



MINISTRY OF FOREIGN AFFAIRS  
OF DENMARK  
*The Trade Council*



Food & Bio Cluster  
Denmark

**INDUSTRIENS  
FOND** FREMMER DANSK  
KONKURRENCEEVNE  
The Danish Industry Foundation



Danish Energy  
Agency



WASTE,  
RECYCLING  
AND BIOGAS  
ADVISORY

**Renew**  
energy

# WELCOME TO THE WEBINAR 'FOOD WASTE & BIOGAS; DRIVING THE CIRCULAR ECONOMY IN DENMARK'

MARCH 24<sup>TH</sup>, 2021

Claus Mortensen, Business Development Manager at Food & Bio Cluster Denmark and INBIOM

Christopher Michael Voell, Senior Advisor in Ministry of Foreign Affairs Trade Council

Lars Ravn Nielsen, CEO of Gemidan Ecologi A/S

Poul Ejner Rasmussen, CEO and founder of RENEW Energy A/S



**Food & Bio Cluster**  
Denmark

## GREENING THE GRID USING WASTE

– The quiet revolution of biomethane in Denmark and the role of food waste

International Business Development Manager  
Claus Mortensen, Food & Bio Cluster Denmark

*Food & Bio Cluster Denmark is your agrifood and bioresource gateway to one of the most sustainable countries in the world.*

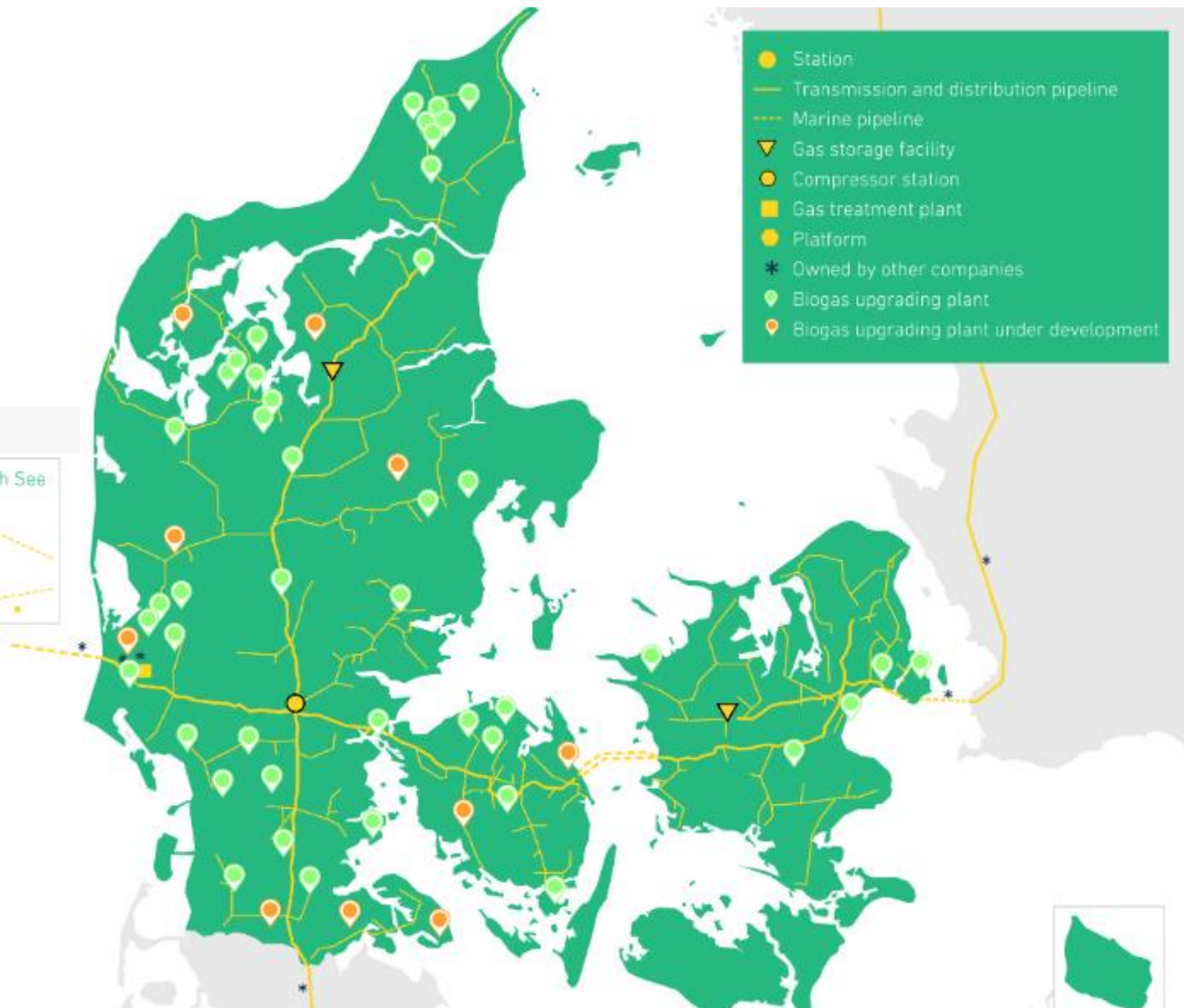
[cm@foodbiocluster.dk](mailto:cm@foodbiocluster.dk) // [www.foodbiocluster.com](http://www.foodbiocluster.com)





## RENEWABLE ENERGY & CIRCULARITY

- 2/3 of all renewable energy in Denmark is bioenergy. 34% of all energy production is RE.
- Goal: Climate neutral by 2050 – 70% by 2030 (baseline: 1990)
- All organic household waste to be collected by 2023.
- Green policies: Overall strong political consensus across the 10 parties in the Parliament.
- Triple Helix Cooperation key!



# WHY BIOGAS?

## Agri-environment

Less smell and leaching  
Less methane and laughing gas slip  
Higher availability of nutrients  
Proper handling of food waste

## Energy

Renewable and storable gas that replace fossil fuels in transport and high temp. industries  
Enables companies to be green  
Opportunities to integrate wind power in the gas system

## Economy

Jobs through local value chains  
Energy independence

# THE DANISH APPROACH

## Circular economy

Urban-country “cooperation”  
Co-digestion: Agri-, food-, industrial wastes  
Fertilizer - high value for organic farming  
AD is much more than just energy

## Technology & Process

Economy of scale, but no size fits all  
Mainly thermophilic processes in CSTR  
Flexible plants putting gas to the grid

## Ownership & Management

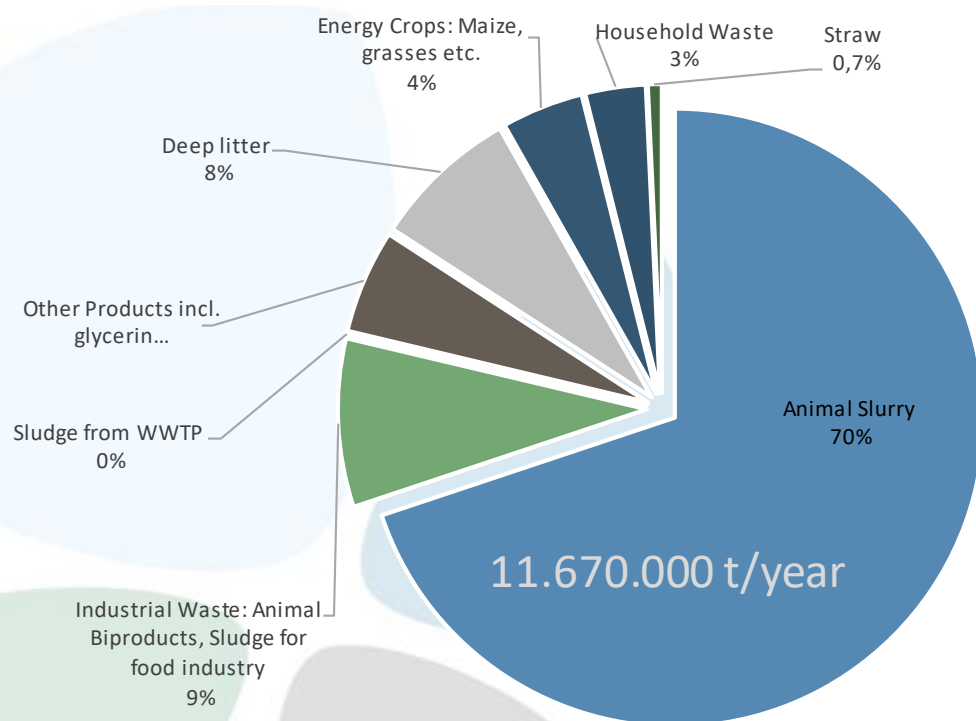
Biomass suppliers co-invest  
Long contracts and partnerships on in/output  
Operation is key and not a part time job!



# FROM FARM BASED TO INDUSTRIAL BIOGAS PLANTS IN A FEW DECADES

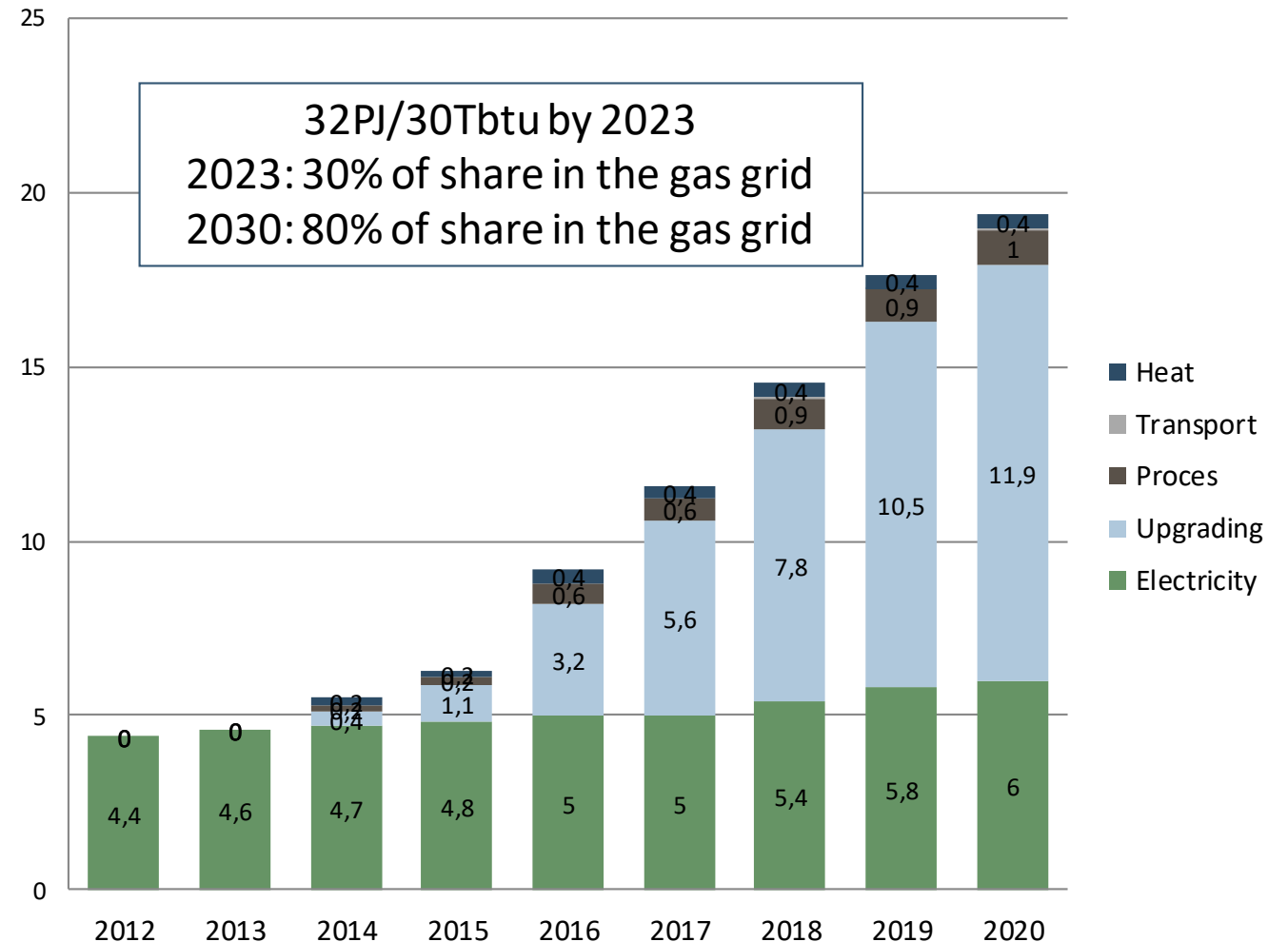
## Currently 170 biogas plants in Denmark

- 56 waste water plants
- 6 industrial plants (food waste)
- 28 landfills (no more landfills are build)
- 27 agriculture co-op plants (increasing)
- 49 farm based plants

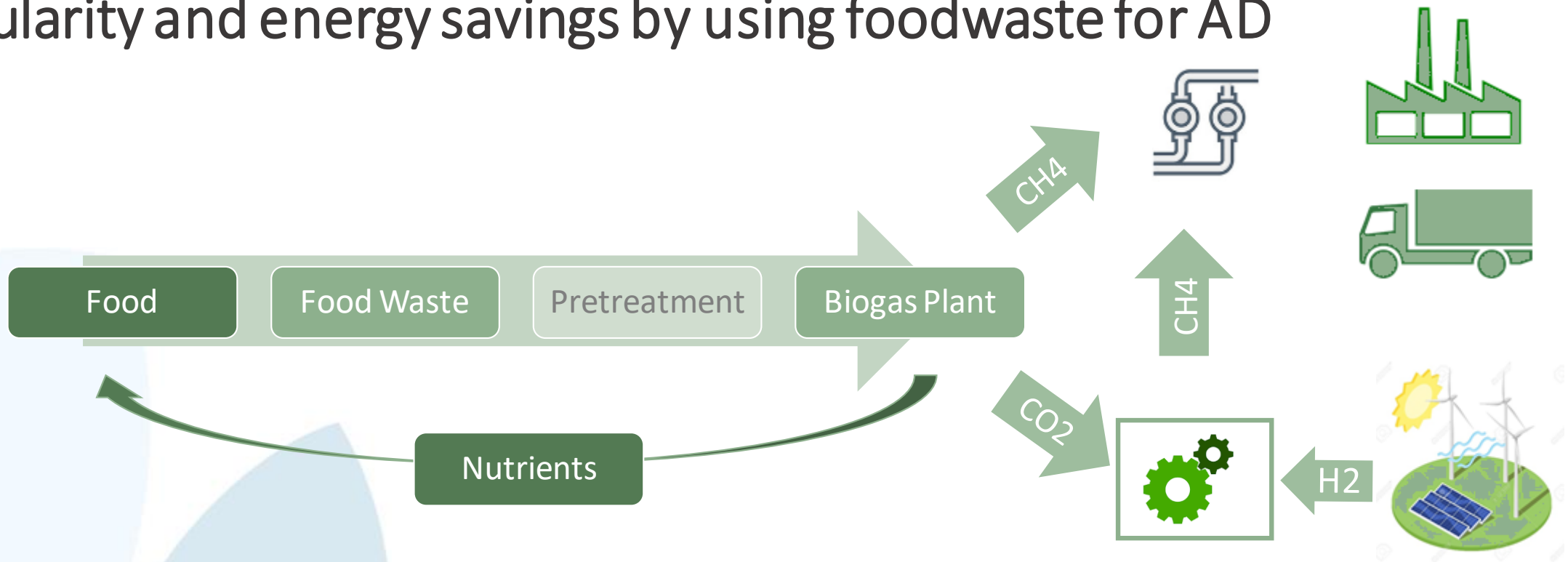


Source: Danish Energy Agency, 2019/2020

## Biogas production and use in Denmark 2012-2020 (PJ). Source: DEA



# Circularity and energy savings by using foodwaste for AD



In Denmark, 370.000 tons foodwaste households produce 1,25 GJ storable biomethane and landfill-divers around 1900t total nitrogen, 233t phosphorous and 559t potassium.

The Habor-Bosch process producing ammonia from natural gas consumes close to 2% of all global energy and responsible for 3% of the total GHG emission. Since it takes average around 38GJ of energy to produce 1 ton of ammonia through the HB process, **recovery of 1 ton of nitrogen from foodwaste saves the use of 34GJ natural gas equal to 3.600ton CO2/eq in total GHG savings by using food waste nutrients in Denmark** not to mention that this 1 kg N has a value of around \$1.8 kg maning saving around \$3,4 million in fertilizer costs.

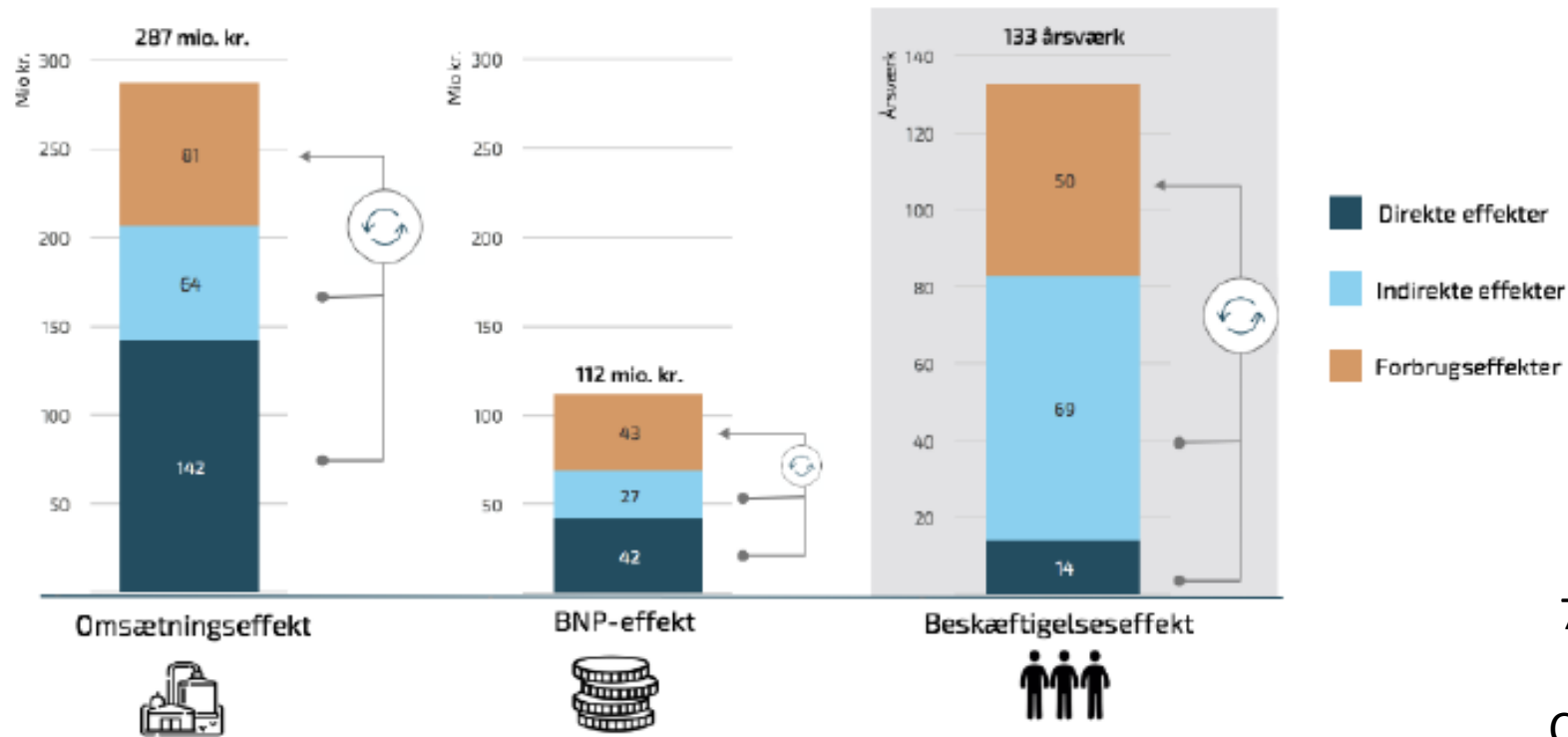
*\*1 ton of ammonia with 95% efficiency in the field, 1 ton total N from food waste with 85% efficiency over 4-5 years.*

# Think globally, act locally: Jobs in biogas

\$46 mio in turnover effects

\$18 mio in BNP/y

133 jobs in one plant



nature  
energy



**Nature Energy Korskro**

710.000ton biomass – 22 mio m3 CH4

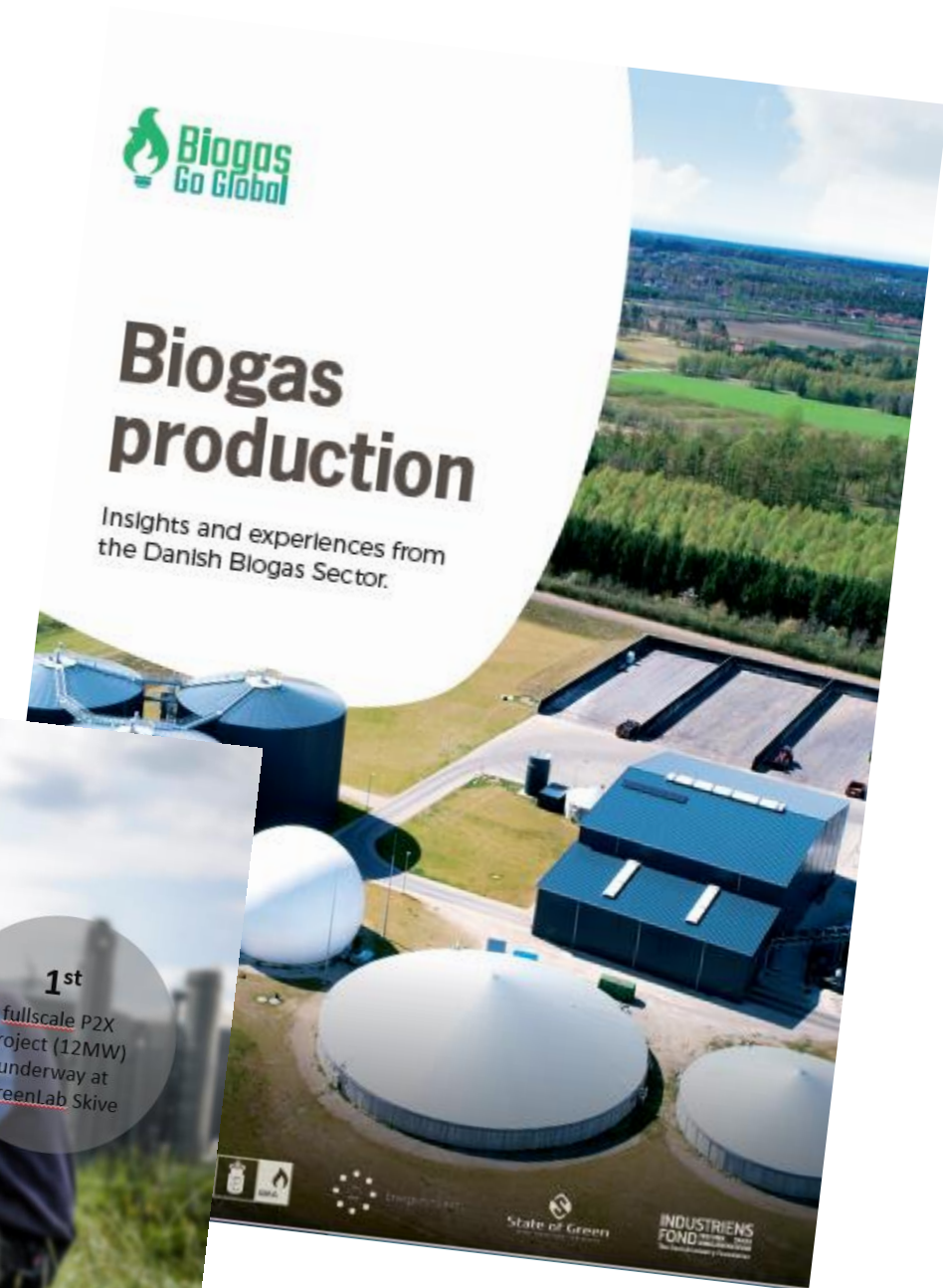
130\$ mio investment

Creates/maintain 133 jobs in the areas

# Read more in our brand new publication

- Environmental benefits
- Pretreatment of biomass: Straw, grass, food waste
- Good use of digestate
- Upgrade of biogas to natural gas quality
- Power-2-X: Wind & Solar power integration

Download for free [here](http://www.biogasglobal.com) via  
[www.biogasglobal.com](http://www.biogasglobal.com)



## BIOGAS GO GLOBAL: US – DENMARK PARTNERSHIP PLATFORM



**Commercial Partnership** – Intensifying commercial partnership between Danish and US biogas companies and project developers.

**Authorities** - Cooperation between the DEA and US gov. stakeholder - joint work program with analyses, knowledge sharing and workshops

**Investors** - Mapping and further development of financing models for biogas plants

**R&D cooperation**- Establishing collaborations between leading Danish and American universities

**Network** - Global knowledge sharing of the Danish biogas model and cluster



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Danish Energy  
Agency

## REMEMBER THE NEXT BIOGAS GO GLOBAL WEBINARS:

5<sup>TH</sup> of May: Economy of scale in biogas production – Key note from Danish Gas Technology Center

Sign up: [cecsor@um.dk](mailto:cecsor@um.dk)



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# New York Circular City week Pretreatment of Organic waste

Lars Ravn Nielsen, CEO  
Gemidan Ecogi A/S



*From waste to a sustainable, green resource*

# Gemidan Philosophy

*Provide a system to extract the maximum energy and nutrient benefits from organic waste sources.*

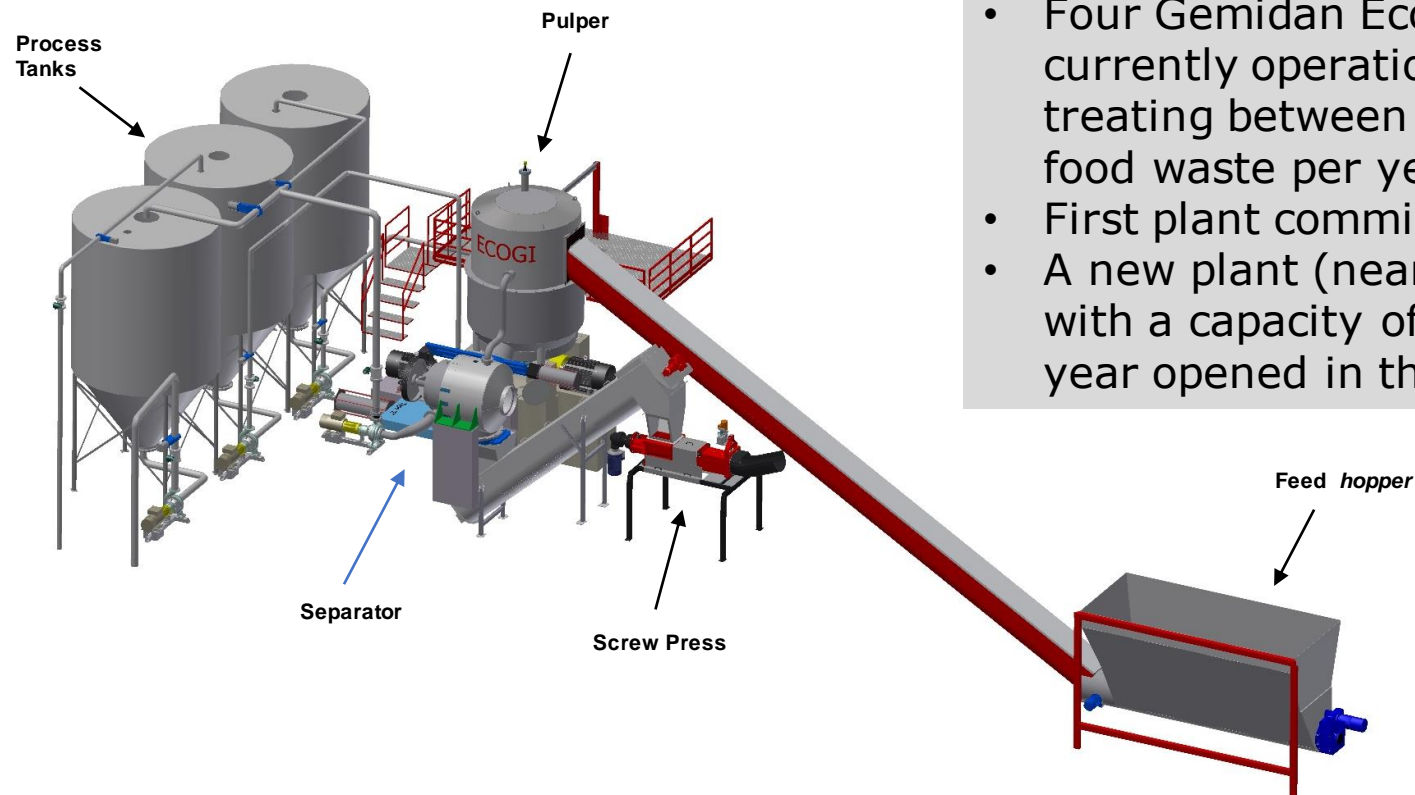
Basics tenants of Gemidan Ecogi pre-treatment system:

1. Flexibility to accept any type of packaging (plastic, glass, paper, metal).
2. Produce a clean, quality bio-pulp that will maximize gas production and provide a high value fertilizer.
3. Low maintenance and labor requirements.



# Standard Ecogi Facility Components

*(Not just a de-packaging system – a fully integrated solution for food waste pre-treatment and bio-pulp production)*



- Four Gemidan Ecogi plants are currently operational in Denmark, treating between 25 & 50K tons of food waste per year.
- First plant commissioned in 2012.
- A new plant (near Copenhagen) with a capacity of 120K tons per year opened in the end of 2020



# System Specifications

- Capacity: 10–13 ton of waste per hour (250 ton/day)
  - Additional lines can be added for higher volumes
- Dry matter content in the bio-pulp is adjustable
  - Between 10-20%
- Extremely small particle size in the bio-pulp allows for accelerated biogas production
- Highly automated system with low OPEX
  - SCADA can be operated remotely
  - Staffing 1-3 hours per day depending upon design



# System Flexibility

- The Ecogi technology is a combined de-packaging and pre-treatment system.
- During the pulping process the packaging will be “opened” allowing the organics to be dissolved into the liquid fraction.
- ‘Low impact’ approach allows larger pieces to be extracted more easily.
- That means that the system is able to treat and properly manage food waste from residential, commercial, institutional and industrial streams.



# Flexibility – Paper, Cans, Glass, Plastic, Cardboard

*The Ecogi system can handle all types of packaging.*



# Flexibility due to contaminated waste

*The Ecogi system can handle all types of waste*



# Video from the plant in Frederikshavn DK

The plant has been operational since  
April 2019

The plant is operated with only 1 operator.



# Pureness of the Biopulp

- System was designed to meet the demand of Danish farmers for high-quality organic fertilizer and strict Denmark/EU regulations.
- The pureness of biopulp is "second to none."
- The Ecogi process is the only food waste pre-treatment system to obtain ETV certificate
  - Documents the pureness and the recovery of the potential methane in the waste
- **E**nvironmental **T**echnology **V**erification – a global, third party verification program for environmental technologies.



# Pureness of the Biopulp

Results from the ETV Certificate:

Table 2 Analysed purity of products (17% dry matter)

	Test run 1%	Test run 2%	Test run 3%	Average %	Standard deviation %
Purity product all impurities (17% dry matter)	99.948	99.967	99.960	99.96	0.01
Purity mix plastics (17% dry matter)	99.992	99.995	99.996	99.996	0.002

# Pureness of the Biopulp

- Expected that more stringent regulations for use of digestate as a fertilizer are coming – will demand biopulp purity.
- In Denmark we don't only measure the weight of the plastic, we also have to measure the covered area of plastic.
- Ecogi is prepared to these future demands.



# Pureness of the Biopulp



AnalyTech Miljølaboratorium A/S  
Bøgildsmindevej 21  
9400 Nørresundby, Danmark  
Telefon: +45 98 19 39 00  
E-mail: lab@analytech.dk

## ANALYSERAPPORT 335095

**I/S AffaldPlus**  
Ved Fjorden 20  
4700 Næstved

**Version:** 1  
**Sagsnr:**  
**Rekv. nr:**  
**Genereret:** 09.08.2019  
**Bilag:** Billeder af fysiske urenheder

<b>LAB nr:</b>	19-19126, Prøve nr. 379480	<b>Prøvetager:</b>	FEG, I/S AffaldPlus				
<b>Prøvemærkning:</b>	B-analyse (renhed) 27Juli2019	<b>Prøvetagningsmetode:</b>	-				
<b>Prøvetype:</b>	Biopulp	<b>Prøvetagningsstidspunkt:</b>	-				
<b>Prøvested:</b>	AffaldPlus	<b>Prøvetagningssted:</b>	-				
<b>Grænseværdier:</b>	Miljøministeriet, BEK nr. 1001 af 27.06.2018	<b>Analyseperiode:</b>	30.07.2019 - 09.08.2019				
Analyseparameter	Resultat	Min	Max	Udenfor	D.L.	Metode/Reference	+/-
Tørstof	18.0 %	-	-		0.002	M-0008 DS 204	10%
Volumen	1000 mL	-	-		1	*EKSTERN	10%
Areal	300 cm <sup>2</sup>	-	-			*	-
Areal dækket af plastik	0.88 %	-	-		0.01	* FQQA0	-
Areal dækket af plastik	2.64 cm <sup>2</sup> /L	-	-		0.01	* FQQA0	-
Areal dækket af plastik	0.15 cm <sup>2</sup> pr. % TS	-	1		0.01	* FQQA0	-
Plast i tørstof	0.0355 g	-	-		0.001	*Beregning	-
Plast i tørstof	0.197 g/kg	-	-		0.001	*Beregning	-
Plast i tørstof	0.020 % i TS	-	0.15		0.001	*Beregning	-
Glas i tørstof	0.0427 g	-	-		0.001	*Beregning	-
Glas i tørstof	0.237 g/kg	-	-		0.001	*Beregning	10%
Glas i tørstof	0.024 % i TS	-	-		0.001	*Beregning	10%
Metal i tørstof	0.0519 g	-	-		0.001	*Beregning	-
Metal i tørstof	0.288 g/kg	-	-		0.001	*Beregning	10%
Metal i tørstof	0.029 % i TS	-	-		0.001	*Beregning	10%
Fysiske urenheder i tørstof	0.1301 g	-	-		0.001	*Beregning	-
Fysiske urenheder i tørstof	0.723 g/kg	-	-		0.001	*Beregning	-
Fysiske urenheder i tørstof	0.072 % i TS	-	0.5		0.001	*Beregning	-

### Bemærkninger:

Der er ikke fundet resultater uden for de anførte min- og maxgrænser.



# Pureness of the Biopulp

## BIOPULP

Clean biofuel for biogas plants

Produced by:

Gemidan KomTek  
 Drivervej 8, 6650 Holsted  
 Telefon 70 20 54 89  
[mail@komtek.dk](mailto:mail@komtek.dk)  
[www.komtek.dk](http://www.komtek.dk)



## Declaration

70999-15  
 06. Nov. 2019

Biopulp from source-sorted organic residual materials (waste) from public, private, retail and industry  
 Approval number DK-05-03-intp-051 to handling of animal by-products in category 3 material for organic biomass.

### Product description:

Biopulp is an energy source for use in biogas plants for the production of biogas.

The product is produced from source-sorted household waste and other organic materials from both retail and food industries in cat. 3 in accordance with the animal by-products regulation.

The product is characterized by the majority of the organic particles being very small, most of which are less than 0,1 mm, and is easily marketable to biogas plants. Biopulp is a very homogeneous product with a very low level of impurities like plastic, glass, stone and metal.

Biopulp is produced on KomTek's Ecogi plant that uses wet-pulping technology with subsequent effective separation of rejection of undesired substances.

### Danish legislation applicable:

Biopulp must be declared after Requirements described in Order No. 1001 of 27-6-2018 on the use of waste for agriculture purposes.

Calculated specs from analysis with 17% dry matter		Analytes		
		Latest	Average	
Total N	4,2	24,7	28,3	
Phosphorus (P)	0,56	3,3	4,2	
Magnesium (Mg)	0,83	4,9	3,4	kg/ton
Potassium (Ca)	1,33	7,8	8,5	dry matter
Sulfur (S)	0,46	2,7	3,0	
Biogas (calculated)	119	m³ biogas		

Purity of biopulp	Limits	Latest analysis 19-30067	Average
Area covered in plastic cm² per% TS	1 cm² per% TS measured in one liter of biopulp	0,20	0,32
Plastic in dry matter% in TS	Plastic > 2 mm is 0.15% by weight per dry matter	0,012	0,015
Physical impurities in dry matter% in TS	Plastic, glass and composite materials > 2 mm is 0.5% by weight / dry matter	0,100	0,124

mg/kg dry matter	Limits	Latest analysis 19-30068	Average
Lead (Pb)	120	3,3	4,4
Cadmium (Cd)	0,8	0,07	0,12
Chromium (Cr)	100	1,4	4,3
Chromium 6 (Cr)	-	0**	0**
Copper (Cu)	1000	97	76
Nickel (Ni)	30	2,2	4,0
Zinc (Zn)	4000	448	347
Mercury (Hg)	0,8	0**	0,03
PAH	3	0**	0,73
NPE	20	1,50	0,9
DEPH	50	0**	3,7
IAS	1300	0**	158

\*\*Concentration 0 are values "non-measurable"



# Efficiency of the system

The Ecogi system recovers more than 95% of the potential methane, which is documented in the ETV certificate.

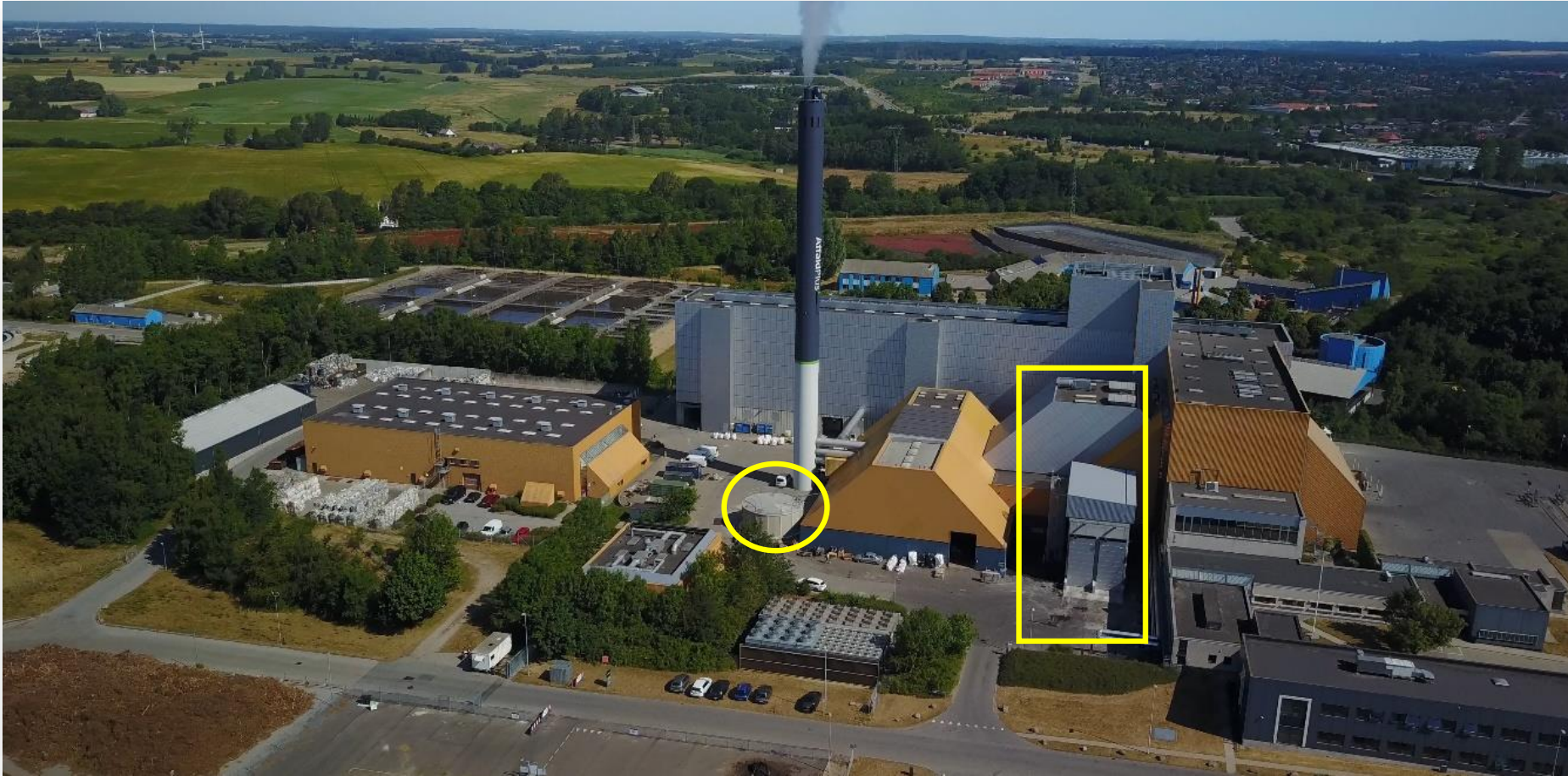
## *Recovery based on expected methane yield in biogas plants*

Test run	1	2	3
Washing water (particles <3 mm) ton VS	0.0143	0.0182	0.0135
Organic material (particles >3 mm) mm ton VS	0.1163	0.0707	0.0816
Organic ton VS in input	1.80	1.44	1.24
Loss of methane potential washing water m3 CH4	5.72	7.27	5.41
Loss of methane potential larger organics >3 mm m3 CH4	23.26	14.14	16.32
Sum loss m3 CH4	28.98	21.41	21.73
m3 CH4	720.07	574.46	495.87
% recovery CH4	95.98	96.27	95.62



# Ecogi plant in Næstved, Zealand, DK

*Installed in existing municipal waste-to-energy facility.*



# Ecogi plant in Frederikshavn, Jutland, DK

*Began operation April 2019.*



# Ecogi plant near Copenhagen, DK

With 2 Ecogi lines - *Began operation January 2021*



# Questions?

Further information on <http://ecogi.dk/en/frontpage/>



# Food Waste & Biogas Driving the Circular Economy in Denmark

Poul Ejner  
Rasmussen  
CEO, Renew Energy

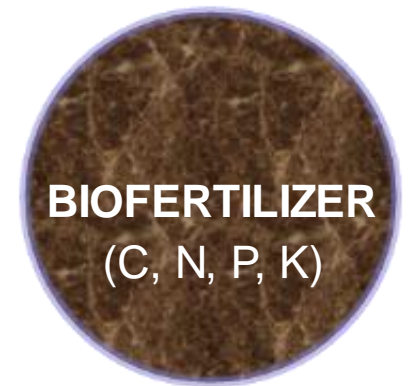
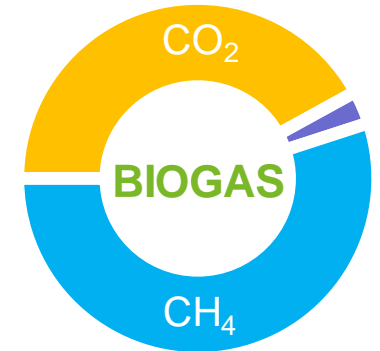
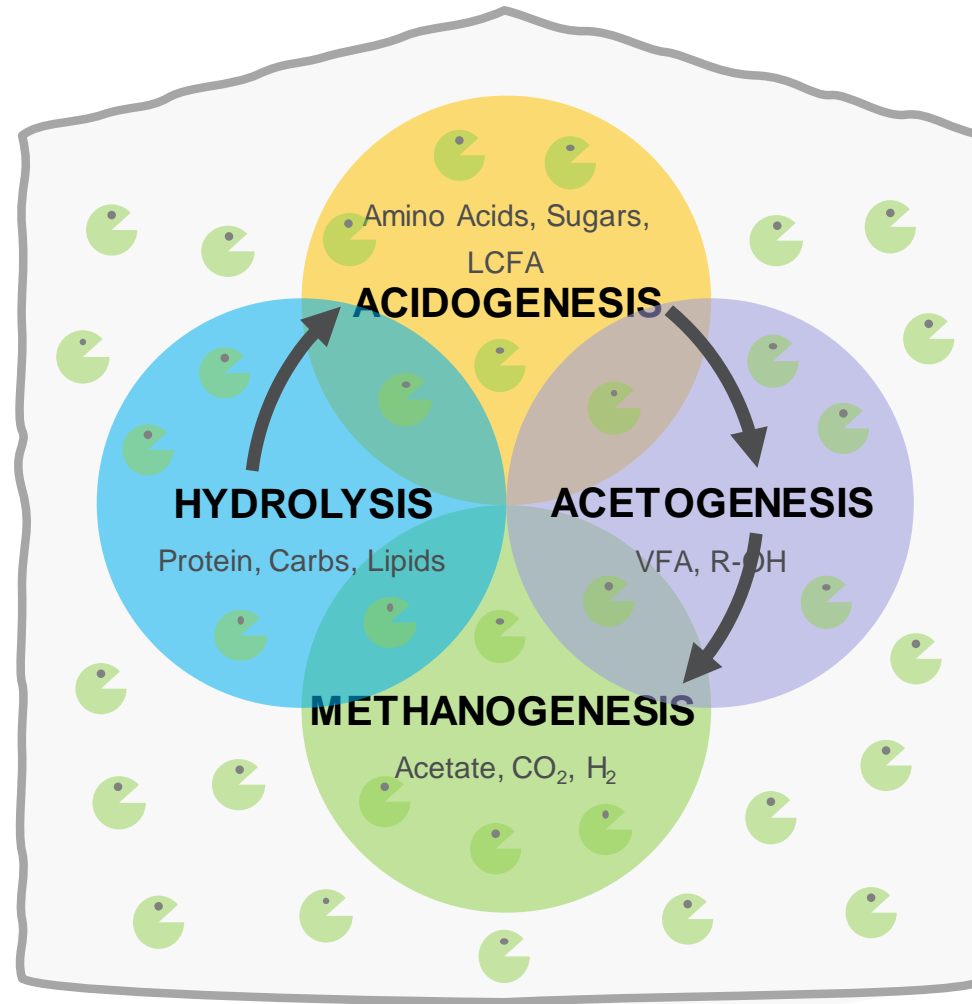
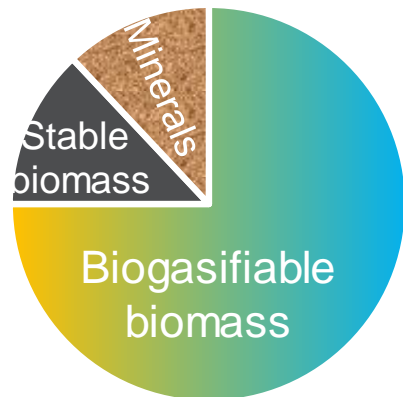
24 March 2021



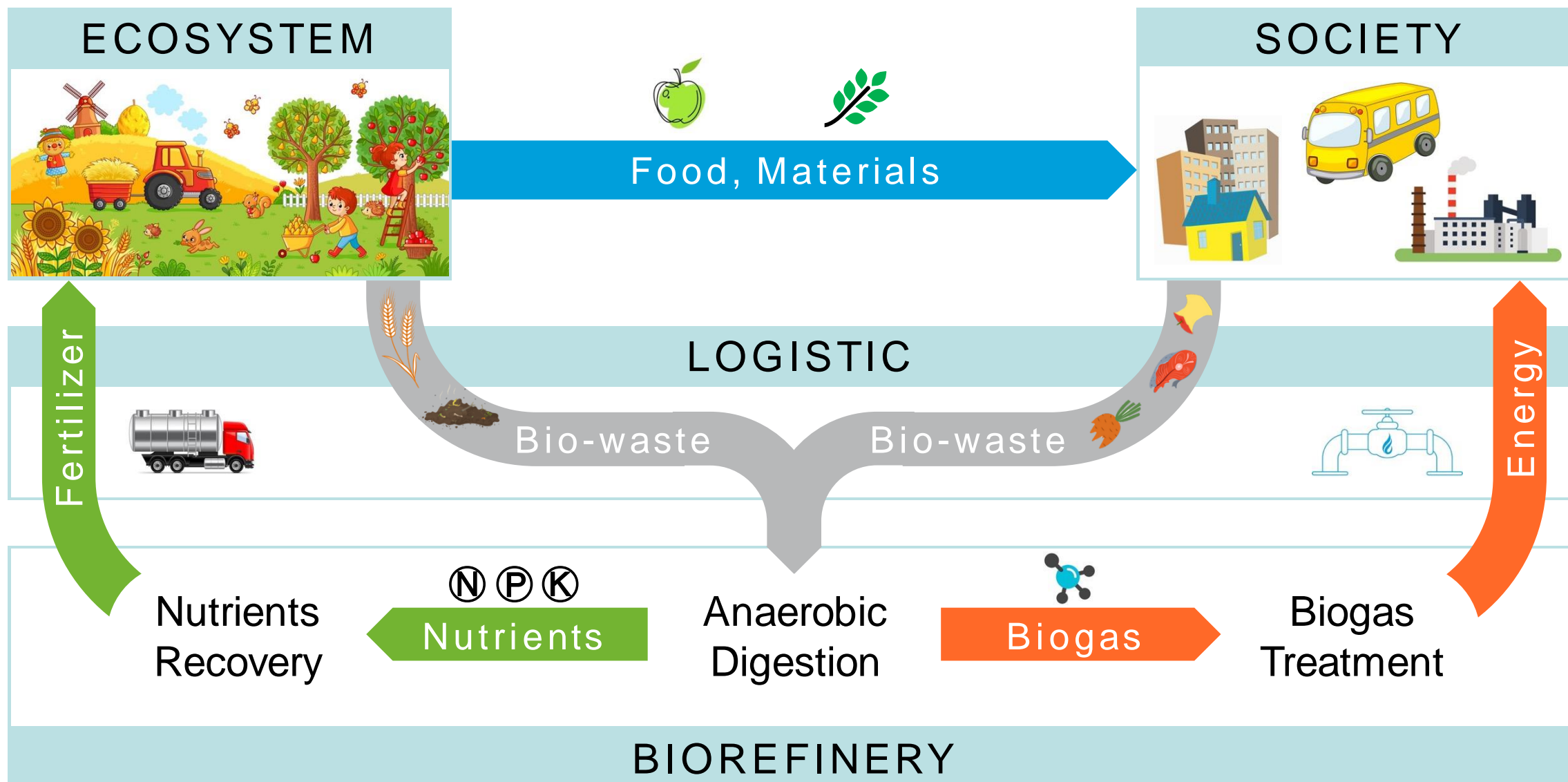
# Waste to energy & nutrient *via* anaerobic digestion

## ANAEROBIC DIGESTION

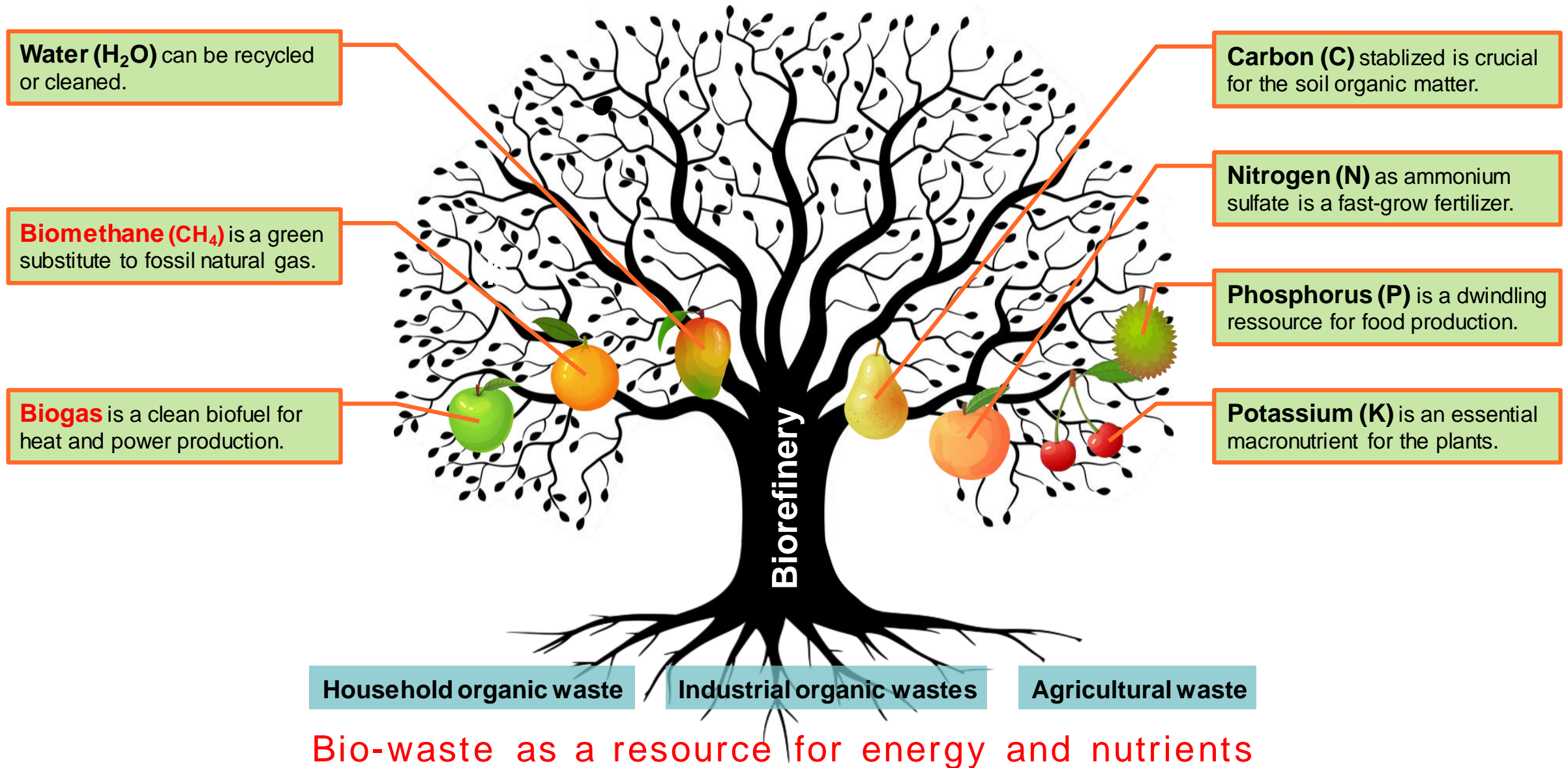
### BIOMASS



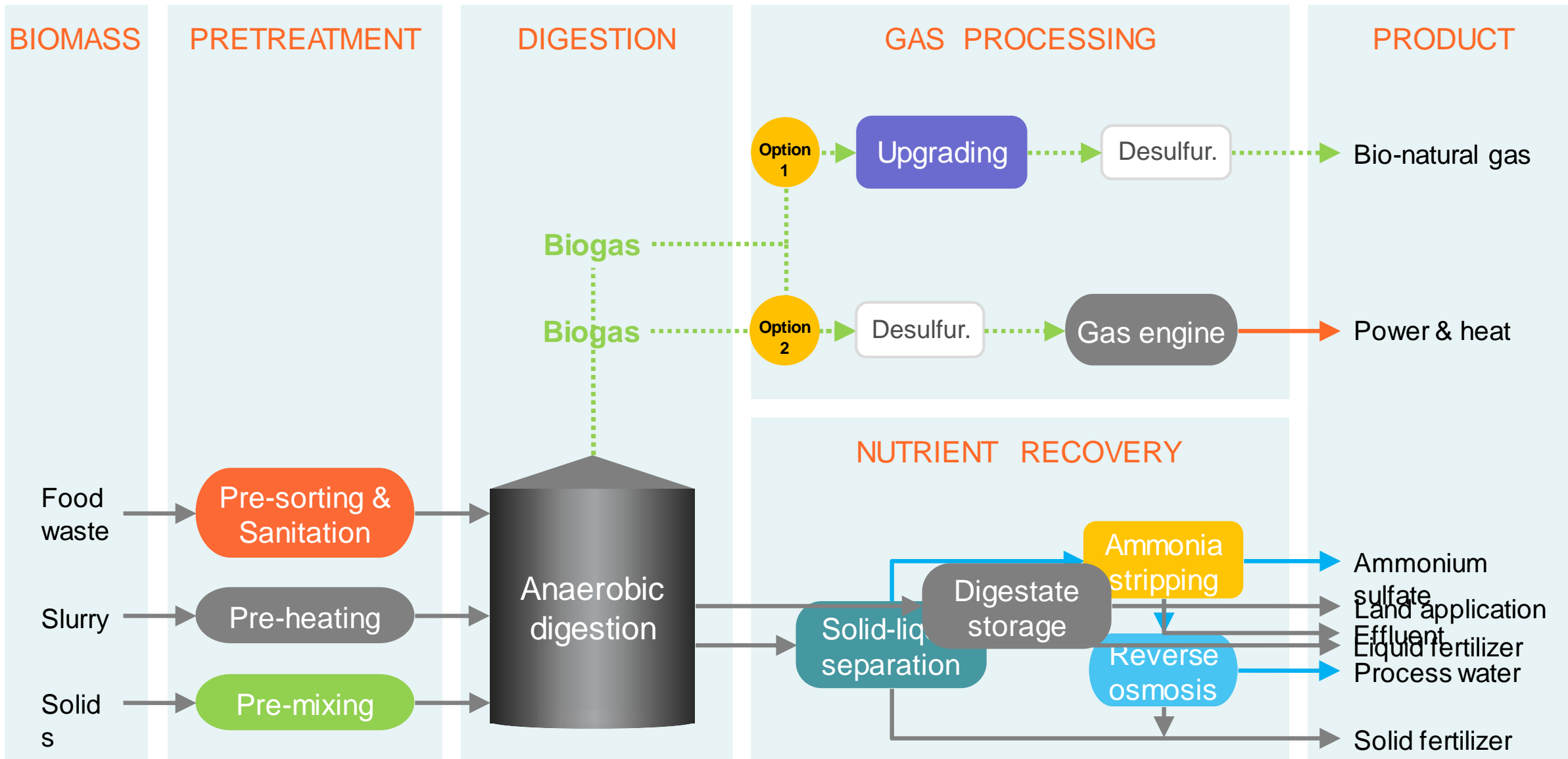
# Biogas as a “catalyst” in circular bio-economy



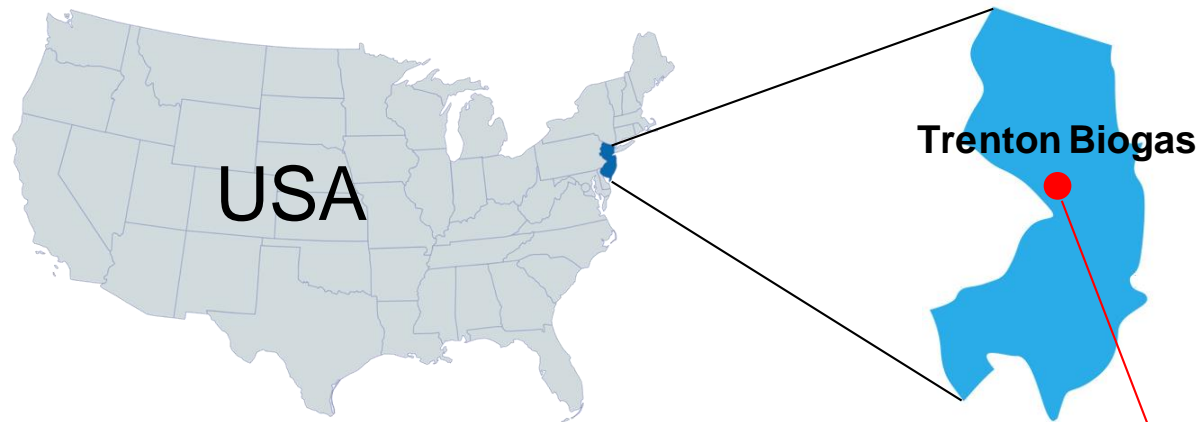
# Low-hanging fruits in circular bio-economy



# From classical biogas to advanced biorefinery



# Trenton Biogas, New Jersey



***300 ton/day Food waste***

***3MW power***

***Construction 2018***

***Commissioning Q4<sup>th</sup> 2019***



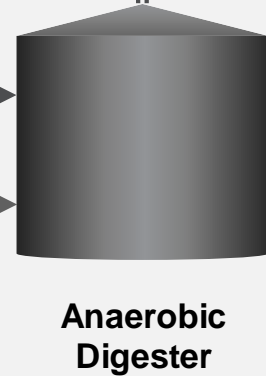
# Trenton Biogas, New Jersey

## PRETREATMENT

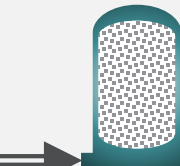


## DIGESTION

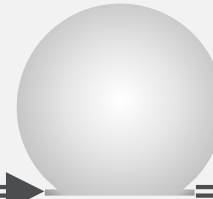
**Biogas**



## GAS PROCESSING



**Desulfurization**



**Gas Holder**



**Gas Engine**

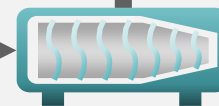
## PRODUCTS

*Electricity*

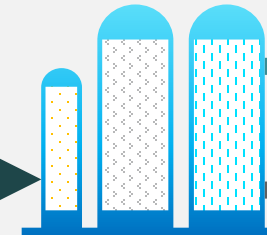
*Heat*

The whole  
biogas plant

## NUTRIENT RECOVERY



**Decanter Centrifuge**



**Ammonia Stripping**

*Biosolids*

*Ammonium sulfate*

*Effluent*

Sewage  
Plant

# Trenton Biogas, New Jersey



5000 m<sup>3</sup> digester



Gas holder



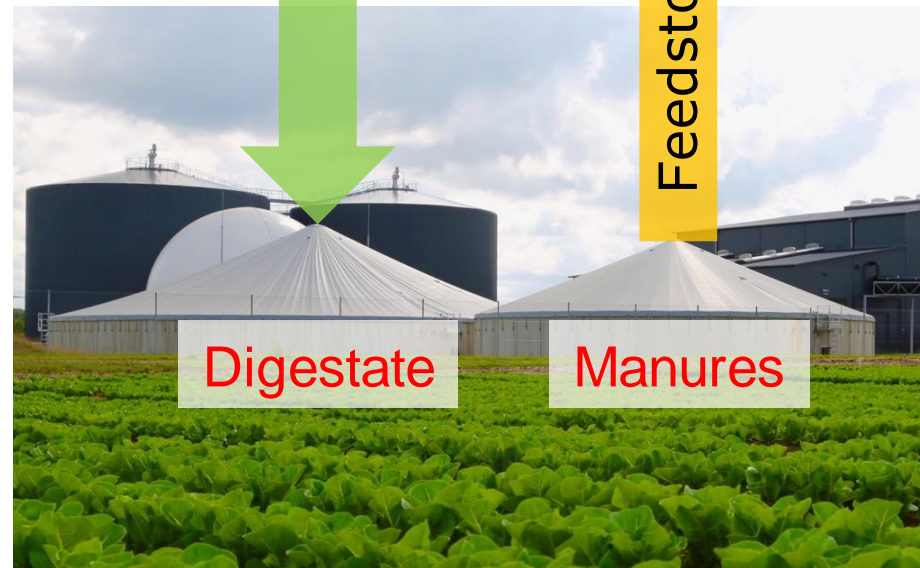
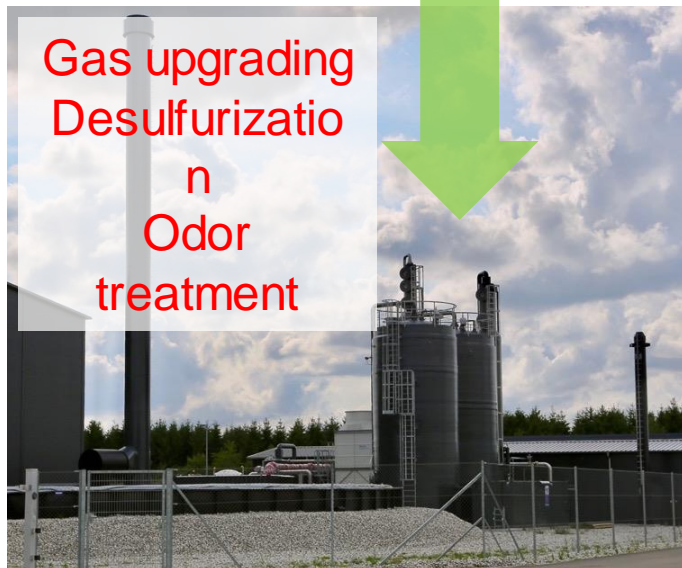
Gas engine



Decanter centrifuge



Ammonia stripping



**Månsso** Biogas  
Denmark's biggest  
"Ecological"  
Biomethane plant

## *Focus on design and engineering of biogas plants*

- ❑ Main office in Svendborg, DK

*JV partner in South Korea*

*Representative in USA*

- ❑ Development, design and service for biogas and biorefinery projects

- ❑ 30 years of experience

*1990 – 2007*

*Bioscan A/S*

*2007 – present*

*Renew Energy A/S*

- ❑ Cooperation with EKF and CIP

*Loan guarantee or investment*





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• Poul Ejner Rasmussen, CEO and founder of RENEW Energy A/S

- [per@renewenergy.dk](mailto:per@renewenergy.dk)