Country Report Ireland

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Biogas Plant Inventory

- Summary of AD Plants:

- 4 Agriculture facilities
- 15 Industrial, Sewage sludge, Municipal (biowaste)
- 7 Landfill Gas projects in Ireland

Landfill Gas

Dunsink Landfill, Dublin	5 MWe
Friarstown, Tallaght, Co. Dublin	1 MWe
Ballyogan, Leopardstown, Co.Dublin	2 MWe
Balleally, Lusk, Co.Dublin	5 MWe
Tramore Valley, Cork	2 MWe
Arthurstown, Kill, Co Kildare	4.2 MWe
Kilkullen, Co Kildare	1.2 MWe
Total	18.4 MWe

Maximum electrical potential 30 – 40 MWe

Commercial feasibility requires site of 50 – 100,000 t

From: Aine Car: “Landfill Gas resource 2010/2020 potential and scenario development” Sustainable Energy Authority Ireland (SEAI)

Farm slurries in Ireland

	Cattle[a]			Pig[a]			Sheep[a]			Poultry[b]			Total		
	2007	2010	2020	2007	2010	2020	2007	2010	2020	2007	2010	2020	2007	2010	2020
Number of heads (M)	6.00	5.89	5.5	1.62	1.6	1.49	3.83	3.45	3.28	12.95	12	12	24.40	22.94	22.27
Slurry quantity (Mt/a)	30.51	29.95	27.97	2.35	2.32	2.16	0.19	0.17	0.16	1.84	1.70	1.70	34.89	34.14	31.99
Biogas[c] (Mm_n^3/a)	671.22	658.90	615.27	51.70	51.02	47.52	10.34	9.15	8.70	81.88	75.81	75.81	815.14	794.88	747.30
CH_4 production[c] (Mm_n^3/a)	369.17	362.39	338.40	28.44	28.06	26.13	5.68	5.03	4.78	45.03	41.70	41.70	448.32	437.19	411.01
Total[d] energy (PJ/a)	13.95	13.69	12.78	1.07	1.06	0.99	0.21	0.19	0.18	1.70	1.58	1.58	16.94	16.52	15.53
Practical energy (PJ/a)	0.14	0.27	0.64	0.01	0.02	0.05	0.002	0.004	0.01	0.00	0.79	1.18	0.15	1.09	1.88

Slaughter waste in Ireland

	Cattle			Pig			Sheep			Poultry			Total		
	2007	2010	2020	2007	2010	2020	2007	2010	2020	2007	2010	2020	2007	2010	2020
Number of heads[a] (M)	1.78	1.67	1.59	2.62	2.60	2.47	3.26	2.74	2.85	12.95	12.00	12.00	20.61	19.01	18.91
Slaughter waste (Mt)	0.37	0.35	0.33	0.07	0.07	0.07	0.02	0.02	0.02	0.007	0.006	0.006	0.47	0.44	0.42
Biogas potential (Mm_n^3)	57.76	54.19	51.59	11.04	10.95	10.40	3.51	2.95	3.07	0.74	0.69	0.69	73.04	68.77	65.75
Methane potential (Mm_n^3)	31.77	29.80	28.38	6.07	6.02	5.72	1.93	1.62	1.69	0.41	0.38	0.38	40.17	37.83	36.16
Total energy potential (PJ)	1.20	1.13	1.07	0.23	0.23	0.22	0.07	0.06	0.06	0.02	0.01	0.01	1.52	1.43	1.37
Practical energy potential (PJ)	0.00	0.00	0.54	0.00	0.00	0.11	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.68

Farm Biogas Plants

- Three existing farm scale digesters in Ireland all in the South East:
  - Camphill (Mark Dwane)
  - Adamstown (Patrick Berridge)
  - Methanogen (Vicky Heslop)
  - Limerick (David McDonnell)

- These facilities are continuously stirred tank reactors (CSTR) digesting predominately slurry with some food industry.

David McDonnell’s Farm, Limerick

12,000 t/a feedstock
- 5,000 t/a cattle slurry
- 2,000 t/a poultry slurry
- 5,000 t/a off farm (Glycerol, dairy waste)

Off farm screened to 12mm, pasteurised at 70^{o}C

2 Digesters 1000 m^3 each; HRT 35 days

460,000 m^3/a biogas; 110 kWe;
8% parasitic electrical demand
Heat from CHP fully employed in heating digesters & pasteurisation

Supports for AD

- OFMSW
  - Landfill levy €20/t in Nov 2009 raising to €75/t in 2012
- Biogas to CHP
  - Was 7.2c/kW_eh in 2007;   Raised to 12c/kW_eh in 2008

As of May 2010 tariffs are indexed and offered on a 15-year basis and include:

- AD CHP equal to or less than 500 kW: 15 c/kW_eh;
- AD CHP greater than 500 kW: 13 c/kW_eh
- AD (non CHP) equal to or less than 500 kW: 11 c/kW_eh;
- AD (non CHP) greater than 500 kW: 10 c/kW_eh

REFITT and ROCS

New REFITT yielding 15c/kWeh for facilities less than 500 kWe. A number of planning permissions have been awarded; a number are under construction. In particular Michlestown Creamery is constructing a significantly sized digester. Many preliminary reports and proposals exist.

Northern Ireland receives 4 ROC's (ca. 25c/kWeh) for facilities sized under 500 kWe. As a result there is significant interest and levels of activity. There are of the order of 50 planning permissions/applications in place. Many of these proposals include for grass silage, dairy slurry and beets.

There is some transportation of crops across the border. The industry in the Republic of Ireland is unlikely to be successful if economic return is significantly better across the border.

Gas grid injection and transport fuel maybe the route for biogas in the Ireland. Cork bus have an NGV bus and is considering a larger scale investment.

Previous research by UCC on two phase digestion of grass silage

Contents lists available at SciVerse ScienceDirect
Bioresource Technology
journal homepage: www.elsevier.com/locate/biortech
ELSEVIER

Use of modeling to aid design of a two-phase grass digestion system

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Contents lists available at SciVerse ScienceDirect
Applied Energy
journal homepage: www.elsevier.com/locate/apenergy
ELSEVIER

Why does mono-digestion of grass silage fail in long term operation?

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Optimizing the Operation of a Two-Phase Anaerobic Digestion System Digesting Grass Silage

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ABSTRACT: This paper examines the optimization of an existing two-phase anaerobic digestion process using grass silage as a feedstock. The system comprises 6 leach beds connected to an upflow anaerobic sludge blanket (UASB). The existing system produced 305 L CH_4 kg^{-1} VS added at an overall retention time of 42 days (6 leach beds emptied and fed sequentially every 7 days in series). The desired improvements were a reduction in retention time with increased methane production. It was noted in the existing system that biogas production and COD levels fell off in the last 2 days of each 7-day cycle. Thus the first change involved reduction in retention time to 30 days (6 leach beds fed sequentially every 5 days in series). This lead to a slight improvement in methane production (310 L CH_4 kg^{-1} VS added). The second change was effected by separation of flows to the first stage (leach beds) and the second stage (UASB) through addition of an extra pump to optimize leaching. This led to an increase in CH_4 production (341 L CH_4 kg^{-1} VS). The overall improvement from the existing system was an increase of 11.8% in methane production and a reduction in size or retention time of 40% (42 days decreased to 30 days retention time).

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How much gas can we get from grass?

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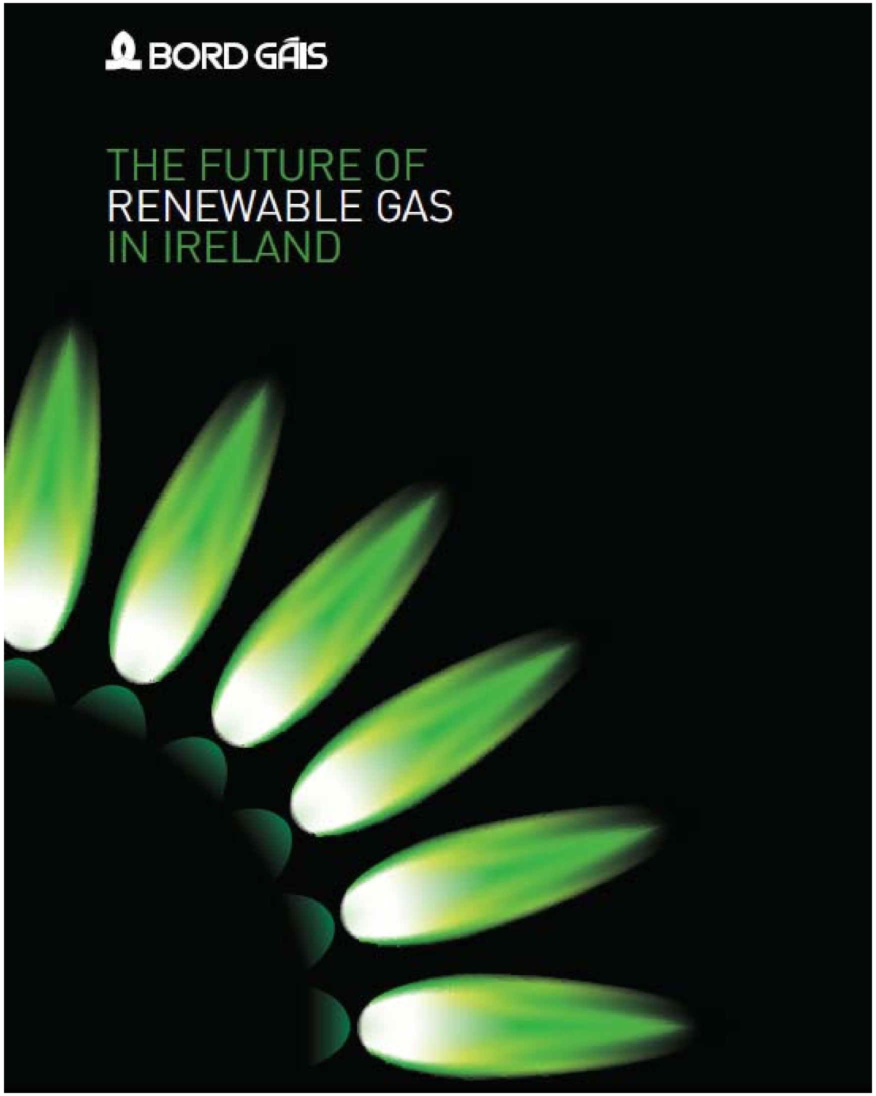


AN SEACHTÚ TUARASCÁIL DEN COMHCHOISTE UM ATHRÚ AERÁIDE AGUS ÁIRITHIÚ FUINNIMH

TUARASCÁIL MAIDIR LE FUINNEAMH BITHGHÁS IN ÉIRINN

SEVENTH REPORT OF THE JOINT COMMITTEE ON CLIMATE CHANGE AND ENERGY SECURITY

REPORT ON BIOGAS ENERGY IN IRELAND

EANÁIR 2011

JANUARY 2011

Food Waste from University Canteen

1

Bulk quantity of food waste collected from UCC canteen
~ 200 kg screened manually for any contaminants

2

Food waste processed with a Buffalo 800W food mincer to particle size of less than 8mm

3

Processed food waste mixed and blended thoroughly for homogeneity

4

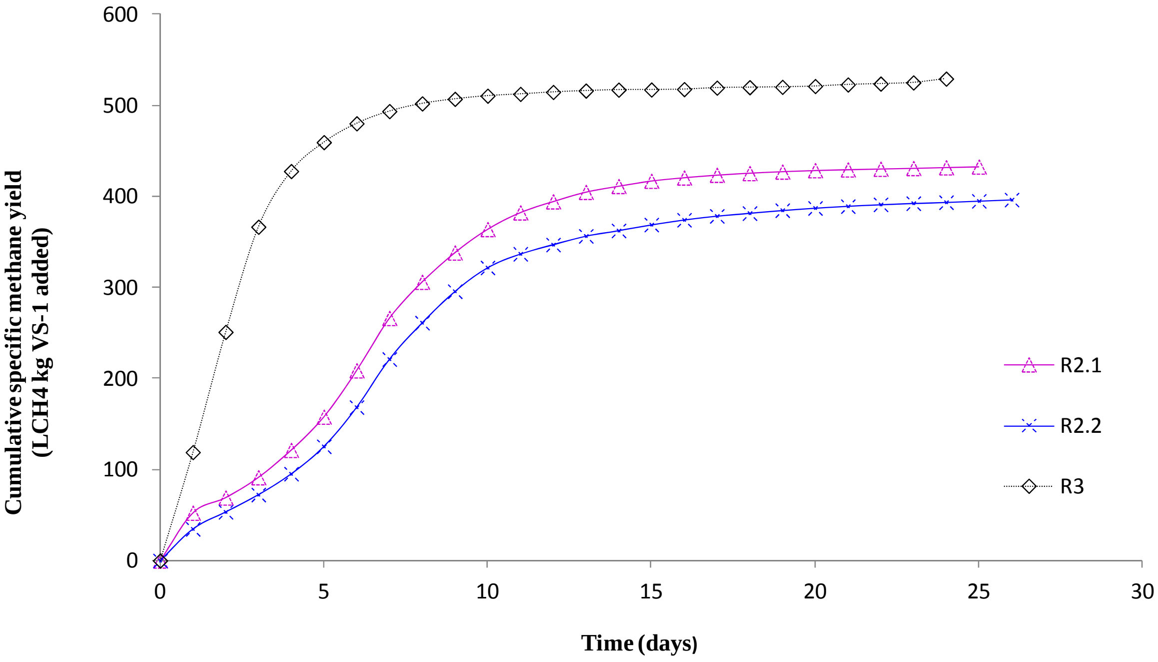
Processed food waste stored in 4L containers in freezer at -20°C until required

Feedstock Characteristics - Dry Basis

Parameters	UCC Food waste	Grass Silage[1]
pH	4.1	4.3
Dry Solids (%)	29.4	30.6
Total Volatile Solids (% DS)	95.3	92.5
% C (% DS)	49.6	43.0
% H (% DS)	7.3	5.8
% N (% DS)	3.5	1.6
% Ash (% DS)	4.7	7.5
C:N ratio	14.2	26.9
BMP (L CH_4/ kg VS $_{added}$)	529	488

[1]Nizami et al. (2012). "How much gas can we get from grass?" Applied Energy **(92): 783-790.**

Biomethane Potential Tests of UCC Food Waste



Unacclimitised inoculum

R2.1 Food waste wet:FW (w/w) = 469 L CH_4/kg VS => 85% of theoretical max

R2.2 Food waste dry: FW (DS) = 432 L CH_4/kg VS => 78% of theoretical max

Acclimitised inoculum

R3.0 Food waste wet:FW (w/w) = 529 L CH_4/kg VS => 96% of theoretical max

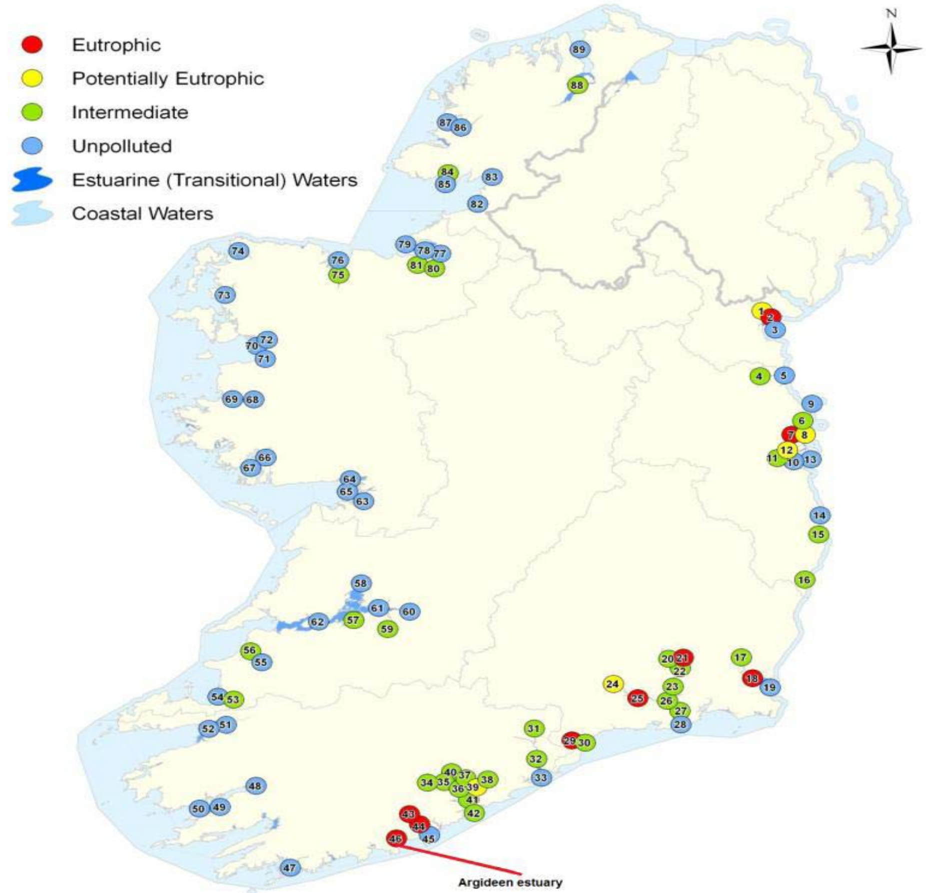
Table 9: Bioresource of OFMSW beyond 2016

Quantity of OFMSW	**530,000 t/a**
Quantity of VS (29.4% DS of which 95.3% VS)	148,500 t VS/a
BMP range 467 to 520 m^3_n CH_4/tVS	470 m_n^3 CH_4/tVS
Biomethane production	70 million m_n^3/a
Energy Value of Methane (STP)	37.78 MJ/m_n^3
Biomethane production	2.65 PJ/a
Expected transport energy in Ireland 2020	188PJ/a
Biomethane production (RES-T)	1.4%
Biomethane production (RES-T) including for credit	2.8%

Macro algae

Macro-Algae: Ulva Lactuca in Ireland

- The Environmental Protection Agency (EPA) has indentified sites with significant levels of pollution.
- Those with eutrophic status are identified (see over).
- Argideen estuary in Cork is rated as eutrophic (excess nitrogen in the estuary due to slurry run off and wastewater discharges)
- 10,000 tonnes of sea lettuce from Argideen Estuary currently land applied on farmland.



Collection of Ulva

Drying of Ulva

Drying took place inside an enclosed warehouse with a space heater blowing heated air through the airing tables.

A constant temperature of 85^{o}C was maintained over the course of 2 weeks to dry the collected Ulva. The samples were macerated in an industrial mincer and frozen prior to lab work.

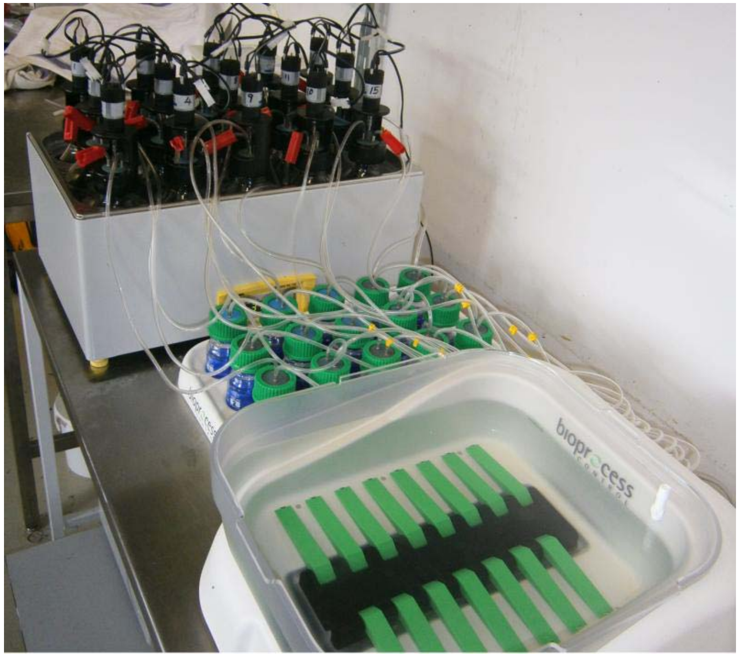
Experimental Work

BMPs carried out on fresh and pre-treated samples of Ulva from 2011 and 2012

Samples numbered as below:

1. Fresh (year 1 & 2)
2. Unwashed & wilted
3. Washed & dried (year 1 & 2)
4. Washed & wilted

Ultimate analysis carried out to obtain theoretical methane yield (Buswell).

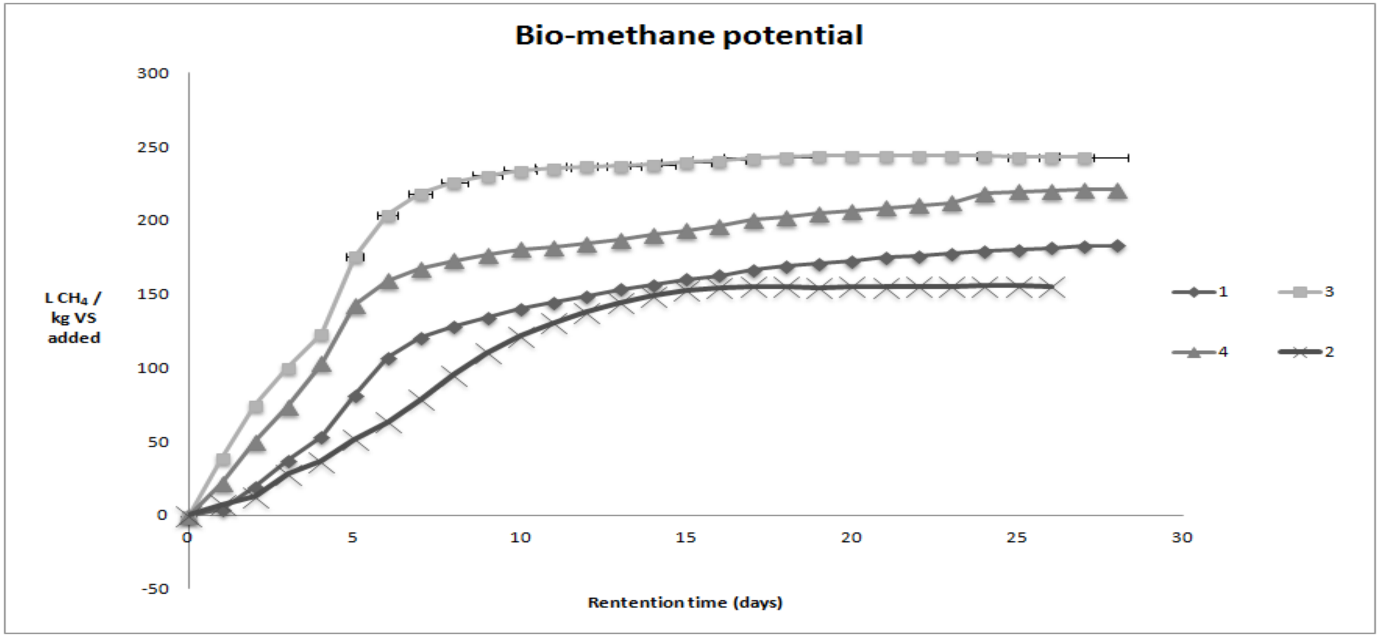


Bioprocess BMP unit used to obtain specific methane yield

Results of BMP assays

Table 7. BMP results as compared to theoretical yield from Buswell Equation.

Sample	BMP result L CH_4 / kg VS	Standard deviation	Max potential L CH_4 / kg VS from Buswell, (Table 4)	VS dest. (%)	Theoretical yield Buswell allowing for destruction	Yield, m^3 CH_4 / t wet based on BMP
Inoc.	33.9	2.66			-	-
1 Fresh	183.2	5.83	431	32.8	141.0	20.2
2 Wilted & unwashed	165.0	9.47	460	30.0	138.0	18.2
3 Washed & dried	250.2	13.32	394	51.4	202.6	100.1
4Washed & wilted	221.1	22.74	402	44.8	180.0	35.4



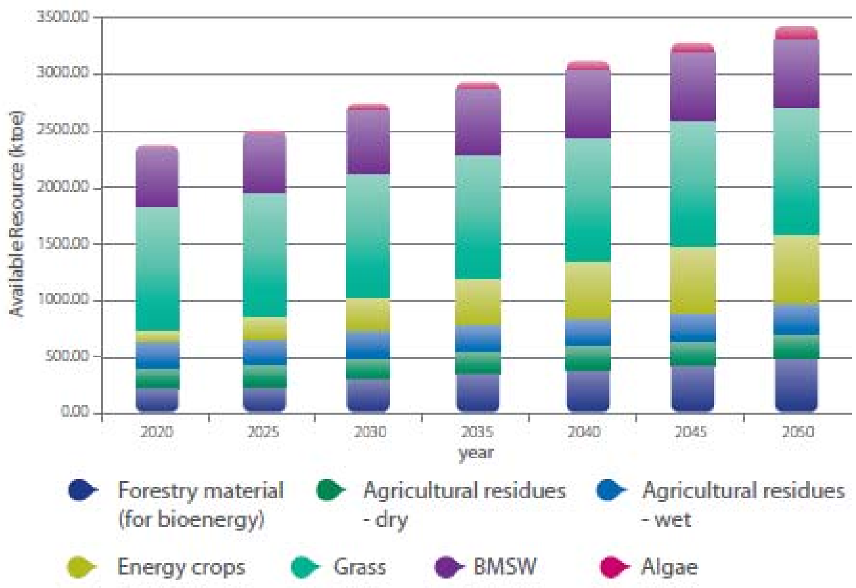
Co-digestion

Sample type and year	BMP yield L CH_4 / kg VS	Expected yield if no synergistic effects L CH_4 / kg VS	% increase
Slurry	136	-	-
Fresh Ulva (Year 2)	205	-	-
Dried Ulva (Year 2)	226	-	-
Dried Ulva 75%: Slurry 25%	210	203	3.3
Dried Ulva 50%: Slurry 50%	193	181	6.7
Dried Ulva 25%: Slurry 75%	186	158	17.3
Fresh Ulva 75%: Slurry 25%	220	188	17.1
Fresh Ulva 50%; Slurry 50%	200	171	17.0
Fresh Ulva 25%: Slurry 75%	183	153	19.2

Co-digestion improves the specific methane yield significantly

Bioenergy to 2050

Total biomass resource for bioenergy to 2050



Key Point: Grass & wastes can be significant energy resources in the coming decades