NovaEnergo

Your new energy

cré
Composting & Anaerobic Digestion Association *of* Ireland

irbea
irish bioenergy association

Anaerobic Digestion Industry Potential Contribution to CO_2 Mitigation in Ireland

Contents

About the Author

Dr. Jan Štambaský is president of the European Biogas Association, executive board member of the Czech Biogas Association, and managing director of the NovaEnergo Company. He received his PhD in chemistry from the University of Glasgow in 2008. He then created his own company, focused at high-end biogas process optimization and consultancy services. Dr. Štambaský has delivered over 150 contributions and key-note speeches in the field of biogas production and utilization. He has co-authored and worked in a number of European and national biogas and biomethane research projects.

Identification sheet

Document name: **Anaerobic Digestion Industry Potential Contribution to CO_2 Mitigation in Ireland**

Clients:

Cré- Composting & Anaerobic Digestion Association of Ireland,
Po Box 135, Enfield, Co. Meath, Ireland

The Irish Bioenergy Association, (IrBEA)
Unit 104, DCU Alpha,
Old Finglas Road,
Glasnevin, Dublin 11, D11KXN4, Ireland

Contractor:

NovaEnergo s.r.o.
nám. 14. října 1307/2
150 00 Praha 5
IČ: 28501152
Tel.: 777 208 020
Fax: 226 013 088
info@novaenergo.cz
www.novaenergo.cz

Processed by: Dr. Anna Pazera, Dr. Jan Stambasky

Approved by: Dr. Jan Stambasky

In Prague on:
Version 1: 17th May 2016
Version 2: 18th June 2016
Version 3: 5th July 2016
Version 4: 19th September 2016 (biowaste emissions added)

Number of pages: 6

1. Executive Summary

The large-scale deployment of Anaerobic Digestion (AD) in Ireland has the potential to decarbonise the agricultural and waste sectors with multiple cross-sectoral benefits.

This report assesses that potential in terms of available feedstocks[1] and quantifies the benefits in terms of GHG emission reduction by 2030 to 32% of total national Greenhouse gas (GHG) emissions.

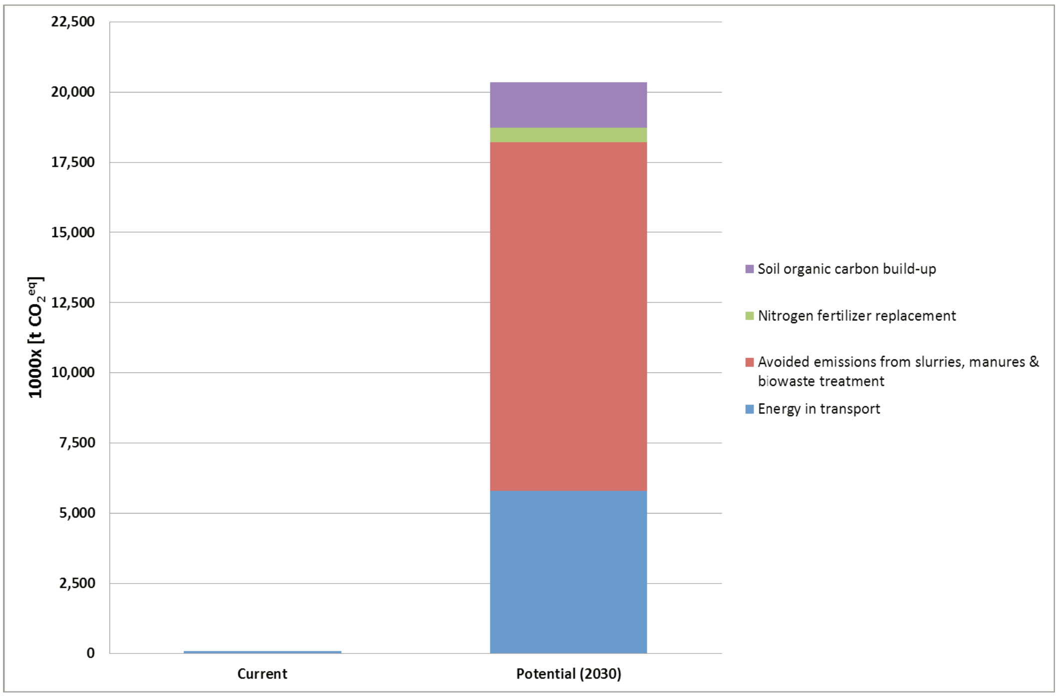
Four significant CO_2^{eq} reduction pathways associated with the production of biogas were identified and discussed,[2] demonstrating the major role that could be played by AD industry in CO_2^{eq} reduction. Table 2 and Graph 1 below outline the total CO_2^{eq} savings that could be achieved in Ireland if the right policies and financial supports for the industry were in place.

Table 2: Current and potential CO_2^{eq} savings delivered by AD in Ireland

Contributions to the total CO_2^{eq} savings	Current 1000× [tpa]	Potential 2030 1000× [tpa]
Renewable energy (in transportation)	n.a.	5,804
Slurries and manures treatment	n.a.	12,409
Biofertiliser production	n.a.	515
Soil carbon sequestration	n.a.	1,623
TOTAL	85	20,350

n.a. – not available *tpa – tonnes per annum*

Graph 1: Current and potential CO_2^{eq} savings delivered by AD in Ireland



2. Introduction

This report examines the potential for the anaerobic digestion industry potential to contribute to significant reductions in greenhouse gas emissions.

Anaerobic digestion (AD) is a mature technology. AD currently makes a major contribution to sustainable waste management processes and the reduction of greenhouse gas (GHG) emissions in the Europe.[3] The generated products – biogas, biomethane and biofertiliser – substitute fossil energy, circulate nutrients and mitigate methane emissions in agriculture. These unique features define AD as a complex GHG mitigation technology.

AD also has significant cross-sectoral benefits. It provides a dispatchable (continuous) electricity supply (compared to the intermittent nature of other renewable energy sources, such as wind energy). When injected into the natural gas grid, it can be flexibly used for heating, cooling and transport. In addition, the deployment of AD across the country has the potential to facilitate rural development and sustainable agriculture.

3. Anaerobic Digestion Industry Potential Contribution to CO2 Mitigation in Ireland

The latest consolidated energy production data for Ireland (2013) records the production of 1,963 TJ of biogas primary energy, which has been converted into 186.2 GWh of electricity.[4] Based on this approximately 167,580 tonnes of CO_2^{eq} was saved compare to electricity production from coal.[5] **85,093 tonnes of CO_2^{eq}** was saved compare to electricity production in Ireland in 2014.[6]

In addition to current output in renewable energy and the apparent and obvious link to GHG emission abatement by replacing fossil fuels, there are surplus reductions in GHG emissions which make anaerobic digestion unique as a renewable energy technology. AD therefore brings by far the best reduction in CO_2^{eq} per unit of energy produced. The total GHG emission savings, together with increments are summarised in the following table (Table 1).

Table 1: Predicted contributions to the total CO_2^{eq} savings of major AD feedstock streams in Ireland, 2030

Feedstock	Transportation 1000× [tpa]	AD Treatment Process 1000× [tpa]	N-Fertilizers 1000× [tpa]	Sequestration 1000× [tpa]	Total 1000× [tpa]
OFMSW	170	779	14	69	1,032
Slurries, manures	2,536	11,630	227	687	15,079
Grass	3,098	-	274	867	4,239
TOTAL	5,804	12,409	515	1,623	20,350

tpa – tonnes per annum

3.1 CO2 Mitigation in Transportation Sector

The biogas currently produced in Ireland is fully utilised in electricity production. However, acknowledging the high GHG reduction potential of AD, future biogas applications could be aimed at the transportation sector, where compressed or liquefied biomethane can play a major role as a biofuel. Biomethane is the only biofuel potentially available in large quantities which can deliver very low or even negative CO_2^{eq} emissions. Whereas electricity production can be decarbonised by various technologies, the transportation sector lacks a pool of commercially mature decarbonisation technologies. Electric vehicles can only be as carbon neutral as the electricity grid. Therefore biomethane is the only viable choice for carbon free transportation.[7]

A conservative estimate for the total production of biomethane in Ireland equivalent in 2030 is 2.2 billion $_{N}m^3$ per year. Based on the feedstock potential assessed[8], and with the right policies in place, by 2030 the AD industry in Ireland could produce 79.3 PJ of renewable energy. This amount equates to approximately 42% of the energy used in the transport sector in Ireland (188 PJ), which would ultimately represent 5.8 million tonnes of direct CO_2^{eq} savings.[9]

3.2 CO2 Mitigation in Slurries, Manures and Brown Bin Treatment

Methane emissions from conventional slurries and manure storage contribute greatly to global GHG emissions. Depending on the animal and type of manure, approximately 10-40 m^3 of methane can be produced per tonne of manure in conventional farming practice through release of methane due to psychrophilic methanation, i.e. release of methane from manure and slurry occurring at ambient temperatures. This amount equals, on average,[10] approximately 250 kg CO_2^{eq} of potentially avoidable emissions from manure storage, if slurry and manure is promptly processed through an AD plant. It is important to highlight that avoided emissions represent bigger CO_2^{eq} savings than would account to biogas if only calculated on the basis of its' use as a renewable energy source.

With over 13 million tonnes of slurry and manure produced in Ireland every year,[11] and with the right policies in place, approximately **3.6 million tonnes** of this feedstock stream can be transformed by AD technology into **34.6 PJ of energy**, delivering **2.53 million tonnes of direct CO_2^{eq} savings** when used in the transportation sector, and further **11.6 million tonnes of CO_2^{eq} savings** in avoided emissions from conventional storage management.

Similar processes produce methane in landfill sites containing brown bin material, and any biodegradable organic matter in general. Produced landfill gas is then released through landfilled material, causing extensive emissions over extended periods of time (10-30 years).

Approximately **492 thousand tonnes** of brown bin waste streams can be transformed by AD technology into **2.3 PJ of energy**, delivering **170 thousand tonnes of direct CO_2^{eq} savings** when used in transportation sector, and further **779 thousand tonnes of CO_2^{eq} savings** in avoided emissions from conventional landfilling.

3.3 CO2 Mitigation in Biofertiliser Production

AD installations produce energy in the form of biogas, and digestate. As part of the processing, digestate is generated. Digestate contains all of the mineral compounds from the input feedstock streams. The microbial processes effectively concentrate and convert mineral nutrients (N, P, K) to more plant available forms. Nitrogen and phosphorus play a particularly important role in the circular economy approach. Phosphorus is an indispensable plant nutrient and there is a finite amount of it left in the planet.[12] Nitrogen fertilisers production account for a considerable share of global energy consumption.[13] When substituting synthetic mineral fertiliser nitrogen, by mineral nitrogen from digestate,[14] GHG emissions can be reduced by up to 6 kg CO_2^{eq} per 1 kg of mineral Nitrogen replaced.[15]

With the right policies in place, the AD industry in Ireland can provide the agricultural sector with over **123 thousand tonnes of nitrogen fertiliser**, accounting for further **0.5 million tonnes of CO_2^{eq} savings** in avoided emissions from conventional fertiliser production.[16]

3.4 CO2 Mitigation in Carbon Sequestration

Digestate also contains a residual organic fraction, which has a considerable value as a soil enhancer. This residual organic fraction adds to the soil organic matter and therefore sequestering carbon from the anthropogenic carbon cycle. While, a major fraction in the soil will subsequently break down and mineralise in the first year, a significant portion (roughly 40%) will resist humification and can rightfully be considered as a carbon sink.[17]

With the right policies in place, the AD industry in Ireland can provide the agricultural sector with nearly **25 million tonnes of digestate** by 2030. The residual organic fraction of digestate will introduce large quantities of carbon into the soil, where nearly **436 thousand tonnes of carbon** will remain intractable to further transformations thus adding this amount to the total soil carbon stock in Ireland. Contribution to the total carbon stock represents a further **1.6 million tonnes of CO_2^{eq} savings**.

4. Conclusions

The AD industry exhibits unique features among all renewable energies due to its ability to significantly reduce greenhouse gas emissions in Ireland.

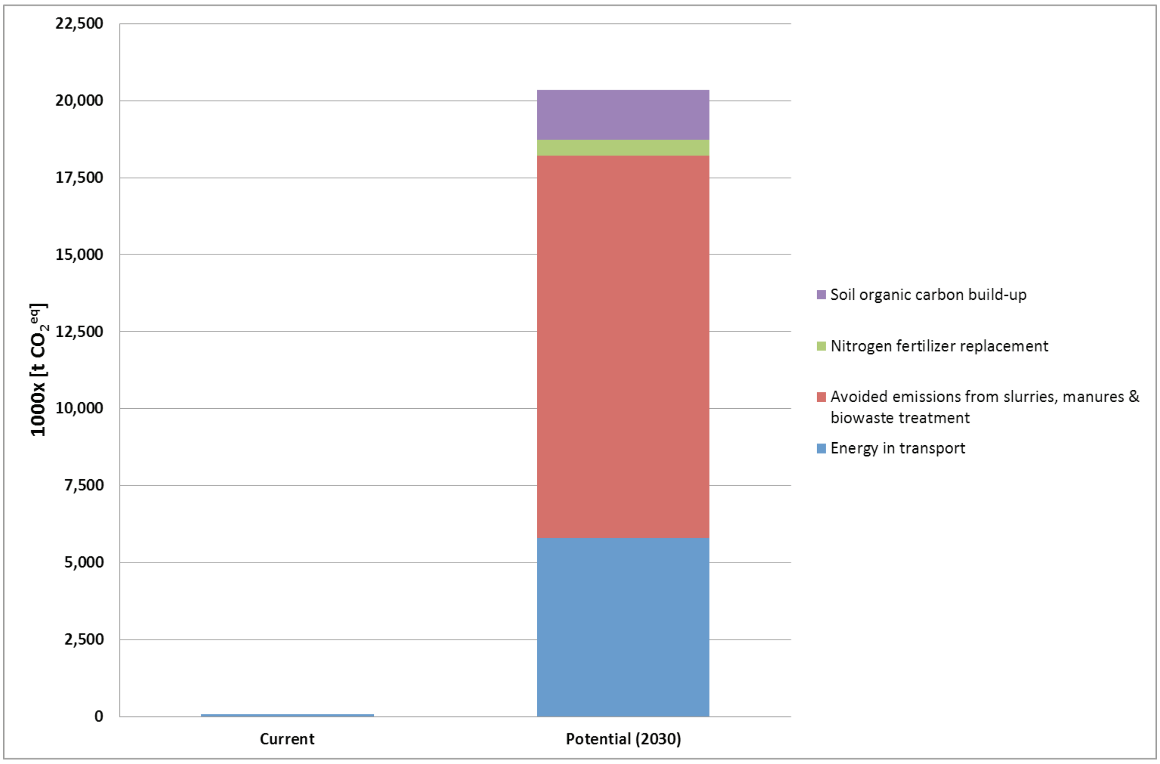
Four significant CO_2^{eq} reduction pathways associated with the production of biogas were identified and discussed,[18] demonstrating the major role that could be played by AD industry in CO_2^{eq} reduction. Table 2 and Graph 1 below outline the total CO_2^{eq} savings that could be achieved in Ireland if the right policies and financial supports for the industry were in place.

Table 2: Current and potential CO_2^{eq} savings delivered by AD in Ireland

Contributions to the total CO_2^{eq} savings	Current 1000× [tpa]	Potential 2030 1000× [tpa]
Renewable energy (in transportation)	n.a.	5,804
Slurries and manures treatment	n.a.	12,409
Biofertiliser production	n.a.	515
Soil carbon sequestration	n.a.	1,623
TOTAL	85	20,350

n.a. – not available *tpa – tonnes per annum*

Graph 1: Current and potential CO_2^{eq} savings delivered by AD in Ireland



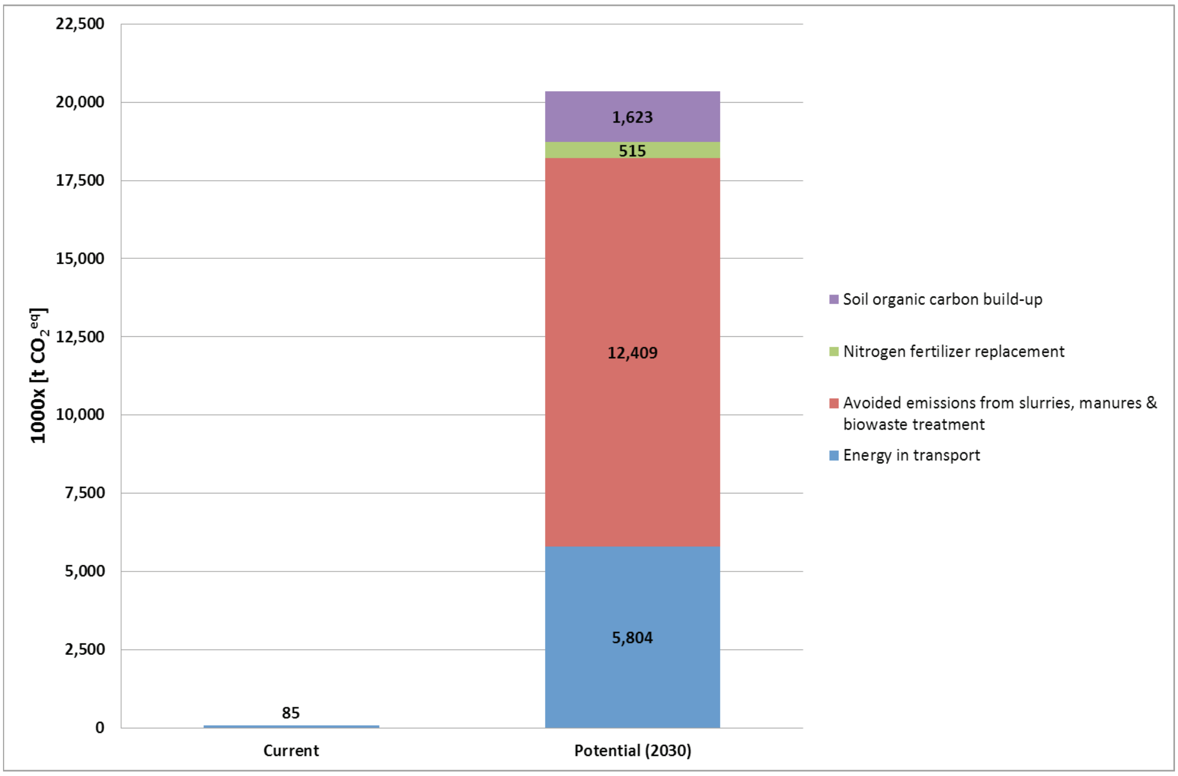
Ireland is forecast to fail to meet RES targets by 2020, which would result in a substantial financial burden of 100 million Euros a year per each 1% Ireland is off the target. However, Ireland is still lacking behind its European counterparts with regard to anaerobic digestion deployment, ranking 20th position among the EU28. This is largely due to inadequate policy and support, despite all the above mentioned cross-sectorial benefits. This may well result in a major missed opportunity, should the current political trend prevail.

The AD industry in Ireland can play a major role in reaching national climate goals. It is important to address AD industry as a complex CO_2^{eq} mitigation technology. The presented scenario outlines a significant development of AD industry, increasing the renewable energy production from 2.0 PJ to 79.3 PJ by 2030. However, this substantial increase in energy production is overwhelmingly surpassed by enormous increase of CO_2^{eq} savings from current 85 thousand tonnes to 20.3 million tonnes (Graph 1).

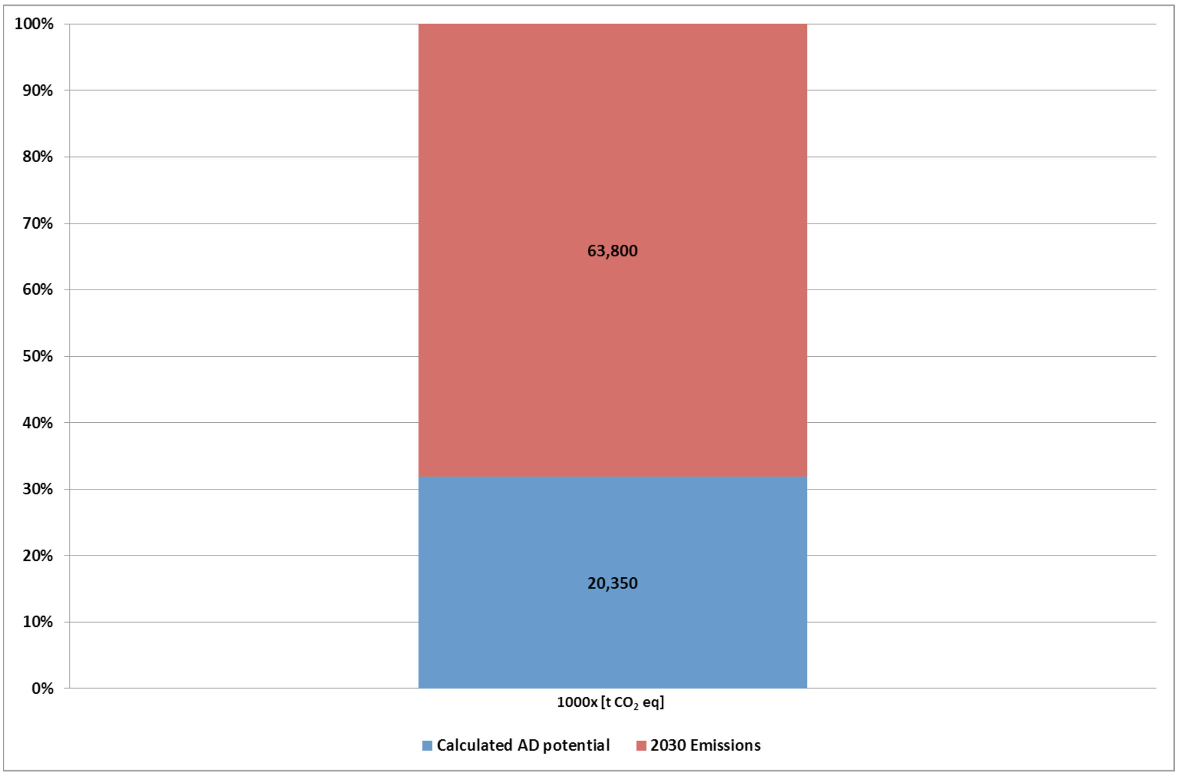
The AD industry in Ireland should be acknowledged as a climate mitigation technology where an amount of CO_2^{eq} savings increases approximately 6× quicker compare to renewable energy production.

5. Annexes

Graph 2: Alternative of the Graph 1, combining Table 2 and Graph 1.



Graph 3: Potential CO_2^{eq} mitigation compared to the total projected 2030 CO_2^{eq} emissions.[19]



6. References

1 The Potential Size of the Anaerobic Digestion Industry in Ireland by the Year 2030

2 Note: further scientific research is heavily focusing at the soil carbon sequestration pathways, and the nutrient recovery beyond the nitrogen loop. More CO_2^{eq} reduction pathways may be acknowledged in the future.

3 Annual Statistical Report of European Biogas Association

4 EurObserv'ER Biogas Barometer 2014

5 US Energy Information Administration: 900 kg CO_2^{eq} is emitted per 1 MWh of electricity (bituminous coal)

6 Sustainable Energy Authority of Ireland (SEAI); 457 kg CO_2^{eq} was emitted per 1 MWh of electricity in Ireland (2014); Carbon Content of Irish Electricity Generation Hits Record Low in 2014 - See more at: http://www.seai.ie/News_Events/Press_Releases/2015/Carbon-Content-of-Irish-Electricity-Generation-Hits-Record-Low-in-2014.html

7 Biomethane can be used in any natural gas application known today. This study assumes transportation to be the final use of biomethane, for the sake of plain emission calculation.

8 The Potential Size of the Anaerobic Digestion Industry in Ireland by the Year 2030

9 US Energy Information Administration: 73.2 kg CO_2^{eq} is emitted per 1 GJ of diesel used as a car fuel

10 This example corresponds to a manure stream releasing approximately 16.6 m^3 of methane per 1 tonne (fresh mass)

11 Quantity of slurries and manures is expressed in tonnes of dry matter

12 U.S. Geological Survey; http://minerals.usgs.gov/minerals/pubs/commodity/phosphate_rock/index.html

13 IPCC; https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch7s7-4-3-2.html

14 In the case of animal manure, only ½ of nitrogen savings were accounted. This corresponds to an increased nitrogen plant availability caused by anaerobic digestion treatment.

15 FP-7 Improved Nutrient and Energy Management through Anaerobic Digestion ; www.inemad.eu

16 Note: only nitrogen fertilizers contribution is calculated. Further emissions savings are legitimately expected. Particular conversion factors are subject to further scientific research.

17 Humification coefficient generically used in common soil organic carbon simulation models (NDICEA; Introductory Soil Carbon Balance Model)

18 Note: further scientific research is heavily focusing at the soil carbon sequestration pathways, and the nutrient recovery beyond the nitrogen loop. More CO_2^{eq} reduction pathways may be acknowledged in the future.

19 PPAN Ireland's Response to the EU's Energy and Climate Change Targets; Total emissions 63.8 Mt CO_2^{eq}; http://www.ppan.ie/wp-content/uploads/2015/12/PPAN-climate-and-energy-paper.pdf