wales
Southampton

Reasons for High Risk

- Large numbers of dairy cattle;
- Frequent high rainfall in summer;
- Impermeable soils;
- Short river catchments which transfer polluted water quickly to the coast;
- Marine conditions which inhibit dilution and dispersion.

Typical British Dairy Farm

- 100 to 300 dairy cows plus beef followers;
- Cows housed indoors for only six months in the year;
- Cows kept in cubicles with sawdust bedding;
- Slurry scraped to underground tanks;
- High dilution of slurry with dairy washwater.

Sandyhills Beach

Sandyhills Landscape

Saltcoats Beach

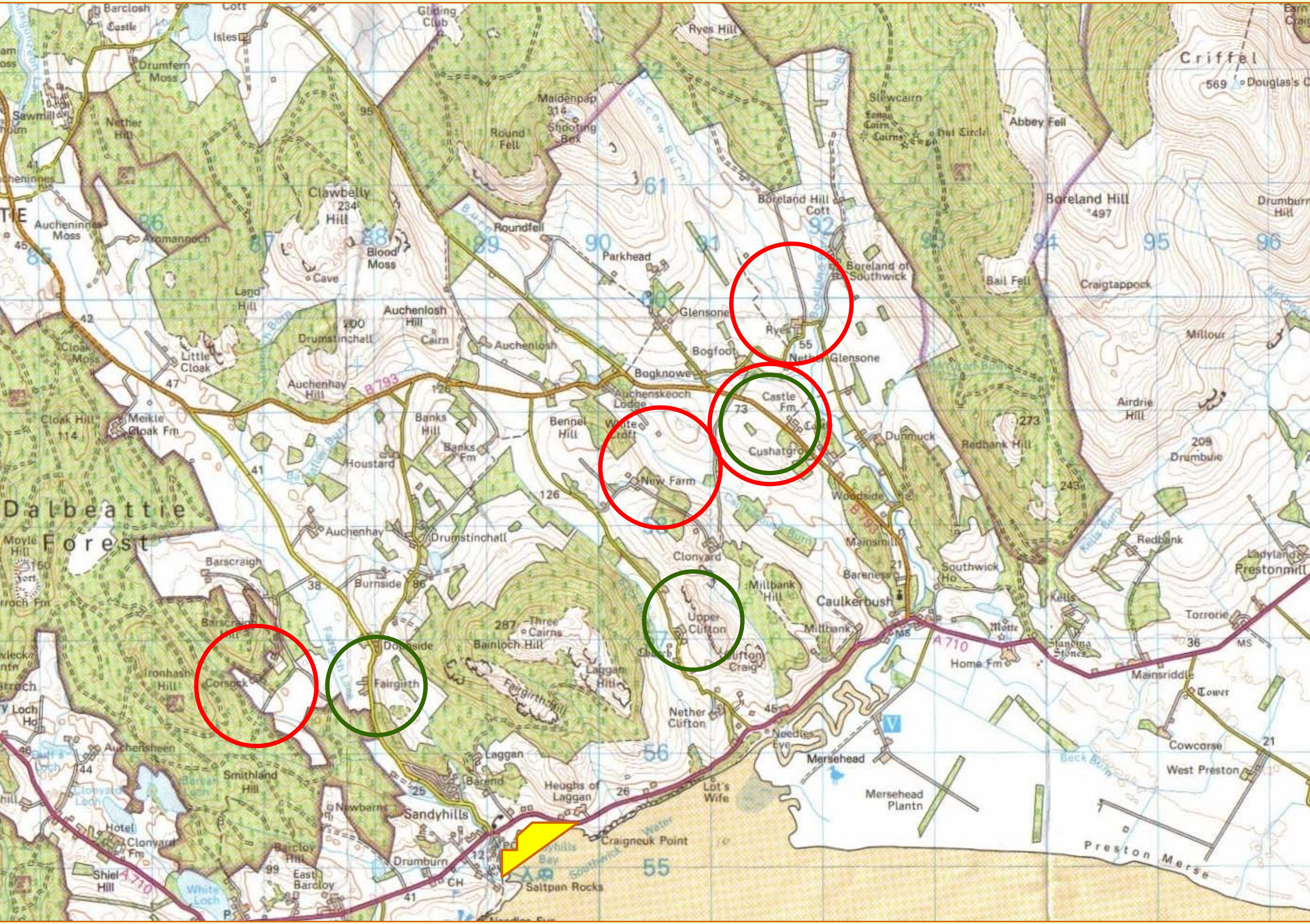
Saltcoats Landscape

Research Programme

- The Scottish Executive invited competitive tenders, and in December 2003 awarded a contract to a consortium comprising Greenfinch and Enviros Consulting to investigate full-scale on-farm biogas and composting technologies.
- In addition to the installation of full-scale plants the project included setting up the methodology to establish the risks to bathing waters of existing agricultural practices and to design the methodology for post-installation monitoring and risk assessment.

First Stages of the Project

- Visited 12 farms, which were identified by the Scottish Executive as high risk in the two catchments (Sandyhills & Saltcoats).
- Discussed on several visits with the farmers the potential installation of a biogas or composting plant.
- Formal agreement was reached with 9 farmers for the installation of a total of 7 biogas plants and 3 composting plants.
- The license agreement with the farmer is for 5 years, after which he may purchase the plant.


Barclosh
Castle
Cott
Isles
Gliding Club
Ryes Hill
Criffel
569
Douglas's
Drumfern Moss
Sawmill
Nether Hill
Maidenpap
314
Shooting Box
Round Fell
Slewcairn
Long Cairn
Cairns
Hut Circle
Abbey Fell
Clawbelly
234
Hill
61
Boreland Hill Cott
Boreland Hill
497
Drumburn Hill
Auchenninnes Moss
Arnmannoch
Roundfell
Blood Moss
Cave
Parkhead
Boreland of Southwick
Bail Fell
Craigtappock
85
86
87
88
89
90
91
92
93
94
95
96
Land Hill
Auchenlosh Hill
Cairn
Glensone
Ryes
Nether Glensone
Millour
Cloak Moss
Little Cloak
200
Drumstinchall
Auchenlosh
Bogfoot
55
Auchenhay Hill
B793
Bogknowe
Auchenskeoch Lodge
Castle Fm
73
Cushatgrove
Airdrie Hill
Cloak Hill
114
Meikle Cloak Fm
Banks Hill
Banks Fm
Bennel Hill
White Croft
Dunmuck
Redbank Hill
273
209
Drumbuie
243
Houstard
New Farm
126
Woodside
Dalbeattie
Forest
Moyle Hill
Auchenhay
Drumstinchall
Clonyard
Mainsmill
Redbank
Ladyland
Prestonmill
Barscraig
Burnside
Millbank Hill
Bareness
Caulkerbush
Southwick Ho
Kells
Torrorie
Three Cairns
287
Bainloch Hill
Upper Clifton
Millbank
Clifton Craig
A 710
Motte
Standing Stones
36
Home Fm
Mainsriddle
Corsock
Fairgirth
Laggan Hill
Fairgirth Hill
Nether Clifton
Tower
46
Needle's Eye
Mersehead
Cowcorse
Auchensheen
Smithland Hill
Laggan
56
Beck Burn
West Preston
Barend
Heughs of Laggan
26
Lot's Wife
Mersehead Plantn
Newbarns
25
Sandyhills
Hotel
Clonyard Fm
Barcloy Hill
Craigneuk Point
Drumburn
55
Preston Merse
Shiel Hill
White Loch
East Barcloy
CH
Saltpan Rocks
41
99


Knockewart
Munnoch Resr
Caddell
Yonderhouses
Meikle Ittington
Cubrieshaw Hall
Yonderton
Tarbert Hill 138
Haupland Muir
Fort 231 & Cairn
Busbie Muir
Resr
Coalhill
Girthill
Meadowfoot
Meadowhead
Hauplands
Kirkland Glen
Rowanside Hills
Darleith
Muirlaught Fm
Chapelton
PH
Glenhead
Homestead
Glenfoot Ho (Hotel)
High Boydstone
Rashley
Boydston Fm
Rowanside Burn
Meikle Busbie
Craigspark
Mount 141
Meikle Laught
Little Laught
Lochwood
Sorbie
Knockrivoch
Diddup
Scart Rock
Mill Fm
Montfode
Chapelhill
Castle
Whitlees
Corsankell
Sharphill
Middlepart
Greenhead
Yellow Craigs
North Bay
Horse Isle (Nature Reserve)
Broad Rock
Horse Isle Shelves
ARDROSSAN
Castle Craigs
South Bay
SALTCOATS
Outer Nebbock
Inner Nebbock
Kerelaw
Mayfield
Auchenharvie
Ardeer
Mains
B7047
B780
A78(T)
A738
B752
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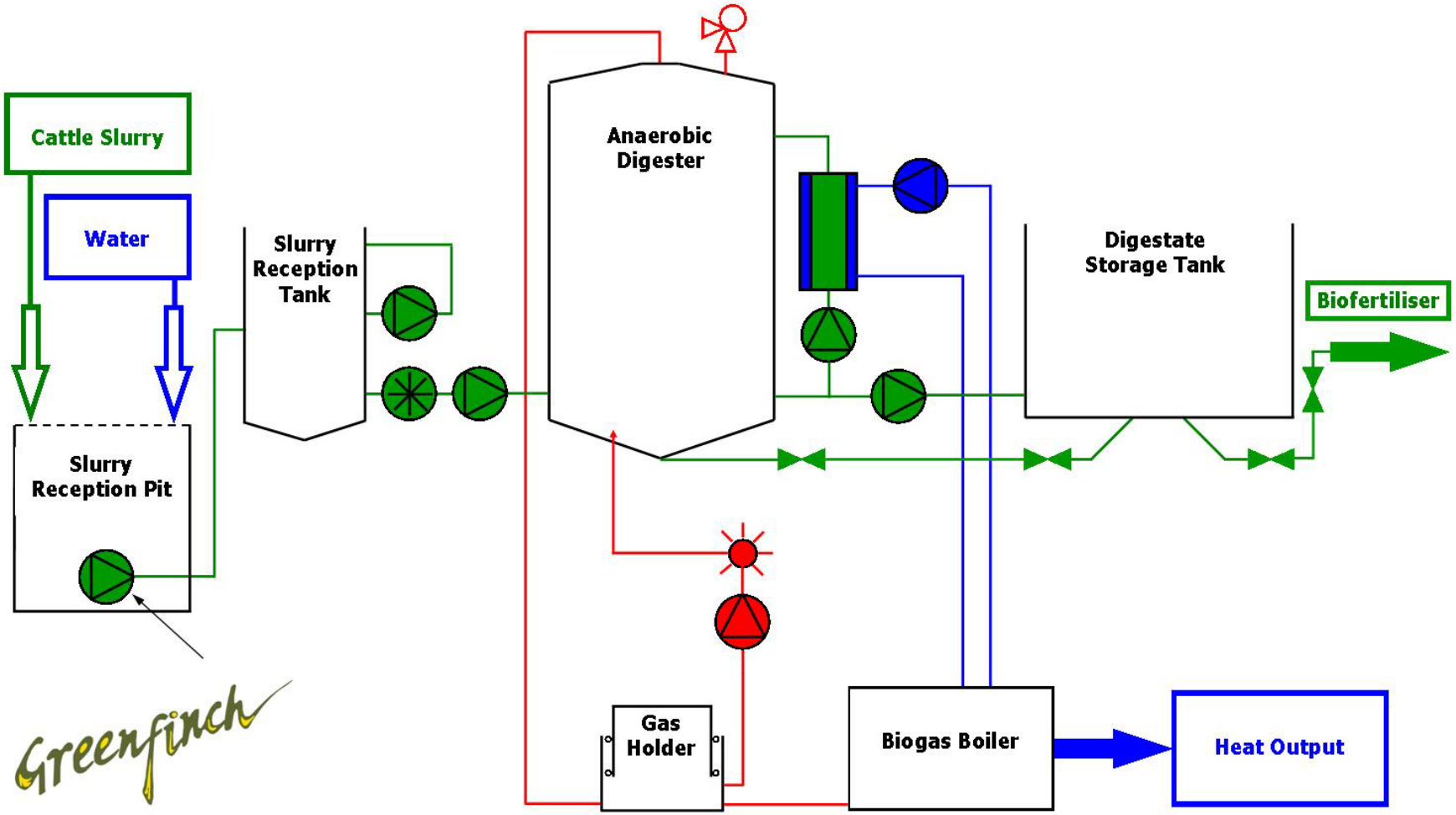
Design of 7 Biogas Plants

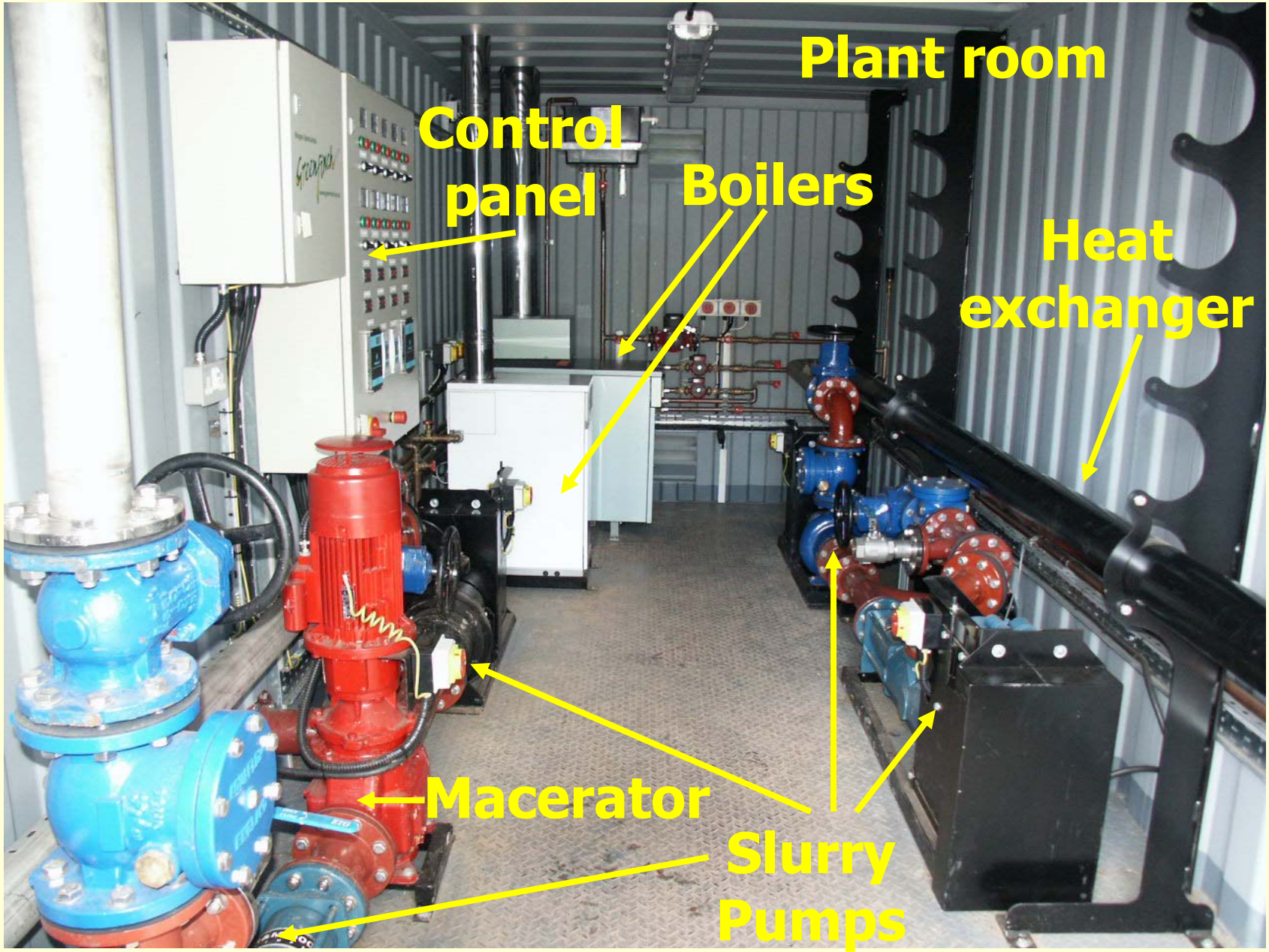
Each digester is a continuous-stirred tank reactor (CSTR), able to be operated at either mesophilic or thermophilic temperatures

Sandyhills 1	**150 Beef Cattle**	**80 m^3 Digester**
Sandyhills 2	**130 Dairy Cows**	**250 m^3 Digester**
Sandyhills 3	**180 Dairy Cows**	**320 m^3 Digester**
Sandyhills 4	**250 Dairy Cows**	**480 m^3 Digester**
Saltcoats 1	**120 Dairy Cows**	**190 m^3 Digester**
Saltcoats 2	**250 Dairy cows**	**480 m^3 Digester**
Saltcoats 3	**250 Dairy Cows**	**480 m^3 Digester**

Process Diagram for Anaerobic Digestion Plant




Reception Tank
Anaerobic Digester
Plant Room
Digestate Storage
80 m³ Biogas Plant


Plant room
Control panel
Boilers
Heat exchanger
Macerator
Slurry Pumps

Three Biogas Plants in Sandyhills

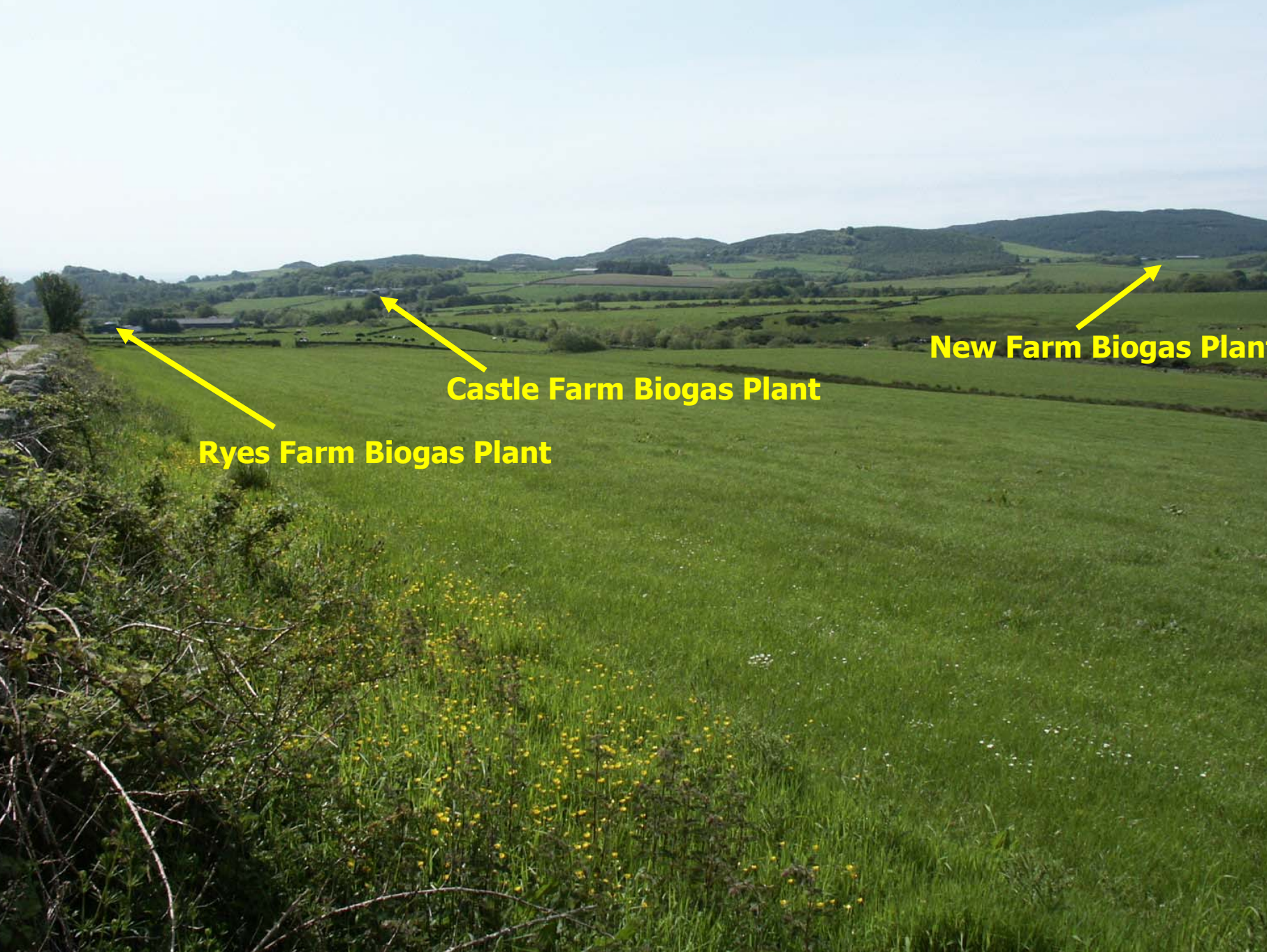
Three Biogas Plants in Saltcoats

Current Status of Project

- The biogas plants have been operational for one year;
- The plants have maintained a positive energy balance during the summer months;
- Farmers are starting to install energy utilisation equipment;
- The reduction of pathogens is in excess of $\log_{10}2$;
- The digestate has a significantly improved fertiliser value;
- The final report is to be presented to the Scottish Executive in September.

Economic Aspects

- Using cattle slurry only the biogas plants are operating at only 25% utilisation :-
- Cattle slurry has a low methane yield – 0.15 to 0.20 $m^3CH_4.kg^{-1}ODM$;
- And cattle are housed for only 6 months.
- Utilisation, and therefore economic viability, can be improved by:
- Co-digestion with energy crops;
- By utilising the heat output from the engine;
- By recovering fibre from the digestate;
- And by housing the cattle for 12 months (zero grazing).


Ryes Farm Biogas Plant
Castle Farm Biogas Plant
New Farm Biogas Plant

Acknowledgements to:

- Scottish Executive
- Scottish Environment Protection Agency
- Enviros Consulting.

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