

# Digeponics

- Use of digestate as growing medium  
and fertilizer in greenhouses

Ketil Stoknes, Lindum, Norway

IBBA 2017, Poznan

# Lindum activities



# Lindum

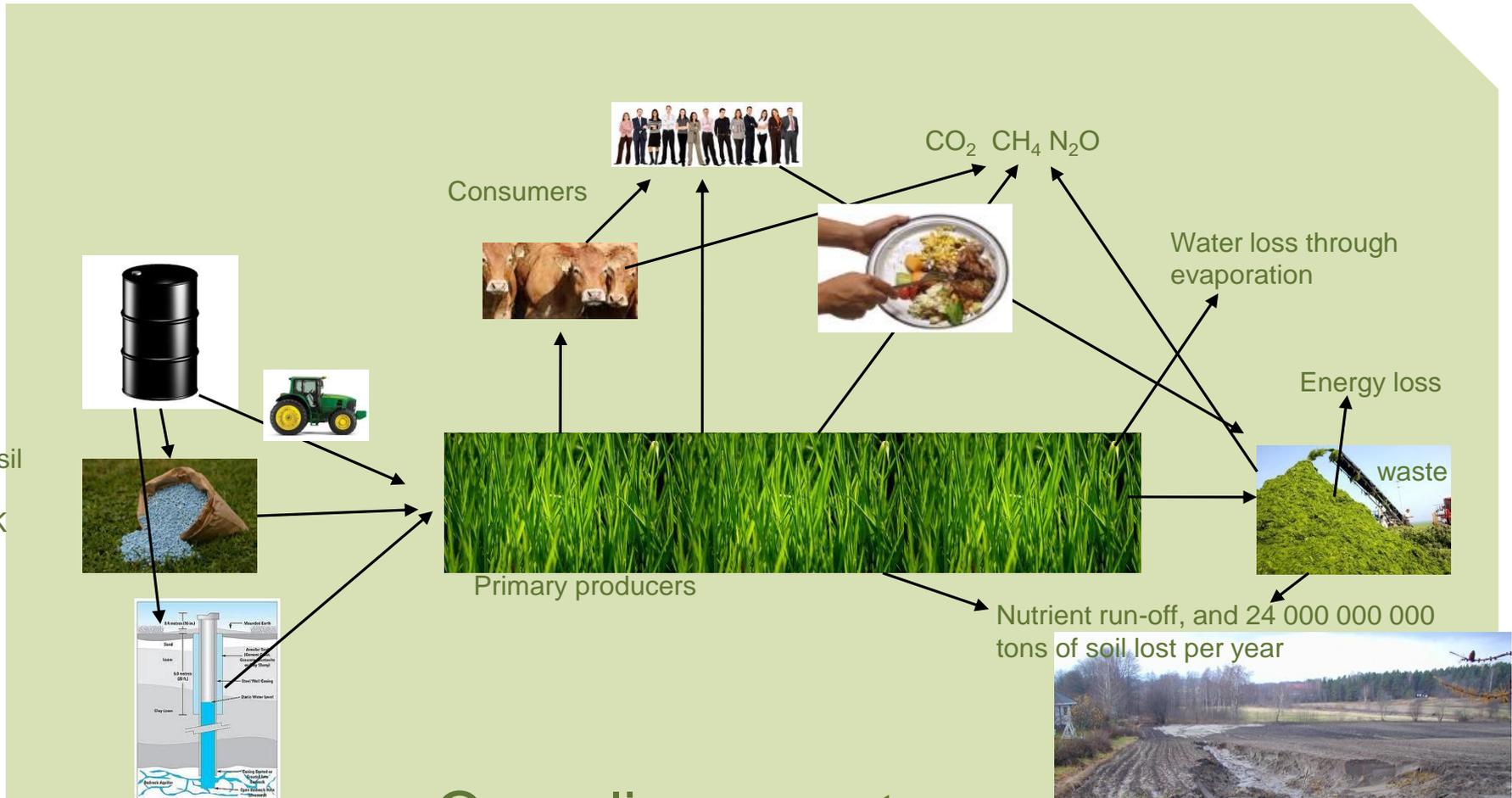
- Originally the “dump” of Drammen City
- Owner: Drammen Municipality 100 %
- Converted to a limited company in 2001 – oriented towards the open waste market
- Now an industrial group with main department in Drammen – 6 daughter companies
- 8 employees and MNOK 16 turnover in 1997
- 192 employees and MNOK 511 turnover in 2016



# Lindum

- Waste processing, all sorts of waste
- Container for hire/transport
- Sorting and recycling centre
- Landfill
- Energy and fuels production and sales
- Composting/biogas (Organic waste, sludge, green waste)
- Recycling of materials externally
- Consulting services / R & D
- Odour reduction, gas cleaning (biofilters and air systems)
- Other processing of waste, sludge and contaminated soil/sediments
- Soil and biofertilizer production/-sale

# How current food production is not circular

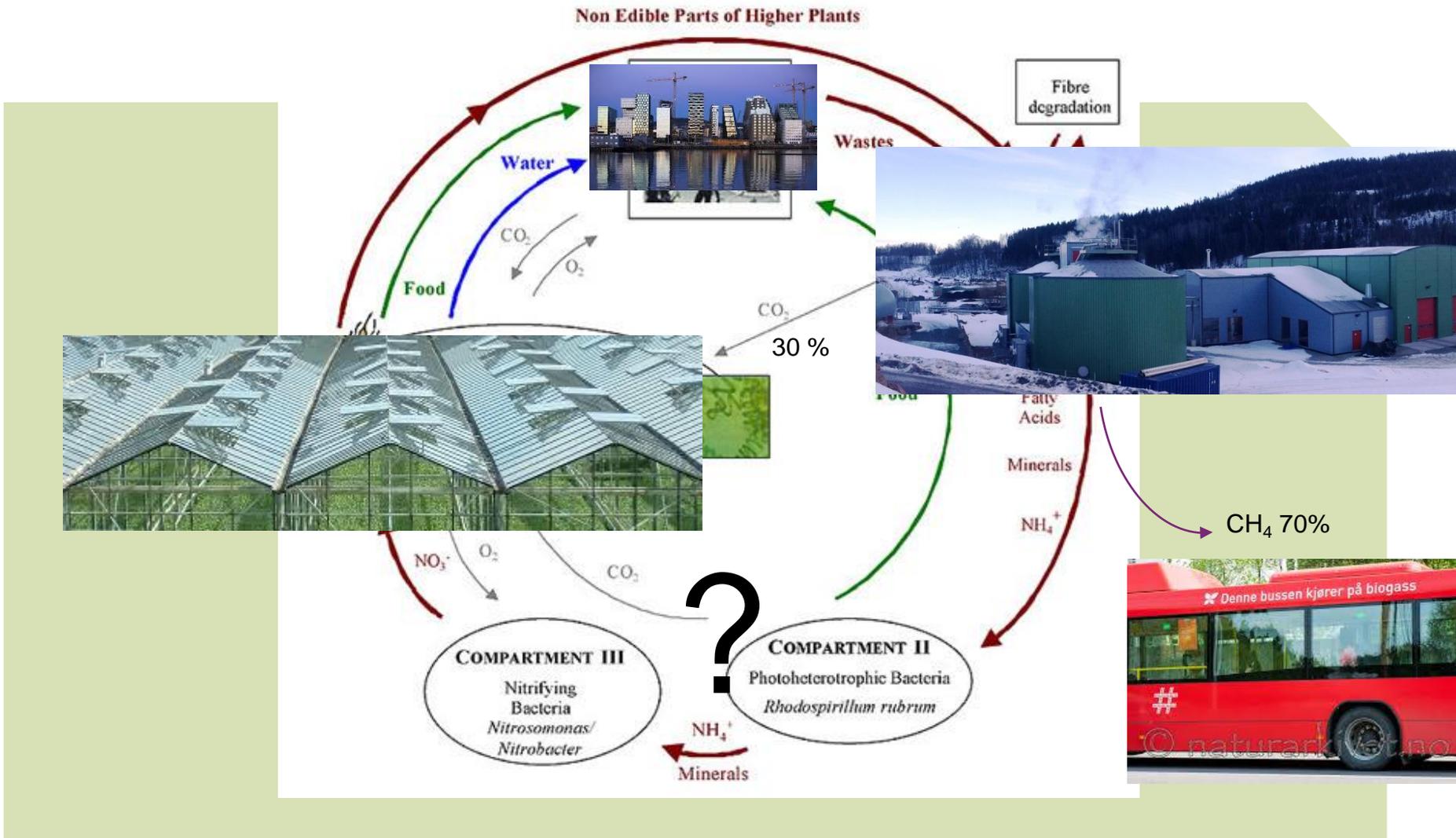


Open linear system

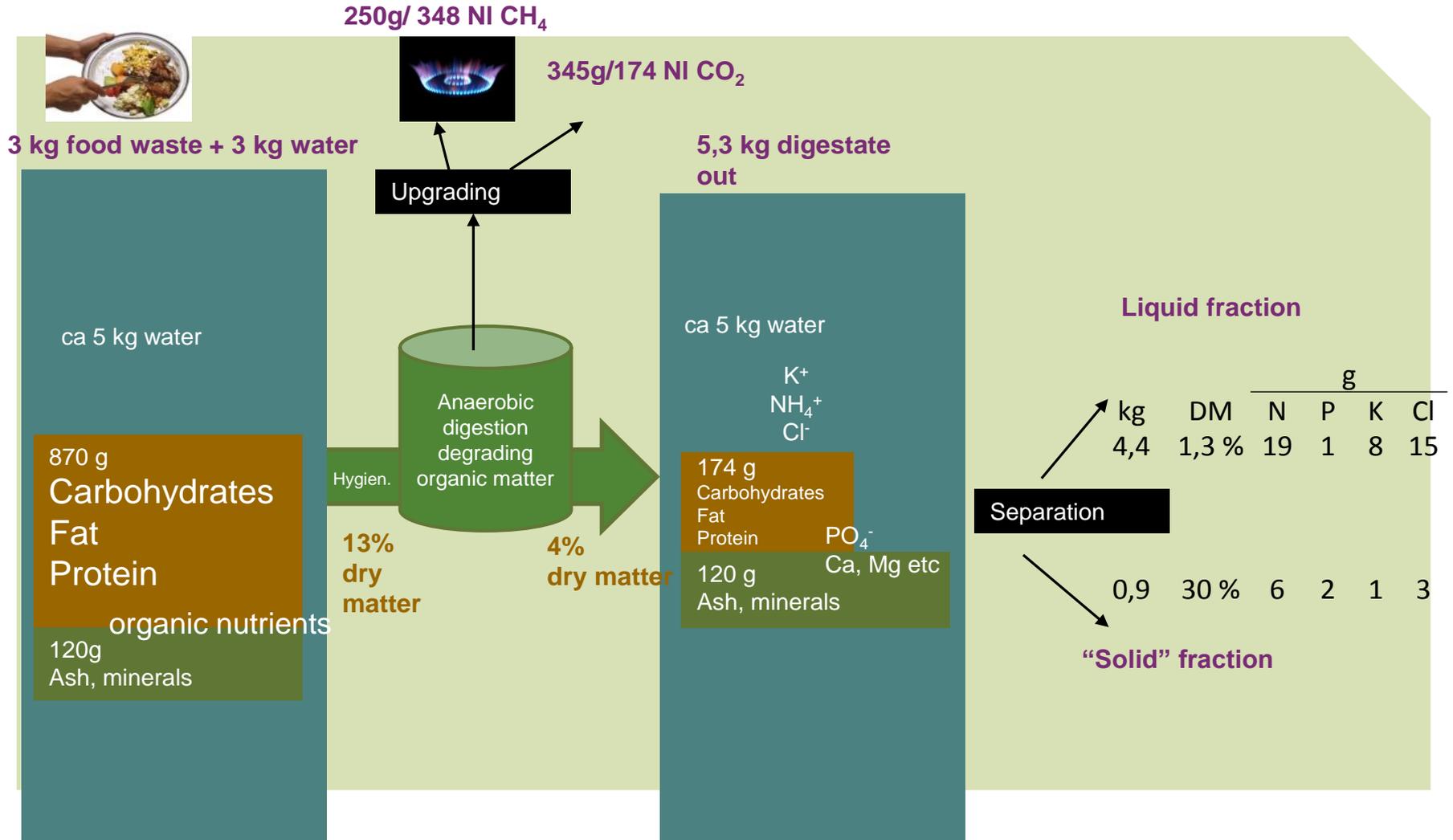


- for miljøets skyld

# The ESA loop for space is circular....



# What happens in a biogas plant?



# Digestate





Illustration: food and waste cycles demonstrated at Lindum







# 2006-2009: sustainable «beef» directly from digestate



## Research Article



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## Anaerobically digested food waste in compost for *Agaricus bisporus* and *Agaricus subrufescens* and its effect on mushroom productivity

Ketil Stoknes,<sup>a\*</sup> David M Beyer<sup>b</sup> and Erik Norgaard<sup>c</sup>

### Abstract

**BACKGROUND:** Source-separated food waste is increasingly being treated by means of hygienisation followed by anaerobic digestion. The fibrous digester residue (digestate) is a potential mushroom substrate, while heat from the biogas can provide steam for the cultivation process. Using bag experiments the present study explored digestate as a full substitute for chicken manure conventionally used in mushroom composts.

Status  
was:

## Hydroponic system for the treatment of anaerobic liquid

K. Krishnasamy, J. Nair and B. Bäuml

### ABSTRACT

The effluent from anaerobic digestion process has high concentrations of nutrients, particularly nitrogen, essential for plant growth but is not suitable for direct disposal or application due to high chemical oxygen demand (COD), low dissolved oxygen (DO), odour issues and is potentially phytotoxic. This research explored the optimum conditions of anaerobic effluent for application and dilutions of the effluent required to obtain better plant growth. A small-scale hydroponic system was constructed in a glasshouse to test different concentrations of anaerobic effluent against a commercial hydroponic medium as the control for the growth of silverbeet. It was found that the survival of silverbeet was negatively affected at 50% concentration due to low DO and  $\text{NH}_4$  toxicity. The concentration of 20% anaerobic liquid was found to be the most efficient with highest foliage yield and plant growth. The hydroponic system with 20% concentrated effluent had better utilisation of nutrients for plant growth and a COD reduction of 95% was achieved during the 50-day growth period. This preliminary evaluation revealed that the growth and development of silverbeet was significantly lower in anaerobic effluent compared with a commercial hydroponic plant growth solution. The nutrient quality of anaerobic effluent could be highly variable with the process and the waste material used and dilution may depend on the nutrient content of the effluent. It is recommended that, a pre-treatment of the effluent to increase DO and reduce ammonium content is required before plant application, and simple dilution by itself is not suitable for optimum plant growth in a hydroponic system.

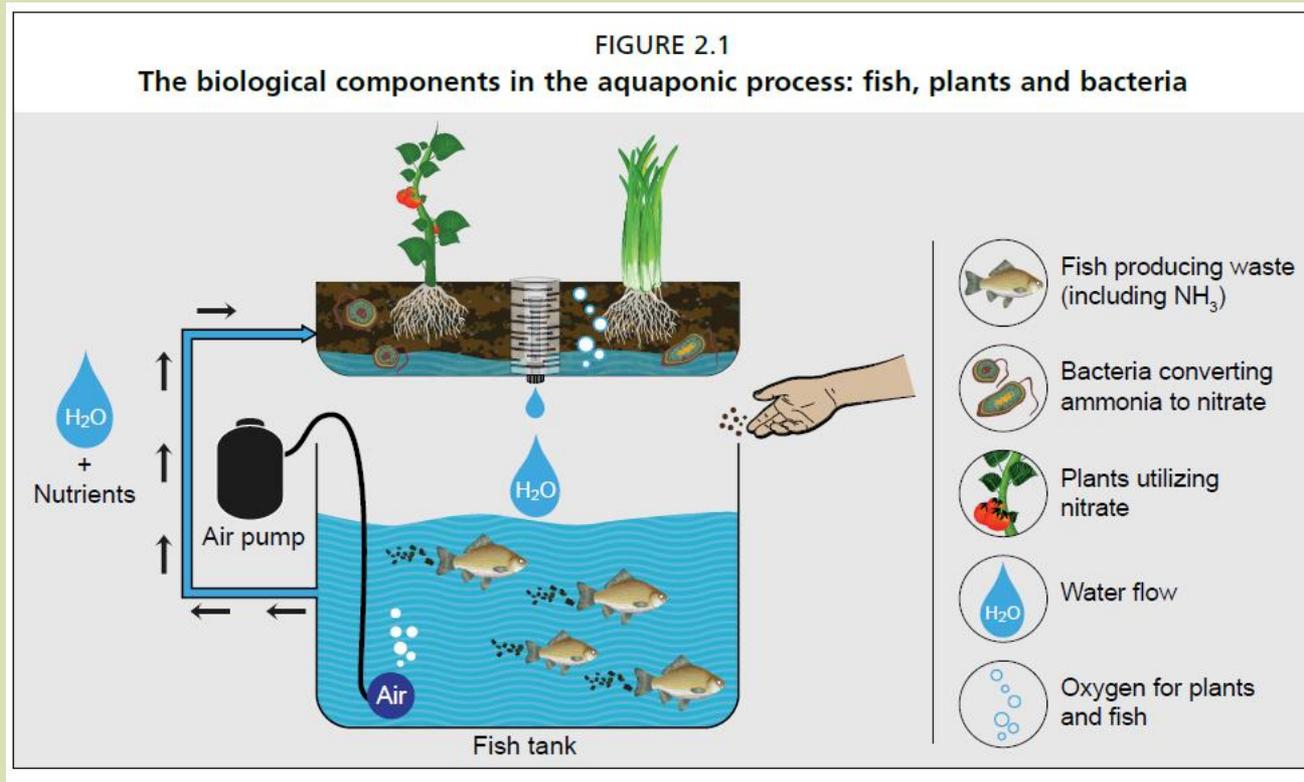
**Key words** | anaerobic digestion, anaerobic effluent, hydroponics, silverbeet, wastewater treatment

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# Aquaculture + hydroponics = Aquaponics



# Digestion + hydroponics = *Digeponics*



# Digestate + earthworms = vermicompost



# Vermicompost makes wonders....

Lindum compost  
mix w/  
vermicompost 😊



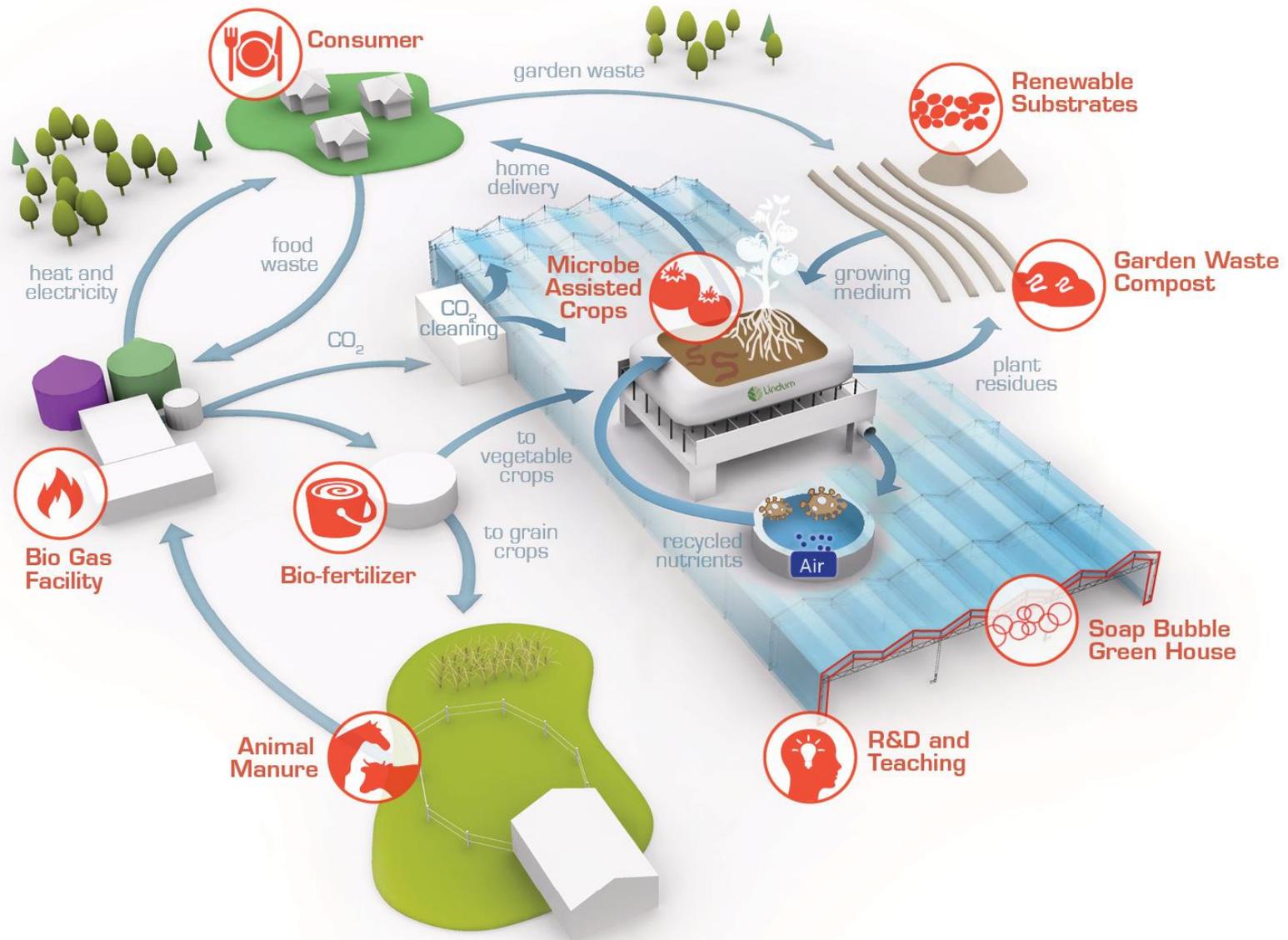
Competitors  
compost mix w /  
same nutrient  
level

Cherry Bioest HIGH

06-29-2016 Wed 20:30:40

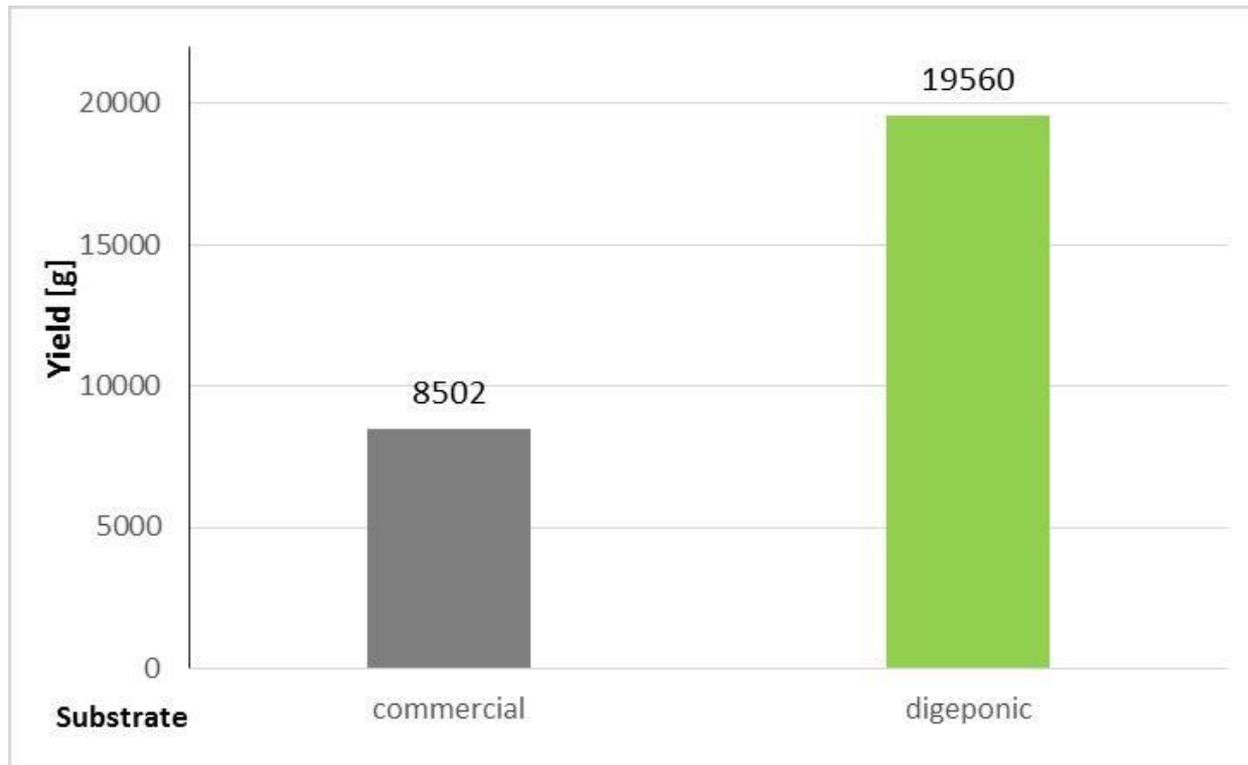
Day 3

TU-IP310PI\_L



98% reduction in tomato C footprint

# Yield of cucumbers





ELSEVIER

Contents lists available at [ScienceDirect](http://www.sciencedirect.com)

# Waste Management

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

## Efficiency of a novel “Food to waste to food” system including anaerobic digestion of food waste and cultivation of vegetables on digestate in a bubble-insulated greenhouse



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### ABSTRACT

At urban locations certain challenges are concentrated: organic waste production, the need for waste treatment, energy demand, food demand, the need for circular economy and limited area for food production. Based on these factors the project presented here developed a novel technological approach for processing organic waste into new food. In this system, organic waste is converted into biogas and digester residue. The digester residue is being used successfully as a stand-alone fertilizer as well as main substrate component for vegetables and mushrooms for the first time - a “digeponics” system - in a closed new low energy greenhouse system with dynamic soap bubble insulation. Biogas production provides energy for the process and CO<sub>2</sub> for the greenhouse. With very limited land use highly efficient resource recycling was established at pilot scale.

In the research project it was proven that a low energy dynamic bubble insulated greenhouse can be operated continuously with 80% energy demand reduction compared to conventional greenhouses. Commercial crop yields were achieved based on fertilization with digestate; in individual cases they were even higher than the control yields of vegetables such as tomatoes, cucumber and lettuce among others. For the first time an efficient direct use of digestate as substrate and fertilizer has been developed and demonstrated.

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# The Magic Factory

- Biogas plant with capacity:
  - 60 000 t food waste
  - 50 000 t animal manure
- Started operation 2015
- Owned by Greve Biogass (Municipality of Tønsberg)
- Operated by Lindum
- Upgraded biomethane serves 80% of the buses in the region
- Low treatment cost
- Manure inclusion improves process and reduces GHG emissions from the area greatly
- Integrated greenhouse and teaching centre for communicating the green shift...
- Second stage for WWTP sludge initiated



# The Magic Greenhouse

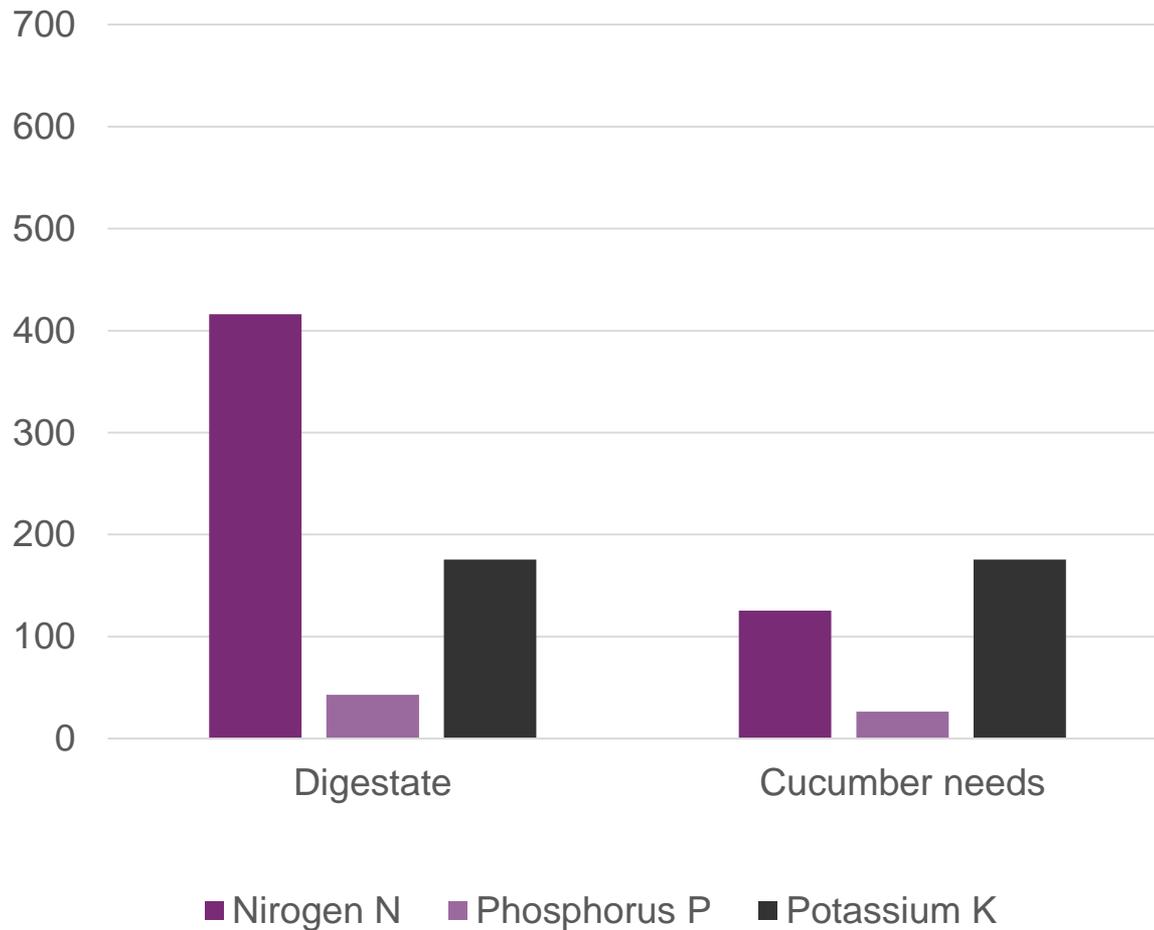
Grønt Skifte AS («Green Shift Ltd») established by

- Group of greenhouse growers
- Lindum
- VESAR (regional waste company)
- BBBLS (Greenhouse technology company)

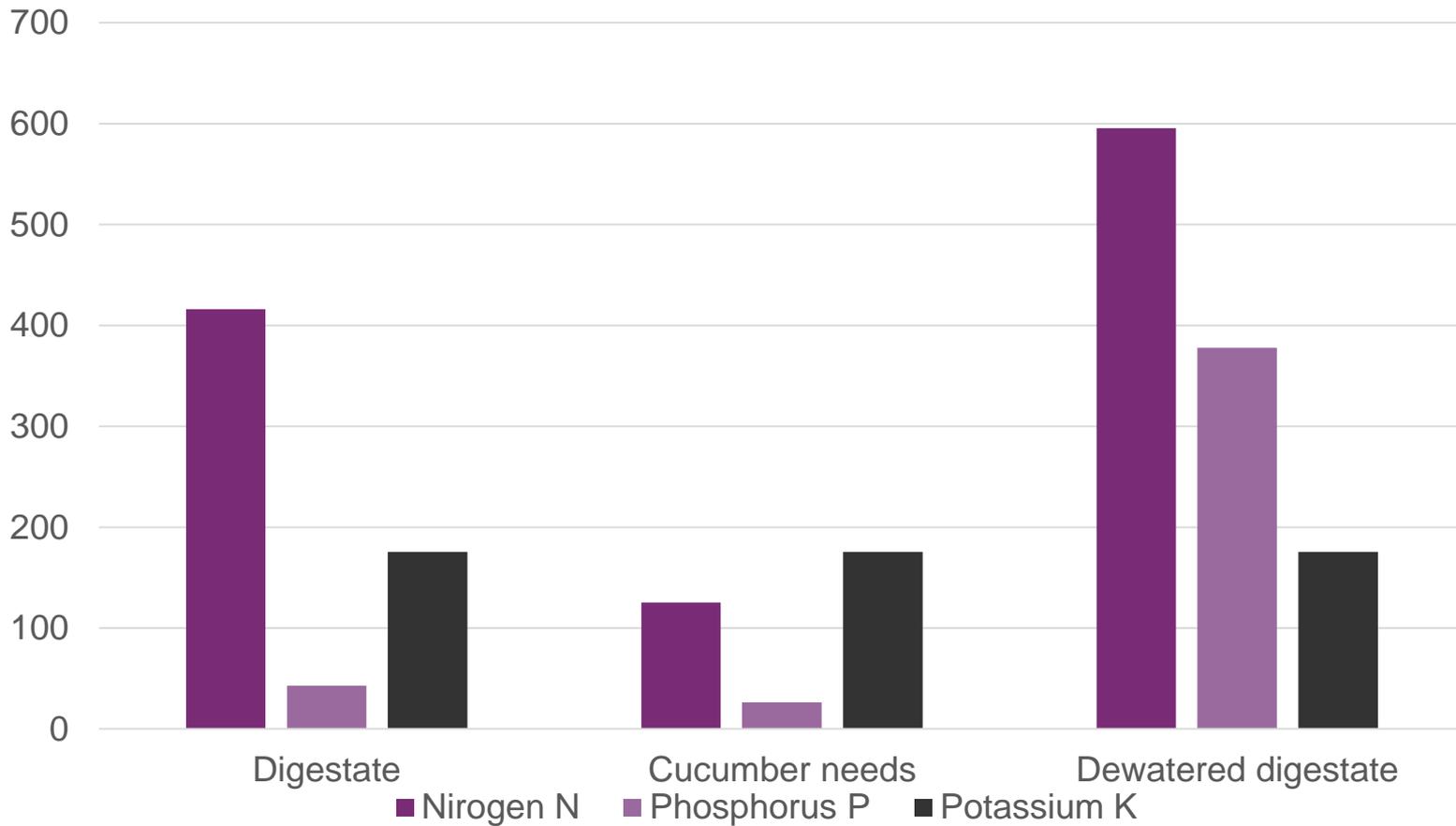
Plans for up-scaled  
greenhouses

Greenhouse pilot  
2017

# Digestate composition compared to cucumber needs

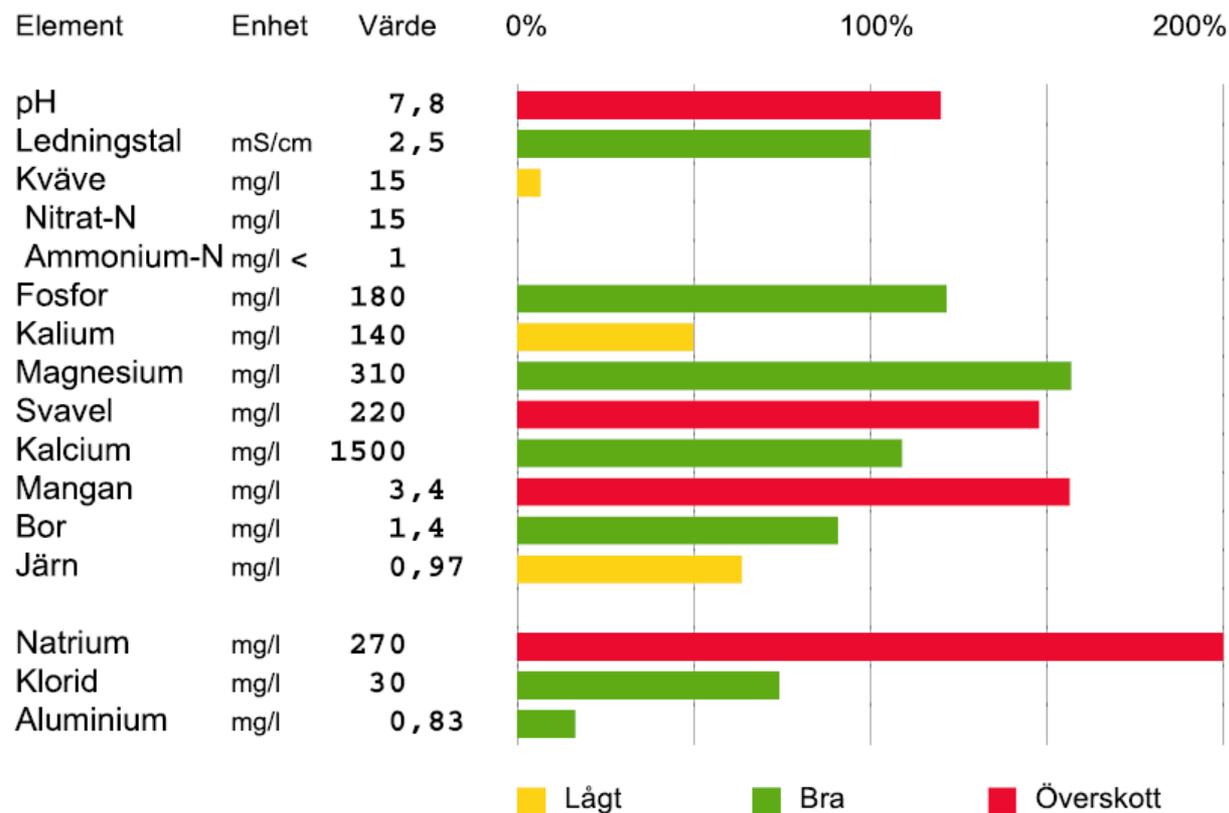


# Digestate composition compared to cucumber needs



Datum 2017-04-07  
Prov Tomat  
Provnamn **Skalleberg - Biorest low**

Lerpeveien 155  
3036 Drammen  
NORWAY



Analysnummer 16893  
Datum 2017-08-11  
Typ Tomat  
Provnamn **2 High pH**

Lindum AS  
Lerpeveien 155  
NO-3036 DRAMMEN  
NORWAY

