



Center for Isotope Research

Greenhouse gases

Aerosols

Stable isotope applications

Radiocarbon analysis & dating

Geo-Energy

Subsurface CO₂ storage

Geothermal energy

Induced seismicity

Subsurface activities

Science & Society Group

Embedment of technology & innovation

Sustainable energy & local conditions

Biobased society & biotechnology in Africa



Combustion Technology

Elementary physical & chemical processes in high temperature energy conversion

Optical & spectroscopic methods for in-situ analysis

Development & characterisation of idealised model systems

Analysis of new fuels (fossil & sustainable)

Center for Environmental Sciences (IVEM)

Socio-technical systems integration

System analysis, modelling & simulation

Biobased systems

Impact of climate change (analysis)

Ocean Ecosystems

Global change & microbes

Fluid mechanics & energetics

Algal applications

Marine biomimetics



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SUSTAINABLE DAIRY MANURE-BASED BIOGAS?

– a perspective from the combined biogas and agricultural
production system

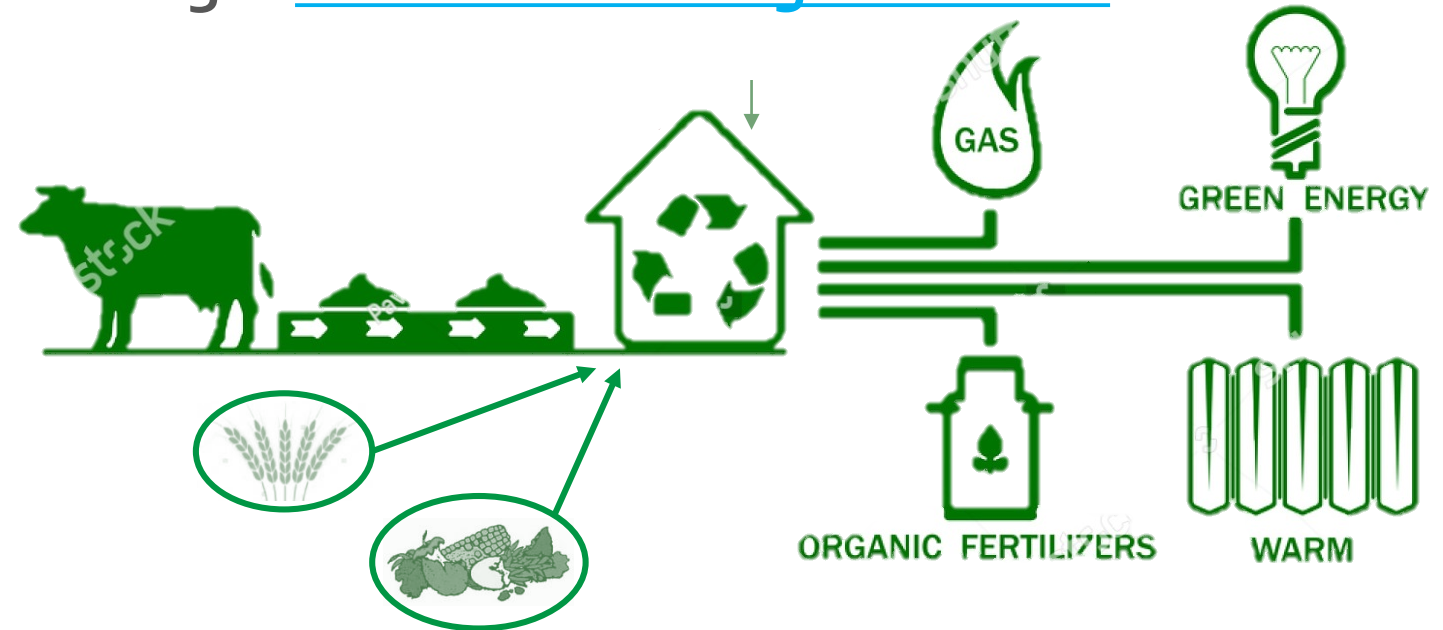
27/03/2018

Dieu Linh Hoang / IVEM PhD student



1. Introduction

1.1. Biogas as a Climate change measure!



- Provides energy → reduces the world dependency on fossil fuels
- “Uses renewable carbon”
- Captures CH₄ – a strong GHG emission
- “Doesn’t interfere nutrient recycling”



1. Introduction

1.1. Biogas as a Climate change measure!



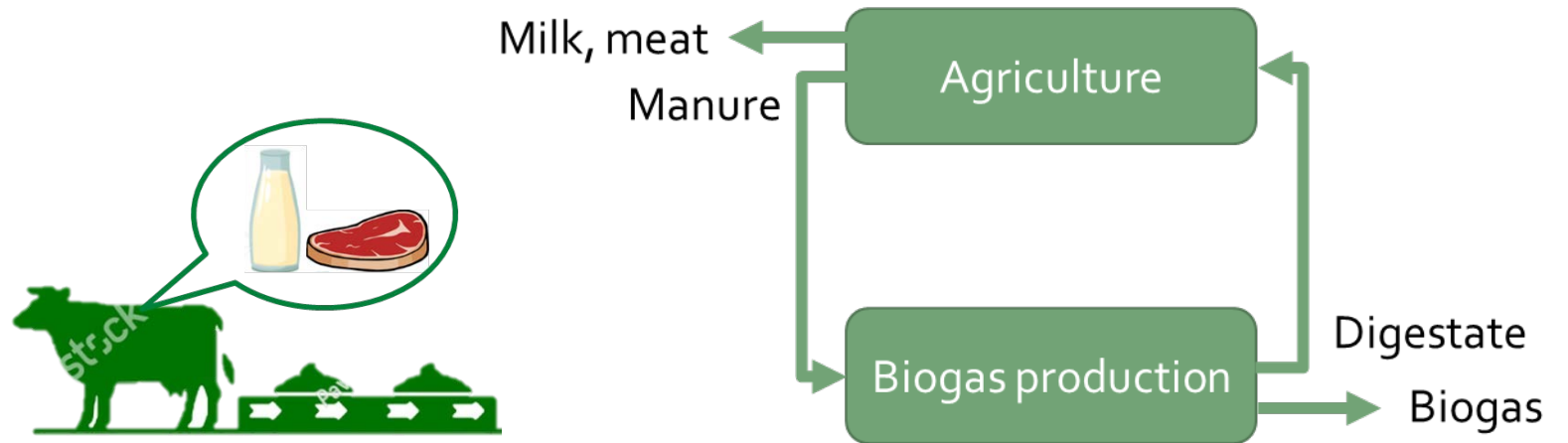
Cattle manure:
 ~ 60 Mtonnes /yr (2017)
 ~ 11 PJ electricity /yr
 ~ 2.5% NL electricity consumption



1. Introduction

1.2. Other environmental links of biogas

- Biogas feedstocks are mostly by-products of agriculture
- Digestate is used in agriculture



→ Sustainability of biogas? Agriculture perspective is a part!!!!

1. Introduction

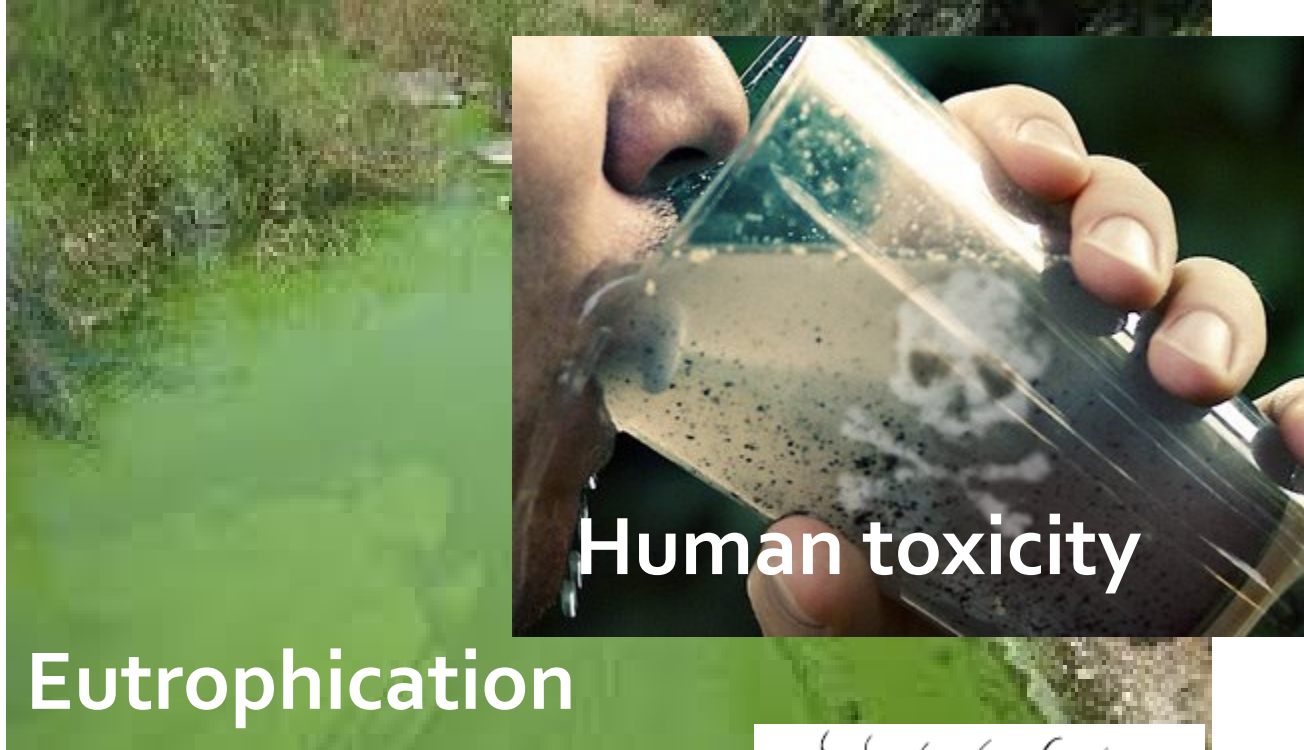
Nitrogen - a critical environmental issue of agriculture



- N is primarily responsible for the growth of plants
- N is the largest largest portion of artificial nutrients provided by farmers
- N emission and N surplus causes significant environmental impacts



Nitrogen environmental impact from agriculture

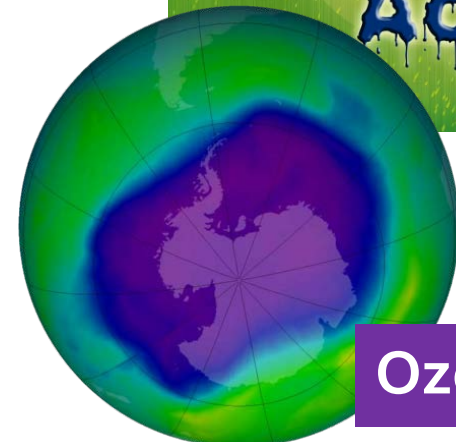
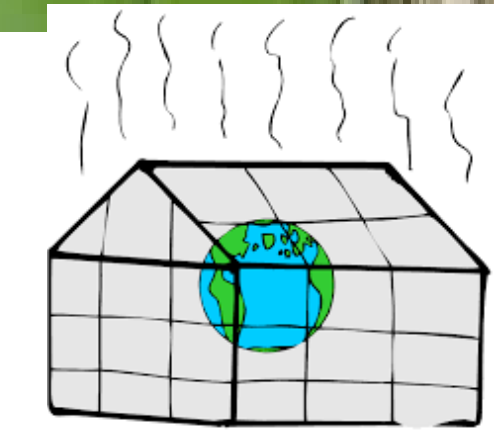


NO_3^-
& indirect losses via NO_3^-

NH_3

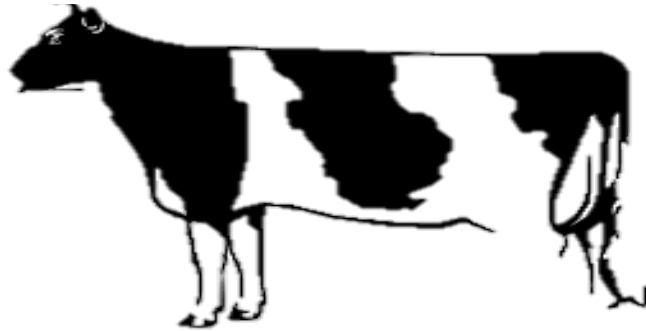


NO_x



N_2O

2. Research questions



No biogas

Mono digestion (manure)

Co-digestion (manure:silage maize 1:1)

In this presentation:

- How the biogas production systems look like?
- What are the nitrogen emissions of each biogas production system?



3. Systems description



Dairy farmers



Biogas producers

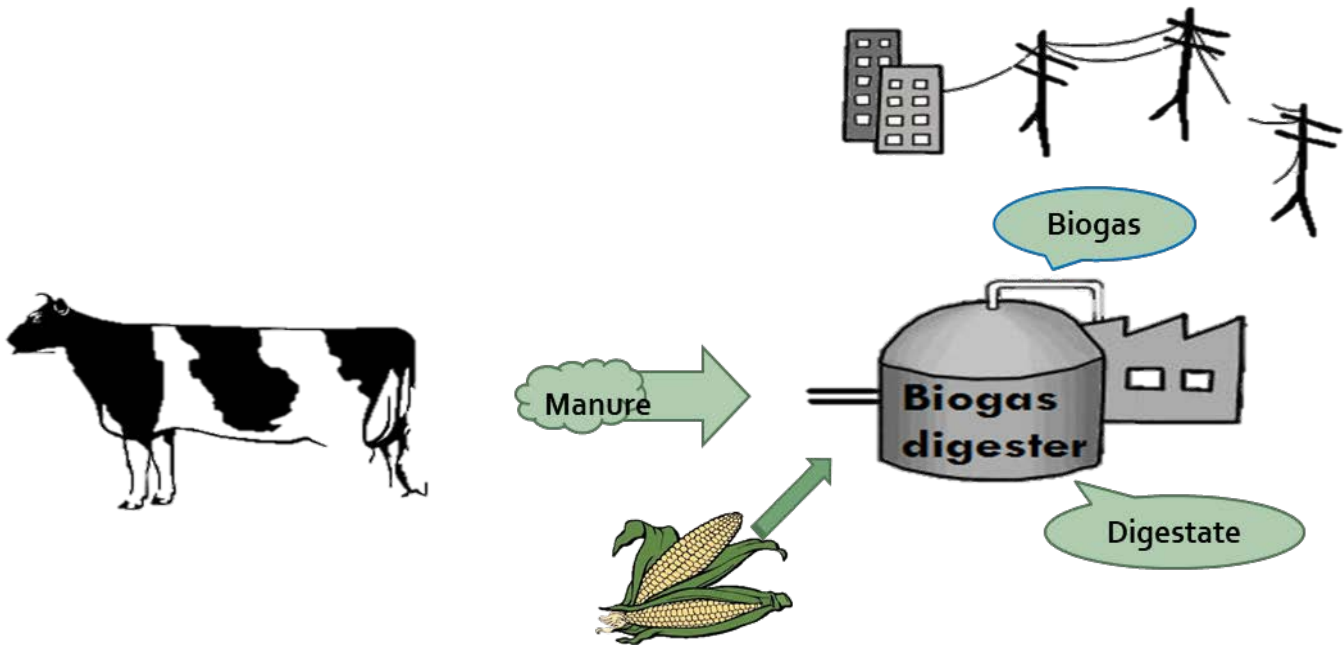
& Production chain approach





3. Systems description

Production system seen by biogas producers



| Substrates | Biogas yield | |
|--------------|--------------|------------------------------|
| Manure | 33 | m ³ biogas/ton FM |
| Silage maize | 172 | m ³ biogas/ton FM |



3. Systems description

Production system seen by dairy farmers



Example of Dutch dairy farm

- Dairy cows: 161
- Milk production: 8996 kg/cow/year
- Young stock: 0
- Fat: 4.47%
- Grassland: 46.9 ha
- Protein: 3.48%
- Maize land: 19.9 ha

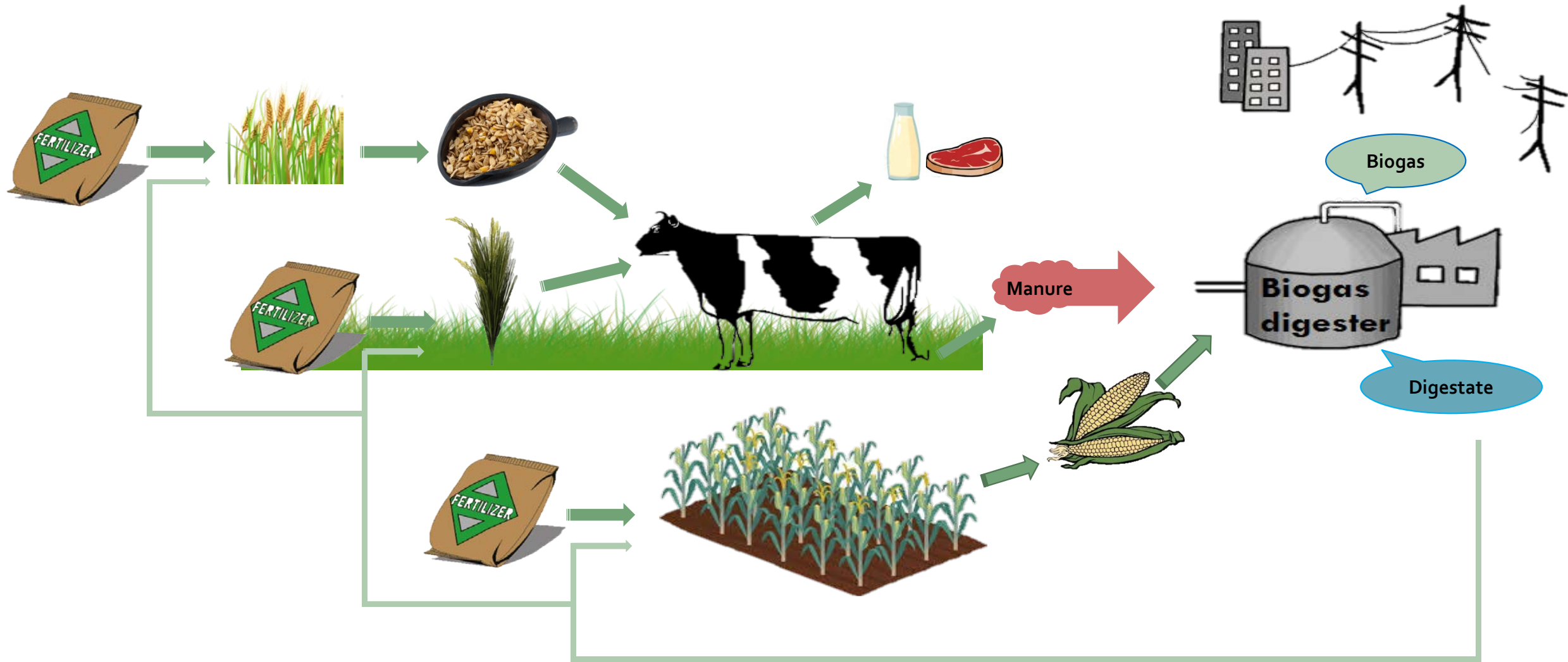




3. Systems description

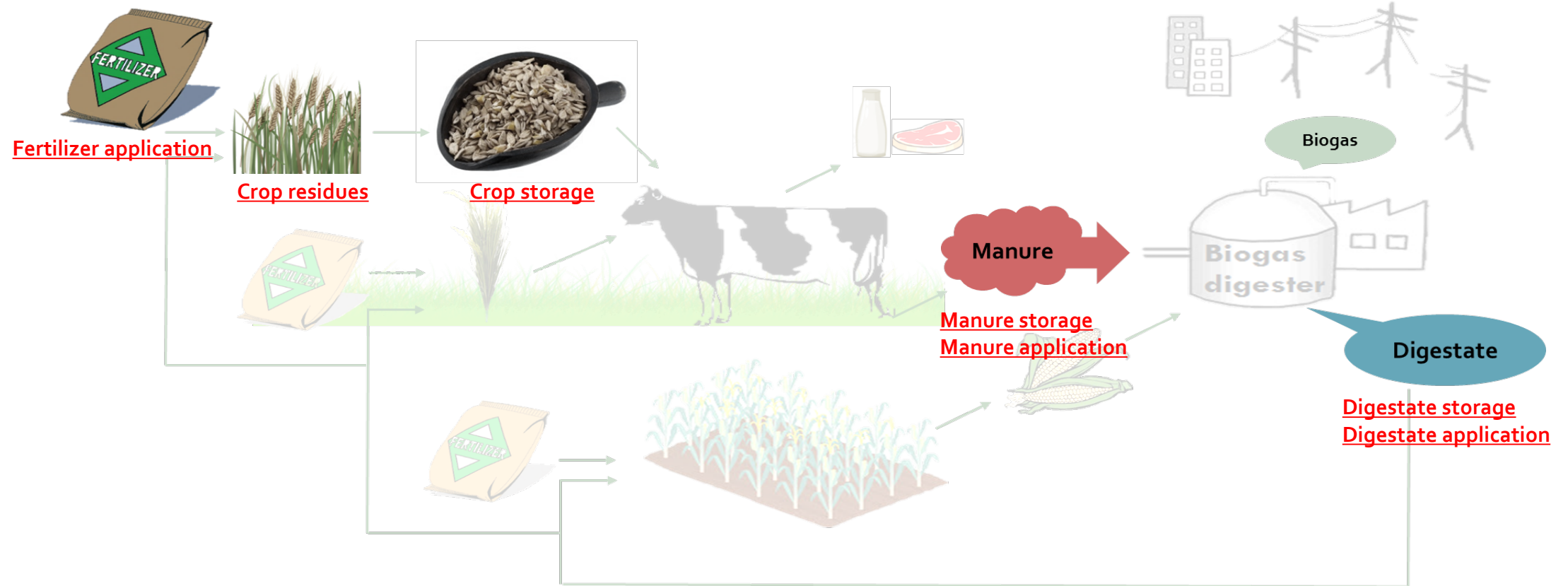
Should-be-seen dairy production system

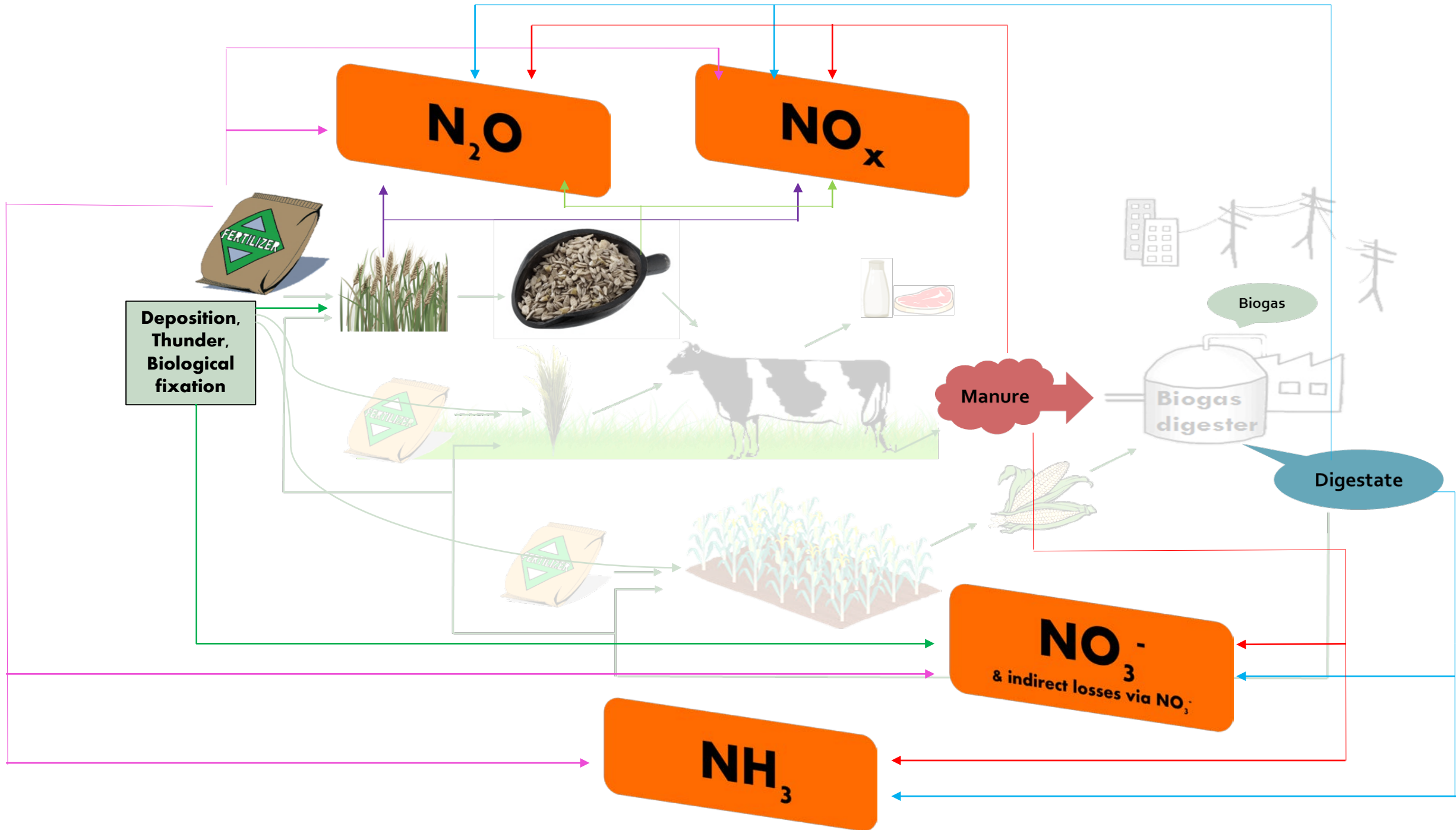




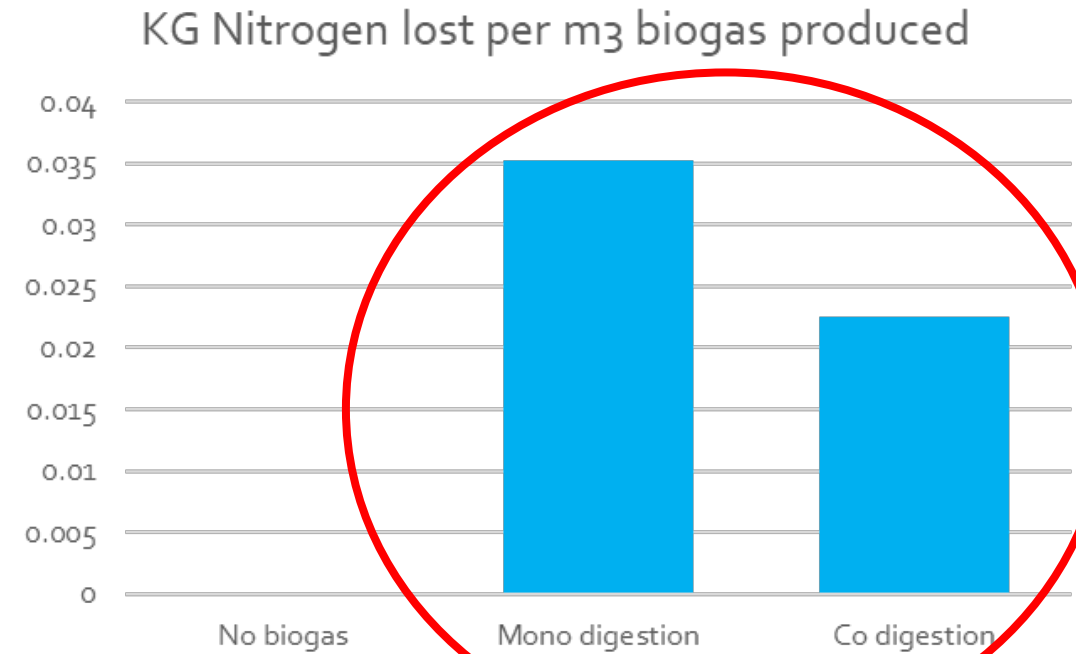
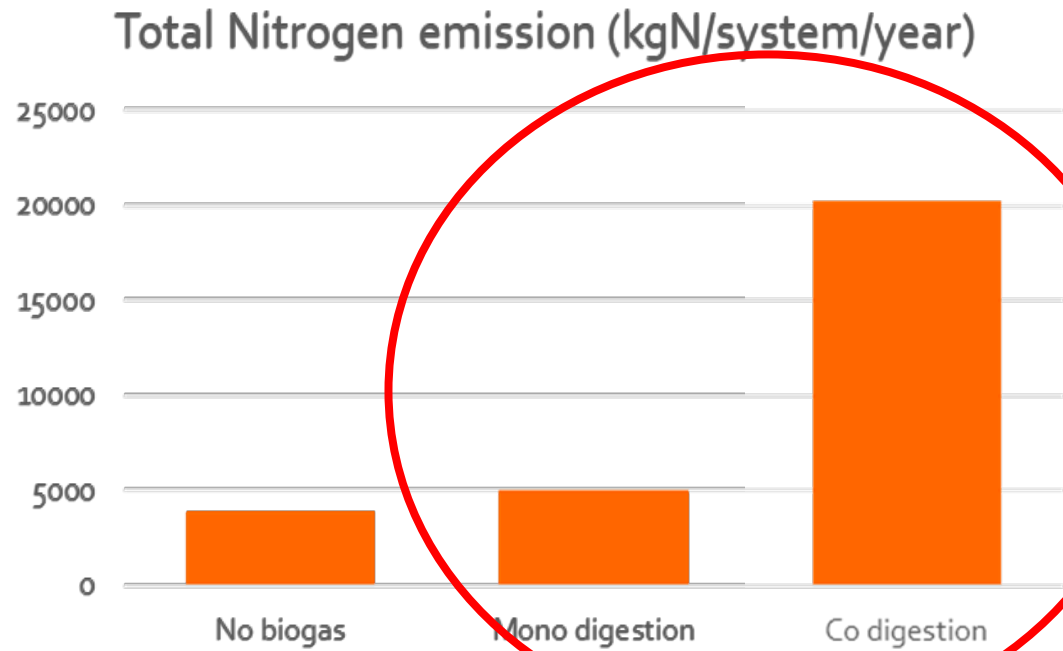
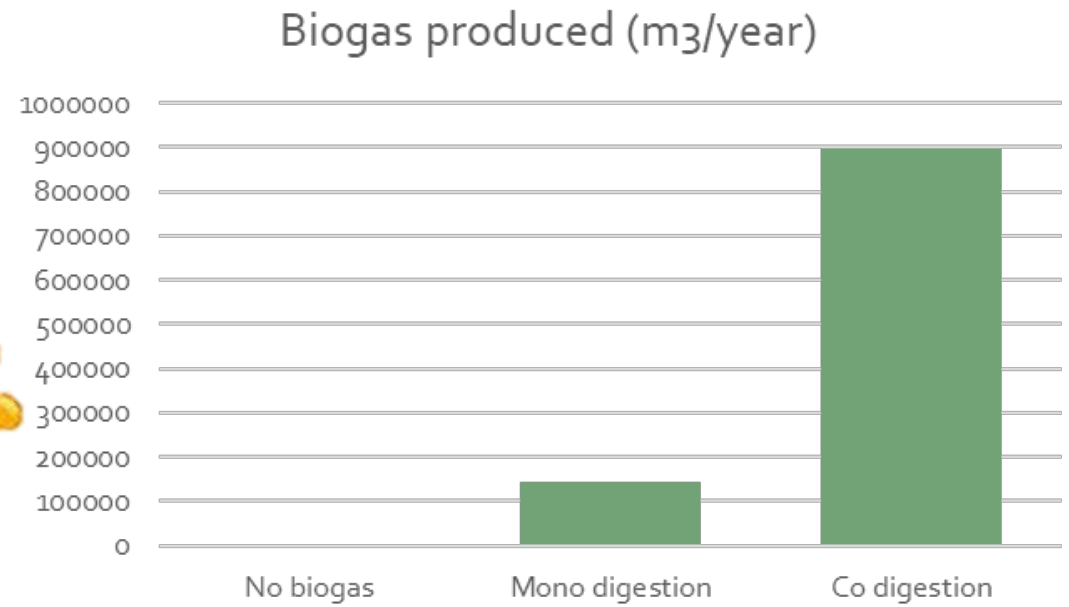
Should-be-seen biogas production system

4. Quantifying nitrogen flows

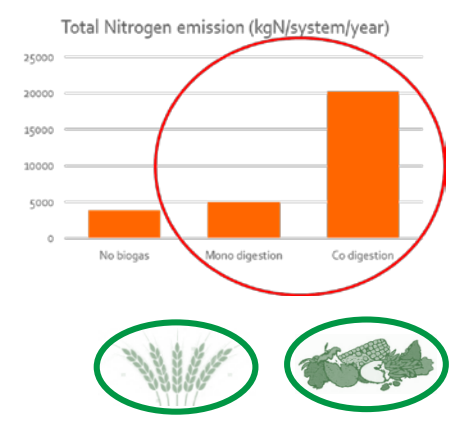
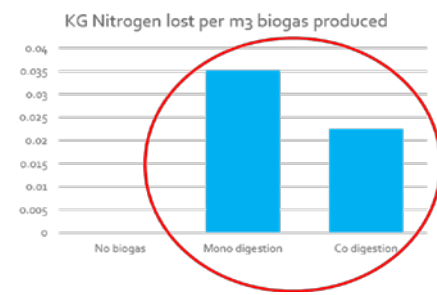
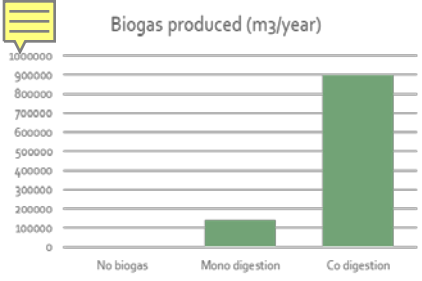




5. Results & Discussion



(Emission from feed production is excluded)



Green energy



6. Take home messages

Biogas production causes more nitrogen emission than no biogas

The sustainability assessment depends on the metrics used



**Thank you for
your attention !!**



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| | |
|-------------------------------|--|
| | |
| Organic waste | https://aggie-horticulture.tamu.edu/earthkind/landscape/dont-bag-it/chapter-2-composting-fundamentals/ |
| Pictures on the biogas system | http://i.huffpost.com/gen/3462210/images/o-CLIMATE-CHANGE-facebook.jpg http://www.eqmagpro.com/wp-content/uploads/2015/12/Renewable-Energy1.jpg http://www.iffcolive.com/wp-content/uploads/2016/10/Milk_Revolution3-1500x1000.jpg https://previews.123rf.com/images/jehsomwang/jehsomwang1402/jehsomwang140200129/26267549-vecteur-du-cycle-de-vie-de-l-arbre-Banque-d%27images.jpg http://media.gettyimages.com/photos/dead-fish-flows-at-south-coast-of-outer-lake-of-dianchi-lake-polluted-picture-id480555368 https://pbs.twimg.com/media/CvXYsYdXyAEg5wE.jpg https://static01.nyt.com/images/2010/05/19/business/19Cowsjp/19Cowsjp-articleLarge.jpg http://www.idfws2016.com/wp-content/uploads/2016/09/Biogas-digester-Holstein-cows.jpg |
| crop | http://www.clipartpanda.com/clipart_images/crop-symbol-isolated-on-white-66923045 |
| Drink water | https://s3.amazonaws.com/user-media.venngage.com/99b4fdd8e3e2cce91fcc8702fe52c36d.jpg |
| Dead fish | http://1.bp.blogspot.com/-Y9PwMkQqgKg/T7Z9JTaiLrI/AAAAAAAAALo/ugeAjVbbQTY/s1600/Dead+fish+floating+in+polluted,+eutrophic+river+-+iStock_Medium.jpg |
| eutrophication | https://phys.org/news/2013-10-toxicity-algal-blooms-tied-nutrient.html |
| Greenhouse gas | https://encrypted-tbno.gstatic.com/images?q=tbn:ANDgGcRVzcFoSEPSLPgYAX6rciW_-ICArf3FdZAzNqstqXPbgqpu7ob |
| Ozon depletion | https://en.wikipedia.org/wiki/Ozone_depletion |
| Air pollution | https://cdn.images.express.co.uk/img/dynamic/11/590x/Cough-symptoms-862572.jpg |
| Nitrogen plant | http://www.knowledgebank.irri.org/training/fact-sheets/nutrient-management/deficiencies-and-toxicities-fact-sheet/item/nitrogen-deficiency |
| Green earth | https://beira.pt/wp-content/uploads/2017/06/energia-verde.jpg |
| Biogas plants | https://assets.ecotricity.co.uk/content/download/2378/svg_image/CONTENT-how-green-gas-works-step2.svg |
| Subsidy man | https://vectortoons.com/wp-content/uploads/2013/07/VecorToonso7222013002.jpg |
| Superman money | https://i.pinimg.com/originals/ff/ea/ba/ffeabab6a5ccc6c4c744ebe8e1ce1a5a.jpg |
| Coughing man | http://clipartmag.com/cartoon-school-images |
| Green smoke | https://encrypted-tbno.gstatic.com/images?q=tbn:ANDgGcQcFfGovWvzIT3otZbf3FVantIhd4HyMismhCK2fJW43pid_ZLh |
| Thank you note | http://www.johnlund.com/page/1513/contented-cow-a-holstein-cow-stands-in-a-green-pasture-with-her-spots-forming-a-happy-face.asp |