



# Country Report Ireland

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IEA Task 37, Den Bosch, The Netherlands, 3  
November 2010



**UCC**

Coláiste na hOllscoile Corcaigh, Éire  
University College Cork, Ireland





# Biogas Plant Inventory

- Summary of AD Plants:
  - - 4 Agriculture facilities
  - - 15 Industrial, Sewage sludge, Municipal (biowaste)
  - - 7 Landfill Gas projects in Ireland

# Farm slurries in Ireland

	Cattle <sup>a</sup>			Pig <sup>a</sup>			Sheep <sup>a</sup>			Poultry <sup>b</sup>			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 <sup>c</sup> (Mm <sup>3</sup> /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 <sub>4</sub> production <sup>c</sup> (Mm <sup>3</sup> /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 <sup>d</sup> 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 <sup>a</sup> (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 <sub>n</sub> <sup>3</sup> )	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 <sub>n</sub> <sup>3</sup> )	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)
- These facilities are continuously stirred tank reactors (CSTR) digesting predominately slurry with some food industry.
- Gate fees for off farm in the range €(40 – 120)t/a
- Patrick Berridge has received a grant for a new digester
- David Donnell in Limerick has recently constructed an anaerobic digester





# 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°C

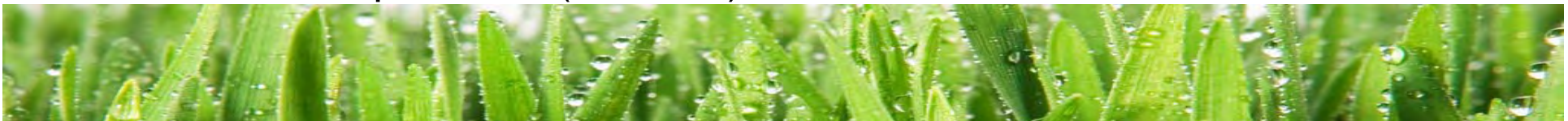
2 Digesters 1000 m<sup>3</sup> each; HRT 35 days

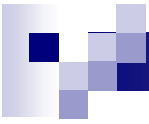
460,000 m<sup>3</sup>/a biogas; 110 kWe;

8% parasitic electrical demand

Heat from CHP fully employed in heating digesters & pasteurisation

€1.4 million capital cost (€116/t/a)





*Completed tank wall.*



*Completed tanks and reception building preparation.*

David McDonnell, Developing an AD project on your farm Bioenergy News Issue 4,  
Sustainable Energy Ireland (SEI) Renewable Energy Information Office (REIO)





# Ballytobin (Camphill) Digester

7,500 t/a feedstock

- 5,000 t/a slurry
- 2,500 t/a off farm (kitchen and food industry waste)

Off farm screened to 12mm, pasteurised at 70°C

2 Digesters: 150 m<sup>3</sup> horizontal plugflow digester @ 55°C; 450 m<sup>3</sup> CSTR digester @ 37°C

HRT 55 days

219,000 m<sup>3</sup>/a biogas; 85kW boiler to heat digester; 85 kW and 200 kW boiler for small district heating system; flare 100 m<sup>3</sup> /day surplus gas in summer (10% of energy in gas is flared)





# Proposed farm digesters

Planning for at least two more facilities in Munster at a scale of 15,000 t/a and 30,000 t/a with grass as a significant feedstock



# OFMSW biometthane

Details	2006	2010	2020
Population <sup>a</sup> (M)	4.23	4.38	4.74
OFMSW production <sup>b</sup> (Mt)	0.78	0.81	0.87
Biogas yield <sup>c</sup> (Mm <sub>n</sub> <sup>3</sup> )	97.38	100.84	108.93
Methane yield <sup>c</sup> (Mm <sub>n</sub> <sup>3</sup> )	53.56	55.46	59.91
Theoretical energy (37.78 MJ/m <sub>n</sub> <sup>3</sup> ) (PJ)	2.02	2.10	2.26
Recoverable quantity to AD (%)	0	0	25
Practical energy (PJ)	0	0	0.57





# Proposed MSW Digesters

- Potentially five facilities at planning or construction phase in size range 14,000 to 100,000 t/a.
- MBT model is proposed with 40% to digester and 60% to Refuse Derived Fuel line
- Biogas to CHP
- Electricity exported
- Heat to RDF line
- RDF to cement factory to replace coal



# 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)



# Supports for AD

- OFMSW
  - Landfill levy €20/t in Nov 2009 raising to €75/t in 2012
- Biogas to CHP
  - Was 7.2c/kW<sub>e</sub>h in 2007; Raised to 12c/kW<sub>e</sub>h in 2008

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

- AD CHP equal to or less than 500 kW: 15 c/kW<sub>e</sub>h;
- AD CHP greater than 500 kW: 13 c/kW<sub>e</sub>h
- AD (non CHP) equal to or less than 500 kW: 11 c/kW<sub>e</sub>h;
- AD (non CHP) greater than 500 kW: 10 c/kW<sub>e</sub>h
  
- Biomass CHP equal to or less than 1,500 kW: 14c/kW<sub>e</sub>h;
- Biomass CHP greater than 1,500 kW: 12 c/kW<sub>e</sub>h
- Biomass combustion using energy crops: 9.5 c/kW<sub>e</sub>h; for all other biomass 8.5 c/kW<sub>e</sub>h





# Research Activities

- Higher Education Authority (HEA) Program Research Third Level Institutes (PRTL), Cycle 4 ERI: **“Should we use indigenous biodiesel or grass biomethane as transport fuel in Ireland?”**
- Department of Agriculture Fisheries and Food (DAFF) Stimulus Fund **“GreenGrass”: Developing grass for sustainable renewable energy and value added products.**
- Environmental Protection Agency: **“Grass biomethane”**
- Bord Gas Eireann (BGE): **Utilisation of compressed natural gas and biomethane as a transport fuel in Ireland**
- Irish Research Council Science Engineering and Technology (IRCSET) Enterprise Partnership with Bord Gais Eireann: **“Biomethane from residues”**



# DAFF “GreenGas”

- Lead by Teagasc Grange
- Partners
  - Queens University Belfast
  - University College Cork





# DAFF “BioGrass”

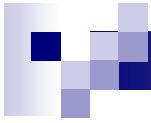
- Lead by UCD
  - This novel project investigates the suitability of Irish grassland, under a range of management intensities, for biofuel production. Factors that will be studied to include grass quality, biogas yield, the full greenhouse gas balance, soil C and N dynamics
  - <http://www.ucd.ie/bioenergy/projects.html>





- The Competence Centre for BioREFINING AND BIOenergy
  - Hosted by NUI Galway
  - Began 2009





# Peer review Journal Papers Biomethane and Policy

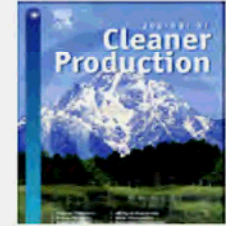




Contents lists available at ScienceDirect

## Journal of Cleaner Production

journal homepage: [www.elsevier.com/locate/jclepro](http://www.elsevier.com/locate/jclepro)



### Can we meet targets for biofuels and renewable energy in transport given the constraints imposed by policy in agriculture and energy?

B.M. Smyth<sup>a,b</sup>, B.P. Ó Gallachóir<sup>a,b,\*</sup>, N.E. Korres<sup>a,b</sup>, J.D. Murphy<sup>a,b</sup>

<sup>a</sup> Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland

<sup>b</sup> Environmental Research Institute, University College Cork, Cork, Ireland





Contents lists available at ScienceDirect

# Renewable and Sustainable Energy Reviews

journal homepage: [www.elsevier.com/locate/rser](http://www.elsevier.com/locate/rser)

## A biofuel strategy for Ireland with an emphasis on production of biomethane and minimization of land-take

Anoop Singh<sup>a,b</sup>, Beatrice M. Smyth<sup>a,b</sup>, Jerry D. Murphy<sup>a,b,\*</sup>

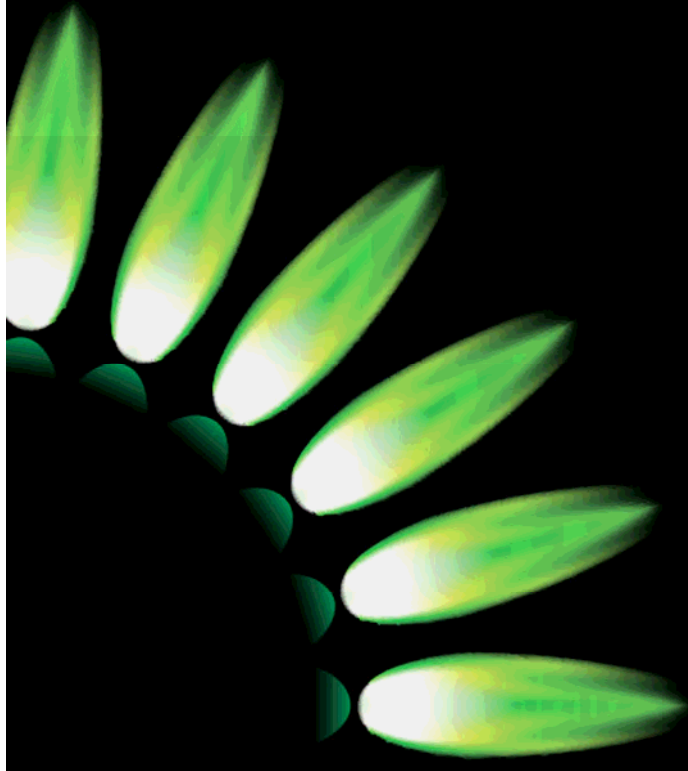
<sup>a</sup> Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland

<sup>b</sup> Biofuels Research Group, Environmental Research Institute, University College Cork, Cork, Ireland

Feed stock	Potential 2020 (PJ)	Practical 2020 (PJ)	Factor for RES-T	Contribution to RES-T	% energy in transport 2020 (240 PJ)	% residential gas demand (34 PJ)
Slurry	15.53	1.88	X2	3.76	1.57	5.5
OFMSW	2.26	0.57	X2	1.14	0.48	1.7
Slaughter	1.37	0.68	X2	1.36	0.57	2.0
Grass	47.58	11.93	X2	23.86	9.94	35.1
Total	66.74	15.03		30.06	12.53	44.3



# THE FUTURE OF RENEWABLE GAS IN IRELAND



## Recommendation 1:

Set targets for gas demand to be met with biomethane

## Recommendation 2:

Review REFIT tariffs provided for anaerobic digestion

## Recommendation 3:

Implement new energy regulations to encourage biomethane injection into the grid

## Recommendation 4:

Align renewable energy and waste management policy

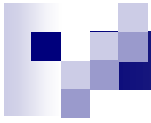
## Recommendation 5:

Implement new support structures for agriculture

## Recommendation 6:

Additional research and development funding for renewable gas technologies





# Peer review journal papers Life Cycle Analysis of Biomethane





ELSEVIER

Available at [www.sciencedirect.com](http://www.sciencedirect.com)



<http://www.elsevier.com/locate/biombioe>



## An argument for using biomethane generated from grass as a biofuel in Ireland

Jerry D. Murphy<sup>a,b,\*</sup>, Niamh M. Power<sup>c</sup>

<sup>a</sup>Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland

<sup>b</sup>Environmental Research Institute, University College Cork, Cork, Ireland

<sup>c</sup>Department of Civil, Structural and Environmental Engineering, Cork Institute of Technology, Cork, Ireland

- Cross compliance regulations: the ratio of permanent grass land to arable land may not change by more than 10% based on 2003
- EU Renewable Energy Directive: May not convert wetland, forestry or grassland to energy crop production for biofuel production.
- Ireland has 8% of EU cattle herd with less than 1% of EU human population
- 91% of Irish agricultural land is under grass; 9% arable
- Arable land fully employed..we import wheat.
- Sustainable indigenous employment in rural areas



*Environ. Sci. Technol.* 2009, 43, 8496–8508

# Review of the Integrated Process for the Production of Grass Biomethane

ABDUL-SATTAR NIZAMI, NICHOLAS E. KORRES, AND  
JERRY D. MURPHY\*

*Department of Civil and Environmental Engineering, and Environmental  
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*Received May 26, 2009. Revised manuscript received September 22, 2009. Accepted  
September 30, 2009.*

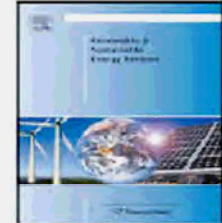




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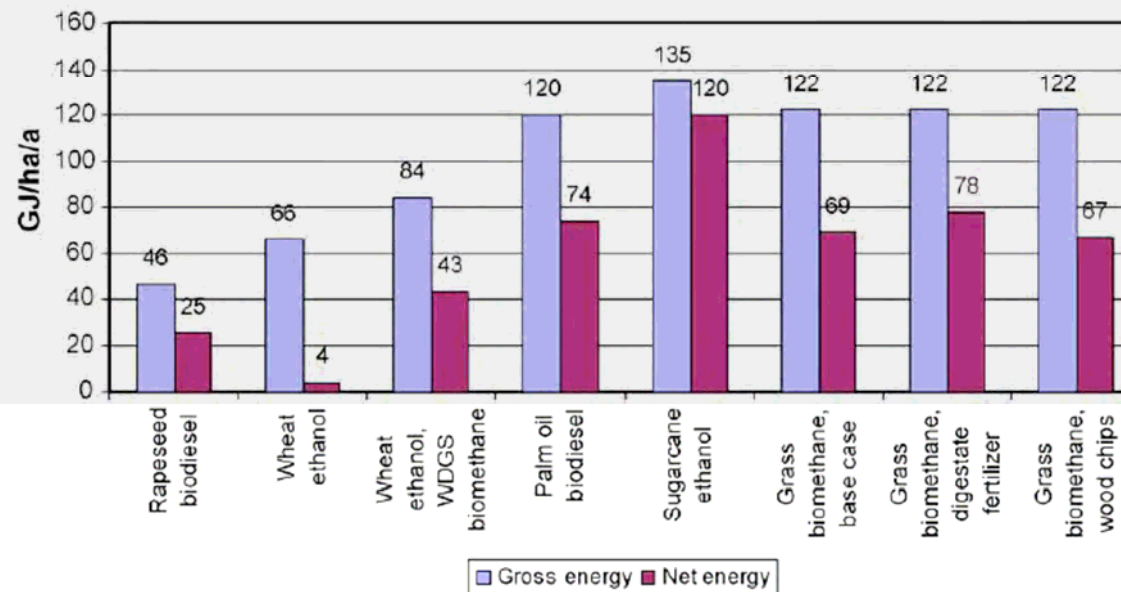
## What is the energy balance of grass biomethane in Ireland and other temperate northern European climates?

Beatrice M. Smyth<sup>a,b</sup>, Jerry D. Murphy<sup>a,b,\*</sup>, Catherine M. O'Brien<sup>a,b</sup>

<sup>a</sup> Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland

<sup>b</sup> Environmental Research Institute, University College Cork, Cork, Ireland

B.M. Smyth et al. / Renewable and Sustainable Energy Reviews 13 (2009) 2349–2360



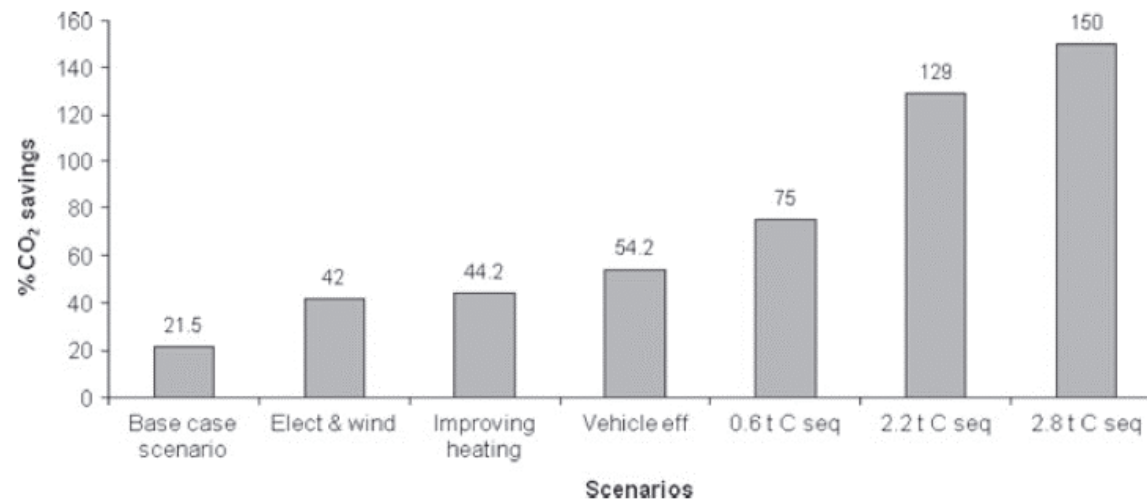
# Is grass biomethane a sustainable transport biofuel?

Nicholas E. Korres, Anoop Singh, Abdul-Sattar Nizami and Jerry D. Murphy,  University College Cork, Ireland

Received December 15, 2009; revised version received February 8, 2010; accepted February 11, 2010

Published online in Wiley InterScience ([www.interscience.wiley.com](http://www.interscience.wiley.com)); DOI: 10.1002/bbb.228;

*Biofuels, Bioprod, Bioref.* 4: xxx-xxx (2010)



# Can grass biomethane be an economically viable biofuel for the farmer and the consumer?

Beatrice M. Smyth, Environmental Research Institute (ERI), University College Cork (UCC), Ireland  
 Henry Smyth, Bord Gáis Éireann, Cork, Ireland  
 Jerry D. Murphy, ERI, UCC, Ireland

Received April 16, 2010; revised version received May 24, 2010; accepted May 28, 2010  
 Published online in Wiley InterScience (www.interscience.wiley.com); DOI: 10.1002/bbb.238;  
*Biofuels, Bioprod. Bioref.* (2010)

**Table 8. Comparison of vehicle fuel costs.**

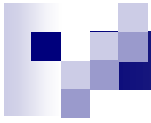
Fuel	Unit cost	Energy value	Cost per unit energy (€c MJ <sup>-1</sup> )
Petrol <sup>a</sup>	€1.224 L <sup>-1</sup>	30 MJ L <sup>-1</sup>	4.08
Diesel <sup>a</sup>	€1.150 L <sup>-1</sup>	37.4 MJ L <sup>-1</sup>	3.07
Compressed biomethane (high) <sup>b</sup>	€1.63 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	4.41
Compressed biomethane (low) <sup>b</sup>	€0.96 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	2.59
CNG – Austria <sup>c</sup>	€0.89 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	2.41
CNG – UK <sup>c</sup>	€0.71 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	1.92
CNG – Germany <sup>c</sup>	€0.70 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	1.89
BioCNG (high) <sup>d</sup>	€0.80 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	2.17
BioCNG (low) <sup>d</sup>	€0.74 m <sup>-3</sup>	37 MJ m <sup>-3</sup>	1.99

<sup>a</sup>Price of petrol and diesel is the price at the pumps.<sup>73</sup>

<sup>b</sup>Price of compressed biomethane is the minimum selling price of grass biomethane. The highest and lowest prices from Table 7 are used.

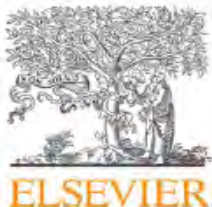
<sup>c</sup>In the absence of Irish CNG prices, the prices in Austria, Germany and the UK<sup>67</sup> are shown for comparison.

<sup>d</sup>BioCNG price calculated using UK CNG prices and a blend of 10% biomethane, 90% CNG.



# Peer review journal papers Reactor Design and Operation





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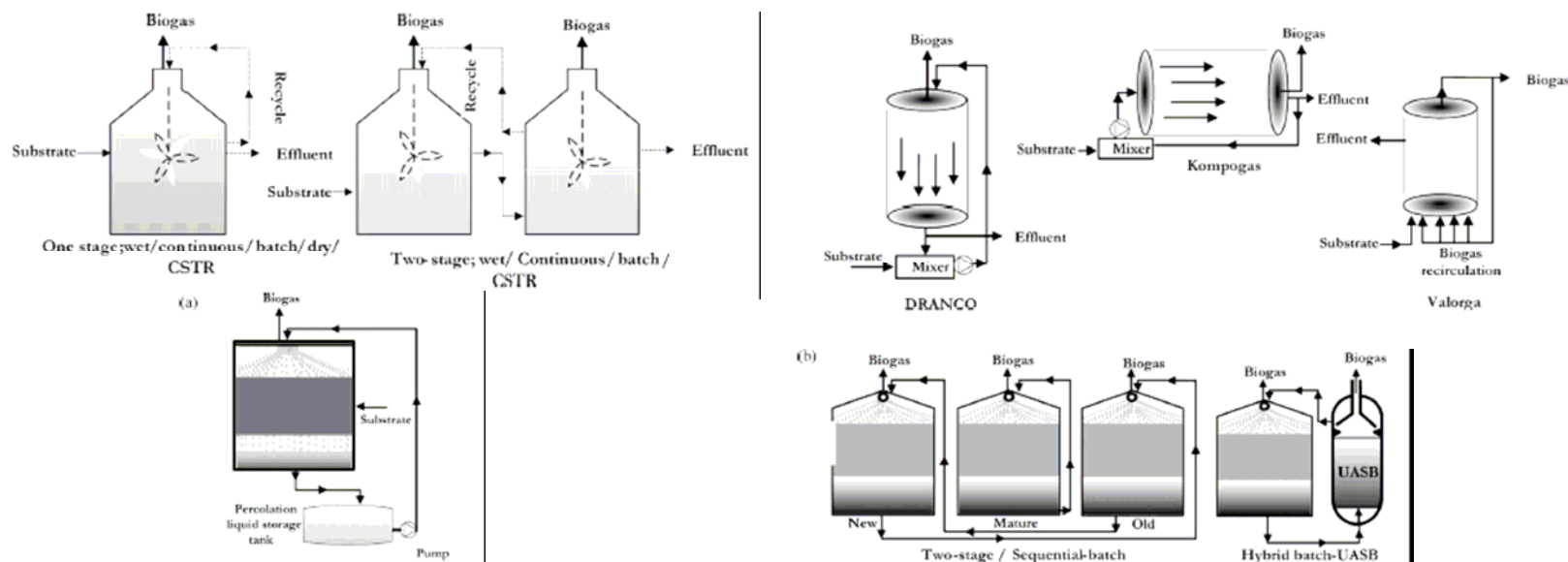


## What type of digester configurations should be employed to produce biomethane from grass silage?

Abdul-Sattar Nizami<sup>a,b</sup>, Jerry D. Murphy<sup>a,b,\*</sup>

<sup>a</sup> Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland

<sup>b</sup> Environmental Research Institute, University College Cork, Ireland

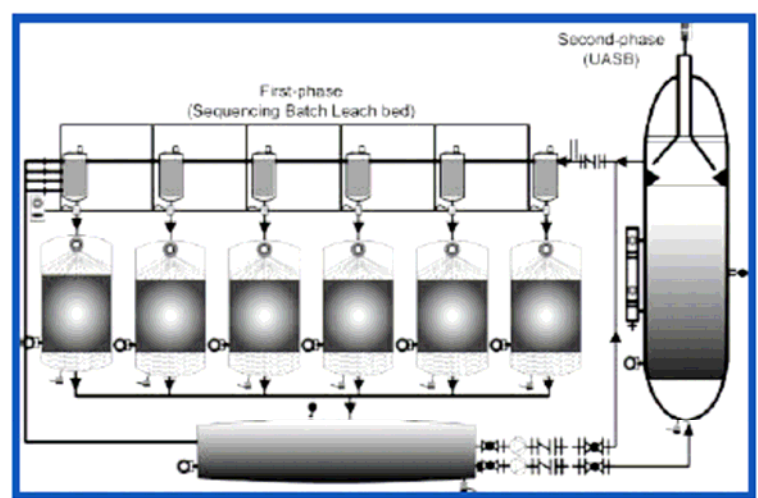


## Role of Leaching and Hydrolysis in a Two-Phase Grass Digestion System

A. S. Nizami,<sup>†,‡,§</sup> T. Thamsiriroj,<sup>†,‡,§</sup> A. Singh,<sup>‡,§</sup> and J. D. Murphy<sup>\*,‡,§</sup>

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*Received June 1, 2010. Revised Manuscript Received July 16, 2010*



70% destruction of volatiles in sprinkling grass over 30 days

Would suggest a regime of feeding of subsequent digesters every 5 days; yielding an overall 30 day cycle time

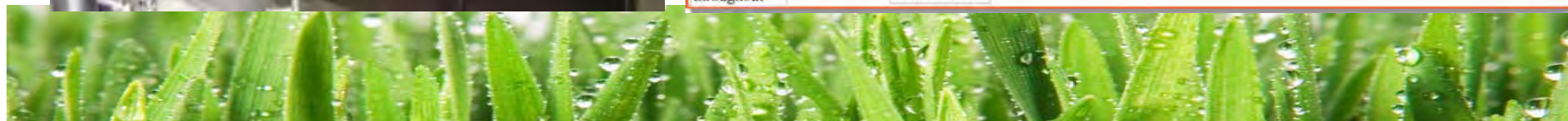
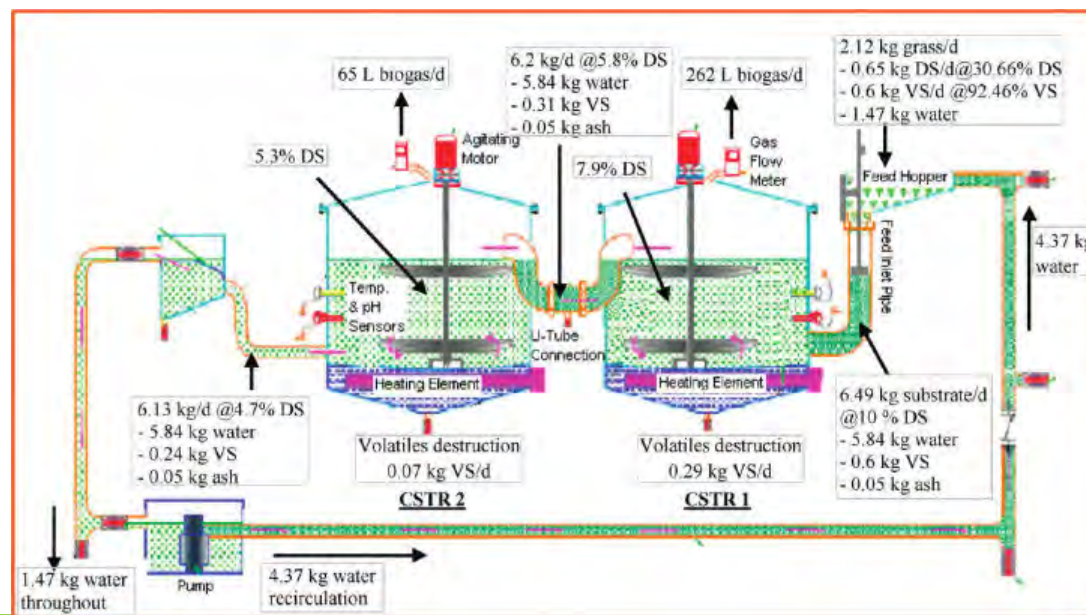


## Difficulties Associated with Monodigestion of Grass as Exemplified by Commissioning a Pilot-Scale Digester

T. Thamsiroj<sup>†,‡</sup> and J. D. Murphy<sup>\*,†,‡</sup>

<sup>†</sup>Department of Civil and Environmental Engineering and <sup>‡</sup>Environmental Research Institute, University College Cork, Cork, Ireland

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Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: [www.elsevier.com/locate/biortech](http://www.elsevier.com/locate/biortech)



## Modelling mono-digestion of grass silage in a 2-stage CSTR anaerobic digester using ADM1

T. Thamsiroj<sup>a,b</sup>, J.D. Murphy<sup>a,b,\*</sup>

<sup>a</sup> Department of Civil and Environmental Engineering, University College Cork, Cork, Ireland

<sup>b</sup> Environmental Research Institute, University College Cork, Cork, Ireland

88% destruction of volatile solids @ 80 day HRT (95 day SRT) generating  
440 L CH<sub>4</sub>/kg VS @ 2 kg VS/m<sup>3</sup>/day

