EIP-AGRI Workshop 'Opportunities for Agriculture and Forestry in the Circular Economy'

28-29 October 2015
Naantali, Finland

All information of the workshop available on www.eip-agri.eu at the event webpage

https://ec.europa.eu/eip/agriculture/en/content/eip-agri-workshop-opportunities-agriculture-and-forestry-circular-economy

funded by the European Commission

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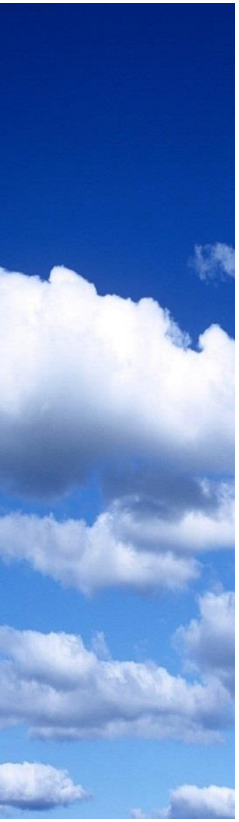
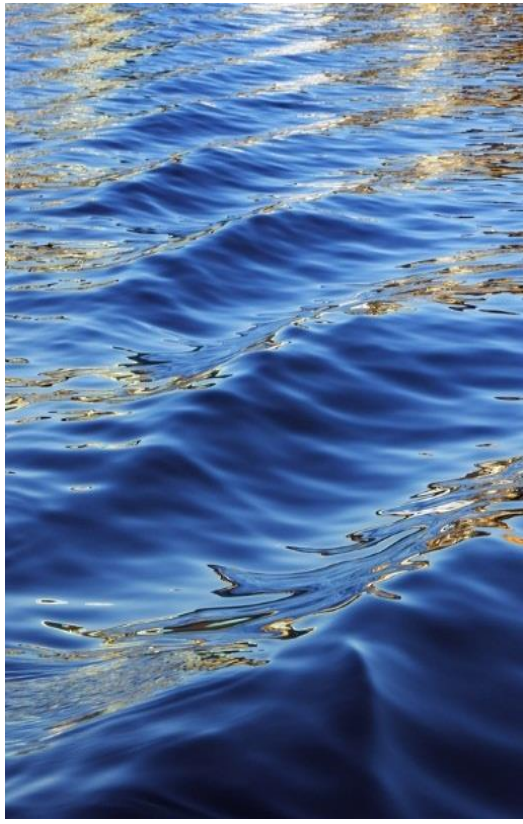
AGRICULTURE & INNOVATION

EIP-AGRI WORKSHOP CIRCULAR ECONOMY

Development of integrated agro-industrial waste management politics maximizing materials recovery and energy exploitation in Western Greece



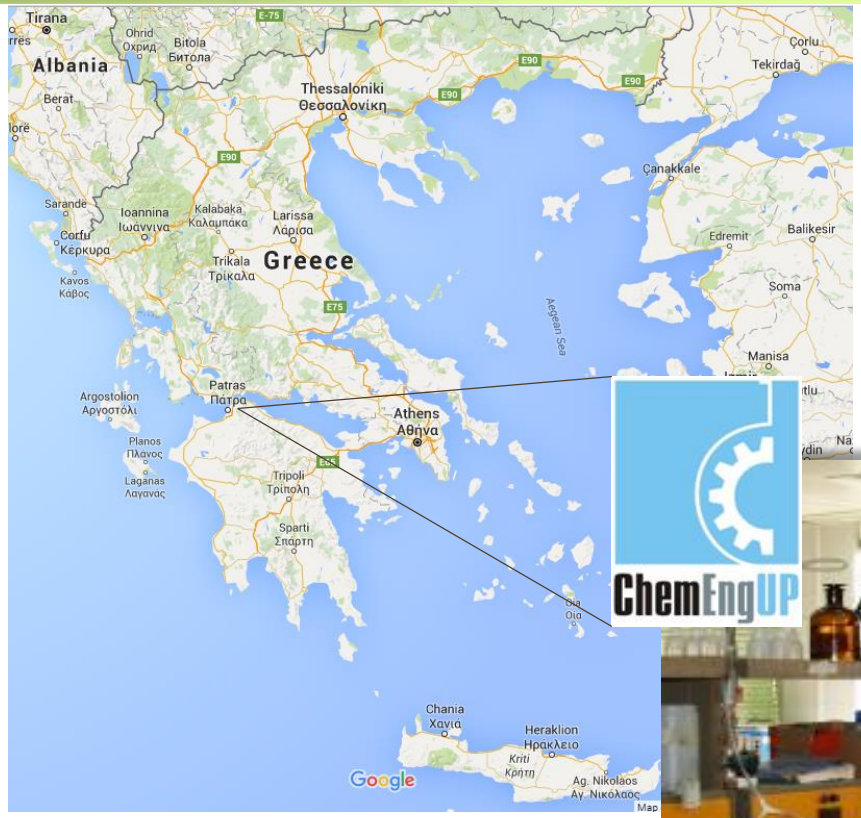


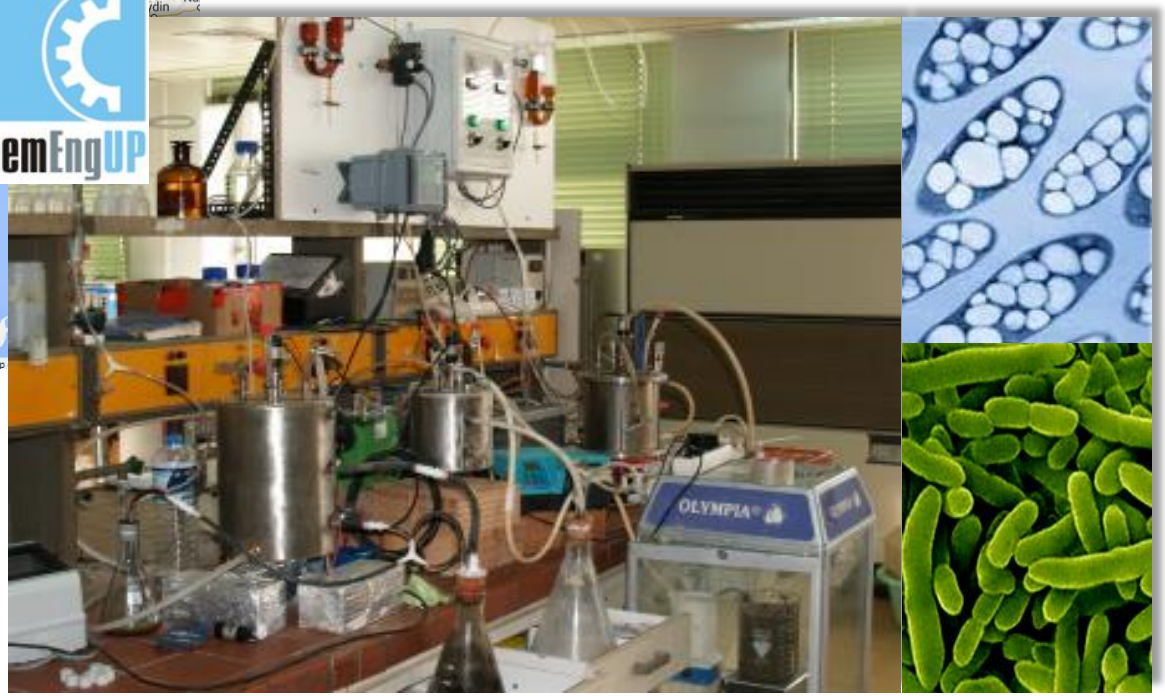
Prof. ***Michael Kornaros***

UNIVERSITY OF PATRAS
Department of Chemical Engineering
Laboratory of Biochemical Engineering
and Environmental Technology (LBEET)

28-29 October 2015, Naantali Finland

Who we are:





Laboratory of Biochemical Engineering and Environmental Technology (LBEET)

INTEGRASTE: the overall picture

LIFE08 ENV/GR/000578

- Coordinating Beneficiary:
  - Western Greece Region
    (former Prefecture of Achaia)
- Associated Beneficiaries:
  - Western Greece Region - Development Enterprise
  - University of Patras
- Total Budget Amount: 1,156,325.00 €
  - Eligible Budget: 1,087,325.00 €
  - EC Co-funding 50%: 543,662.00 €
- Project Duration:
  - 3 years & 9 months (project extension)
  - ***Start:*** 01/01/2010 - ***End:*** 30/09/2013

- Project location:
  - Western Greece

INTEGRASTE: Introductory Information

- **Aim:**
  Development of INTEgrated aGRoIndustrial wASTE management process in order to maximize materials recovery and energy exploitation

- **Objectives:**
  - ✓ Demonstration of the technical efficiency of the proposed integrated process for regional management of **liquid** and **solid** agroindustrial wastes
  - ✓ Assessment of the technoeconomic feasibility of the proposed process
  - ✓ Dissemination of the results to interested stakeholders on the sustainable management of agroindustrial wastes and encouragement of such investments

Motivation

Characteristics of agro- industrial wastes

Olive mill wastes

- High organic content
- High phenols concentration

Energy crops

- High carbohydrates content
- Lignocellulosic material

Cheese whey

- High sugars content
- Readily fermentable

Slaughterhouse wastes

- Condensed organic matter
- Rich in nitrogen

(Liquid) Cow manure

- High nitrogen content
- Increased alkalinity

Oranges

- High organic content
- Rich in sugars

Piggery wastes

- High solids and nitrogen content
- Increased alkalinity

Potatoes

- High organic content
- Rich in carbohydrates (starch)

Poultry wastes

- High solids content
- High nitrogen content

Grape marcs

- Solid organic material
- High phenols content

Motivation

Impacts from disposal of raw agroindustrial wastes and residues:

- *Environmental*: pollution of natural ecosystems (rivers, lakes etc)
- *Social*: public health, land devaluation.
- *Economic*: tourism, limitations in rural and industrial development.

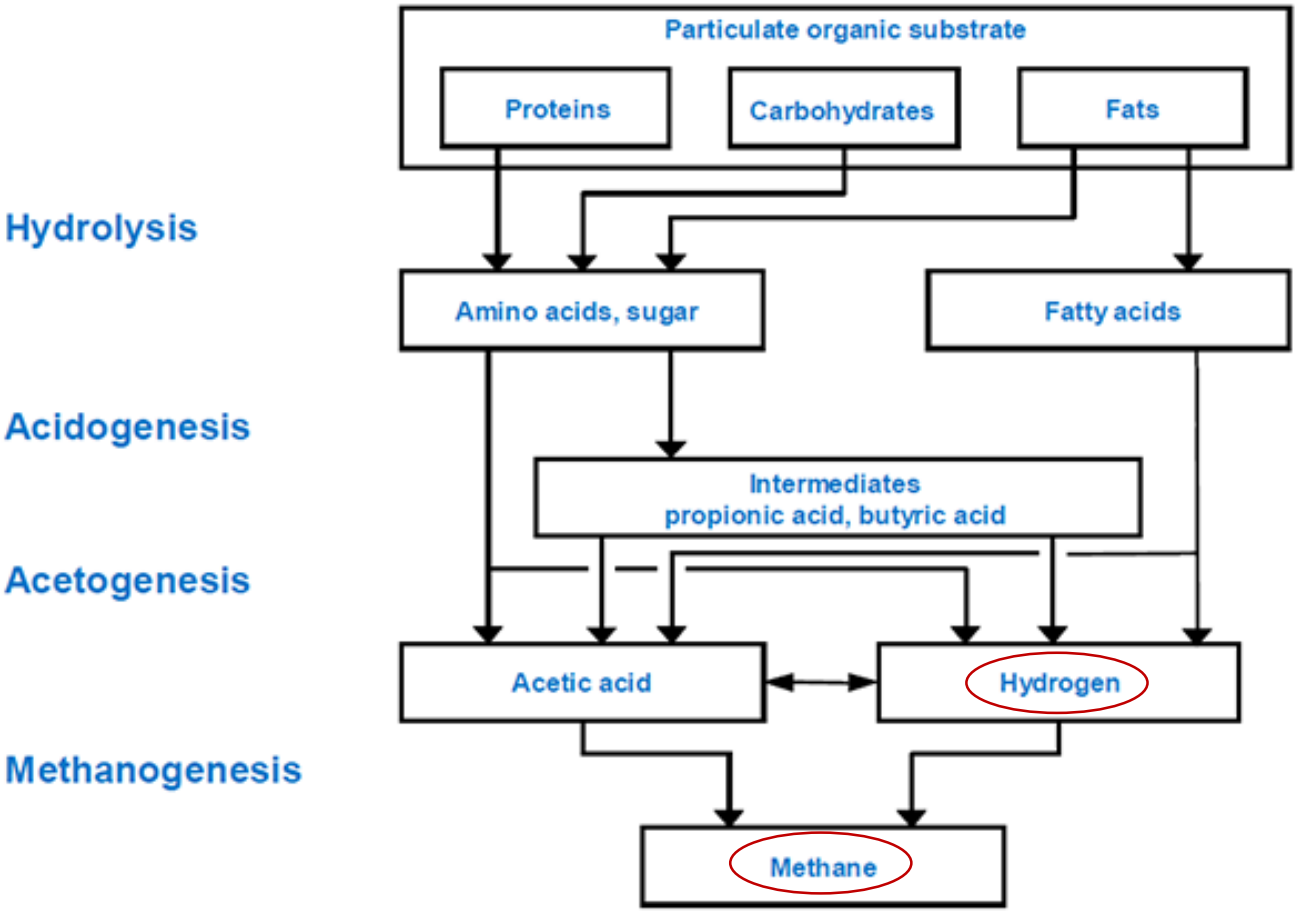
Waste treatment technologies are feasible, efficient and commercially available. However not applicable !

Reasons :

- ***Family-type industries of small to medium capacity.***
  Capital and Operational costs of small Waste Treatment Plants are not affordable.
- ***Spread in the country and seasonally operated.***
  Difficult to connect to central Waste Treatment facilities or build own facilities

Proposed solution

Anaerobic Digestion is the **Best Available Technology** according to the 96/61/EC Directive (IPPC Directive) with minimum technological risk most suited for wastewaters and wastes with a high organic content, such as those produced by agro-industries.



Proposed solution

Centralized plant for anaerobic co-digestion of agroindustrial wastes produced in a close-range area.

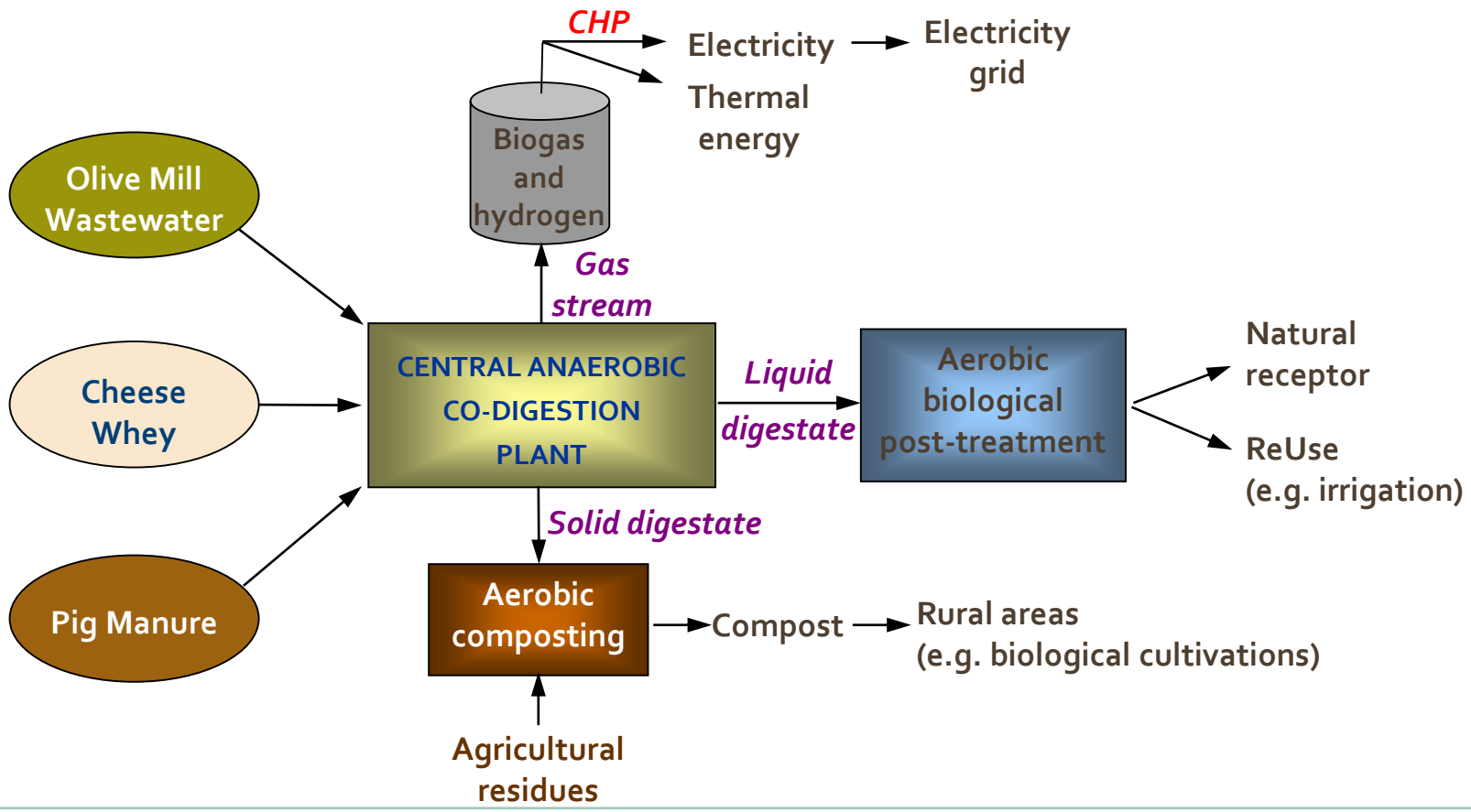
Benefits

- ✓ All-year round operation receiving various complimentary agro-wastes throughout the year avoiding startup delays
- ✓ A mixture of available feedstocks may lead to a balanced (in nutrients) feed
- ✓ Mixing substrates may result to dilution of inhibitors (e.g. OMW polyphenols)
- ✓ Increased biogas productivity and thus better options for exploitation
- ✓ The wider the area from which agrowastes are collected the bigger the plant (economies of scale)

AGROENERGY: the predecessor

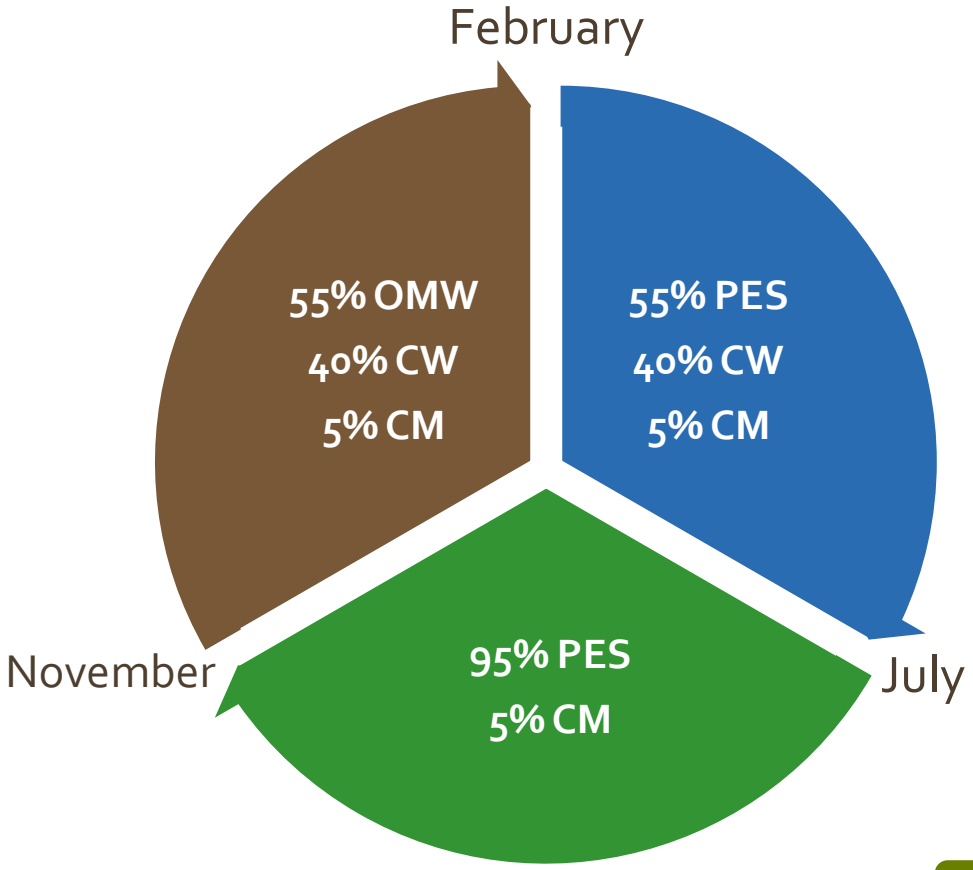
INTERREG IIIA / GREECE – ITALY 2000-2006

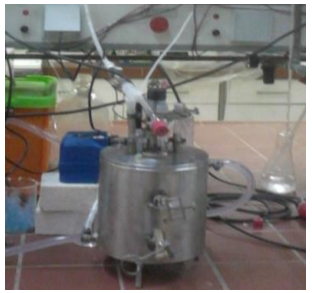
Schematic diagram for integrated management of agroindustrial wastewaters



INTEGRASTE: New concept

Operation of a centralized co-digestion plant on an annual basis under optimized conditions (pH, Hydraulic Retention Time)





pH →
- ⌘ Batch reactor
- ⌘ Constant pH (pH controller)

HRT →
- ⌘ Acidogenic reactor
- ⌘ Methanogenic reactor
- ⌘ Constant pH (in acidogenesis)

INTEGRASTE: Pilot plant upgrade

Pilot plant capacity 10kW$_{el}$

INTEGRASTE: Sweet sorghum cultivation

Sweet sorghum: field studies in the Industrial Zone of Patras (Greece) during 2011, 2012 and 2013 growing periods

→ studying the influence of soil fertility treatments

→ irrigation amount to experimental plots of sweet sorghum

Compared treatments:

- CSFT: conventional soil fertility treatment;
- BSFT: biological soil fertility treatment;
- IAPM: irrigation amount as calculated according to Penman-Monteinth-FAO model;
- IADL: irrigation amount as calculated according to Dercas and Liakatas

Conventional fertilization was compared with

- biological one realized as compost from anaerobic effluents
- anaerobically treated liquid effluent from the pilot INTEGRASTE plant added to the experimental plots

Main results

- ✓ Reduced irrigation inputs combined with compost and effluent from the anaerobic digester of INTEGRASTE pilot plant as fertilization, favored the yields of dry biomass
- ✓ The values were equal or higher than those obtained with balanced mineral fertilization

INTEGRASTE: Technoeconomic analysis

Main results

Key elements of an investment for a 1MW plant:

- Waste Management: 105.000 t/year (depending on waste composition)
- Production of electricity: 9.230 MWh/year
- Production of thermal energy: 10.860 MWh/year
- Production of good quality compost: 5 213 t
- Total investment:

5 440 000 € (Scenario A - transportation cost on plant) or
5 010 000 € (Scenario B - transportation cost on waste producers)

- Overall operating and maintenance costs on annual basis:

667 600 €/year (Scenario A) or 472 000 € / year (Scenario B)

- Overall income from use of energy and materials on annual basis:

2 480 000 €/year (Scenario A) or 2 190 030 €/year (Scenario B)

- Payback time: 2-3 years

INTEGRASTE: Consultation Meetings

- **<u>Target group 1</u> (Waste Producers, Farmers)**
  Brief presentation of Integraste project & Environmental impacts of agroindustrial waste
  The treatment plant gives solution to the environmental problem and likely future economic benefits
- **<u>Target group 2 (Local Actors)</u>**
  Brief presentation of Integraste project & Environmental impacts of agroindustrial waste
  Networking issues for stimulating political, scientific and financial support and inform citizens
- **<u>Target group 3 (Potential Investors)</u>**
  Brief presentation of Integraste project & Environmental impacts of agroindustrial waste
  Communicate and emphasize on techno-economical data from pilot-plant operation

INTEGRASTE: Consultation Meetings

INTEGRASTE: involvement of farmers

Farmers; producers of agro-wastes

- Realisation of the environmental problem and the proposed solution
- Worries that environmental solutions may increase the price of the final product (transportation costs, treatment fees etc)
- Opportunity to gain economic benefits if participate in the development and operation of centralized anaerobic co-digestion plants

Farmers; cultivators of energy crops

- Possibility of cultivating marginal lands
- Secured income through contracted agriculture
- Potential to make water and fertilizer savings and enhancement of biological agriculture by exploiting anaerobic effluents and composts

After INTEGRASTE : BioGAIA

- **Co-ordinator: University of Patras (Western Greece)**
- Development Enterprise of Achaia Prefecture (Western Greece)
- Development Agency of Etoloakarnania Prefecture (ANAIT) S.A. (Western Greece)
- Prefecture of Preveza (Epirus)
- Prefecture of Kefallinia & Ithaki (Ionian islands)
- Laser Center (Italy)
- Province of Bari (Italy)

CONTACT DETAILS:

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Thank you for your attention

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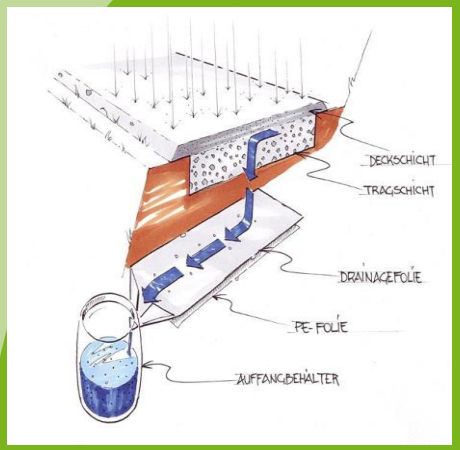
Development of innovative processes for wood ash recycling

DI Felix Montecuccoli



NATUR NÜTZEN.
NATUR SCHÜTZEN.

Motivation: (Holistic) Renewable CO2-Cycle

General Information

- Start of the Project: December 2009
- Project Costs: 1,55 Mio. € (~60% FFG Sponsorship)
- Promoter and Management: Association of Wood Industry on behalf of FHP (Forest – Sawmills - Pulp and Board Industry Kooperationplatform)
- Scientific Management: Prof. DI Dr. Ingwald Obernberger; University of Natural Resources and Life Sciences/ Vienna
- Scientific Partners:
  - BIOS BIOENERGIESYSTEME GmbH
  - BIOENERGY 2020+ GmbH
  - Chamber of Agriculture Styria
  - 12 partners from the forestry-, wood-, paper- and construction industries

Project Aims in Detail

- Investigation, development and evaluation of new and practicable wood ash utilization
  - short-rotation-coppice fields
  - (Forest-) Road Construction
- Improvement of already known wood ash utilization routes
  - Establishing of sustainable meaningful addition of wood ash in composting
  - Investigation and assessment of the application technique in forestry
- Investigation and assessment of the entire process chain from biomass heating plant to utilization with the aim of fully worked out solutions for the investigated recycling processes of wood ashes from burning of biomass to ash application
  - Guidelines for wood ash utilization in practice should be created
- Examination of the outdoor storage of ashes and the basics of the "aging" of wood ashes and their environmental impact
- Monitoring of biomass-fuel and ash data
- Elaboration of recommendations for the modification of existing respectively the creation of new legal frameworks

Motivation

- Increasing the choice of practicable methods for recycling of wood ash
  - Increase flexibility respective to ash utilization for plant operators
    - Operators are often farmers or groups of farmers

- Investigation, development and evaluation of new and practicable wood ash utilization in agri and forestry instead of costly desposal.

- Amount of wood and straw ash in Austria 2007: 170.000 t
- Disposal of ash 2007: 93.499 t
- Utilization of ash 2007: 76.501 t

(under the assumption that the ash, which is not deposited, will be utilized)

Present Utilization Potentials in Austria

- (conservatively calculated):

▪ Application on short-rotation-coppice fields	30.000 t/y
▪ Potential in composting	40.000 t/y
▪ Potential in renovation of forest roads	412.500 t/y
▪ Potentials of forest road construction	93.500 t/y
▪ Potentials of other road construnction	150.000 t/y
▪ Forest-fertilization	100.000 t/y
	∑ 826.000 t/y

- In 2014: 4.000.000 ha forest; total harvest 17.088.552 fm and 5.058.832 fm burned fuelwood;

Wood ash utilization

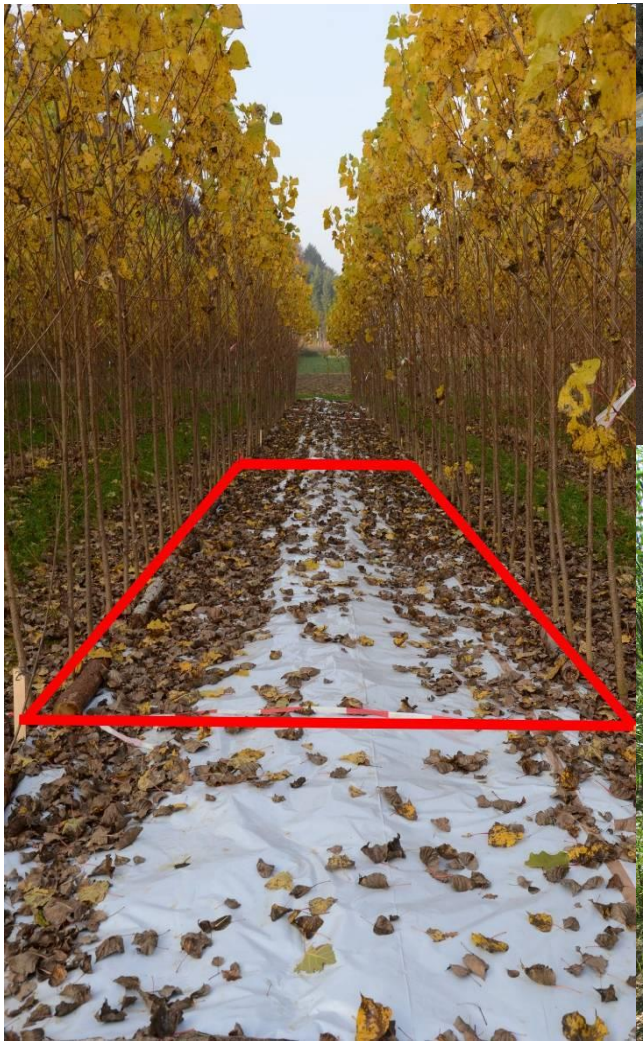
Selected results from the previously conducted scientific work

Use of wood ash in short rotation coppice (SRC)

- Aims:
  - Ecological assessment of the use of wood ash on SRC (soil, biomass)
  - Contained nutrients in the ashes should be returned to the narrowest possible circulation
  - Assessment of the effects of the use of wood ash on SRC and on the yield of energy wood cultures
  - Assessment of the potential of heavy metal discharge from SRC by ash fractionation

- Status Quo:
  - Minor differences between versions of artificial fertilizers, wood ashes and the zero-variant
  - In April 2010 planted crops (poplar and willow) were harvested in November 2013
  - Thereafter, analysis of biomass and soil, evaluation and review

Short-rotation coppice-fields



Use of wood ash in road construction

- Aims:
  - Development and evaluation of wood ash as a binder in road construction (used for stabilization in the body)
- Status Quo/ Results:
  - ➢ Technical Asessment and economical evaluation completed positively
  - ➢ Ecological Assessment in progress (positive trend)

Optimization of ash Logistics

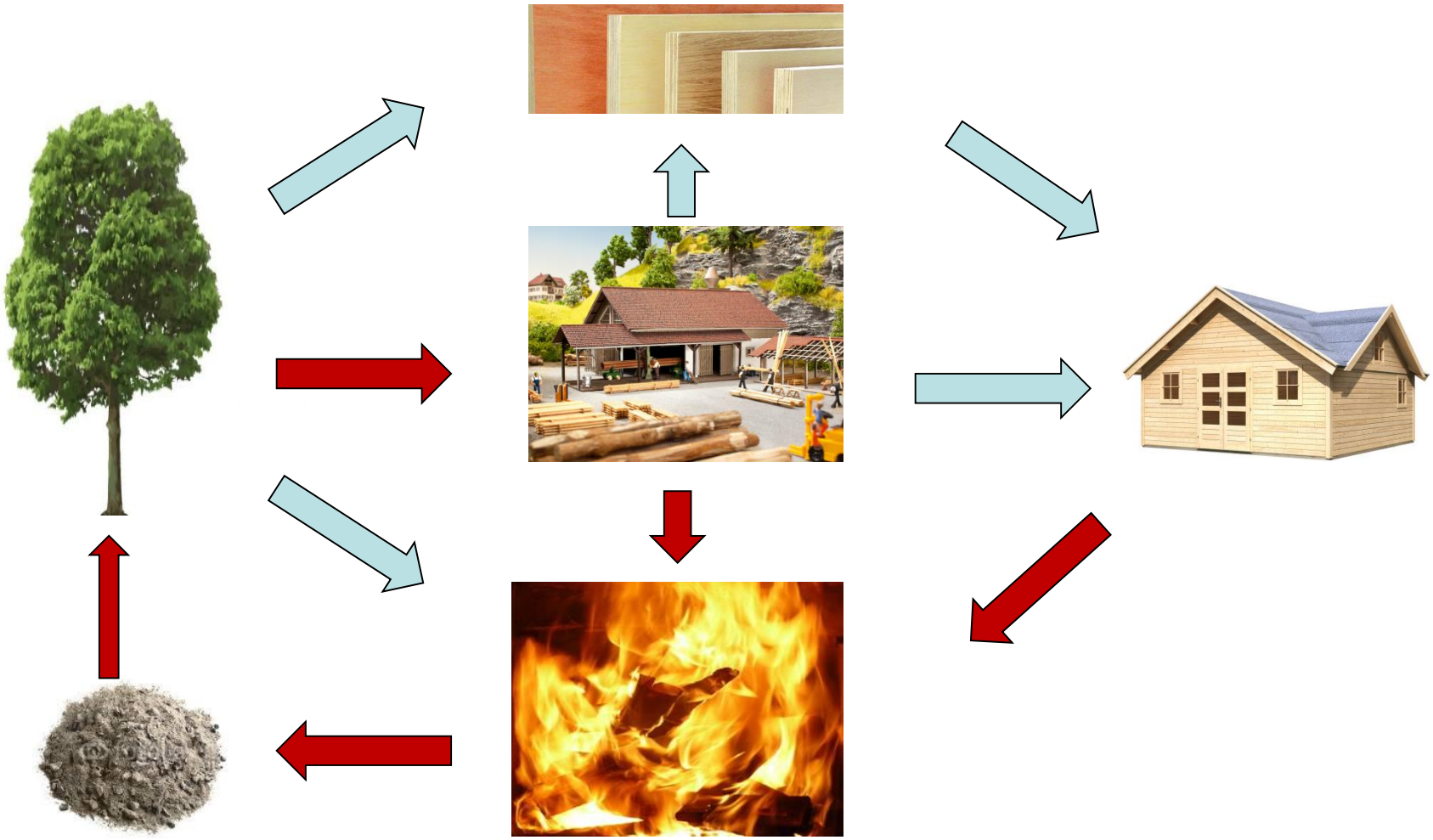
- Focus on the storage, transport and application of ashes

- Vulnerability analysis in ash logistics and storage
- Investigation and assessment of ashes stored outdoors on the physical and chemical properties (“aging” and “curing”) of the ashes and on the environmental impact
- Definition of the optimal process from heating, storage, transport and conditioning for each investigated recycling method
- Definition of quality requirements for the ash for each investigated sampling taking into consideration the technical, environmental and economic requirements
- Definition of selection criteria from the perspective of ash producers and from the perspective of ash recyclers

Future Outlook

- Continuation of the exchange of experience with international experts
- Implementation of an international workshop
  Completition of the economic assessment of all studied ash utilization methods
- Discussion of the project results with the responsible legislative bodies
- Identification of and proposals for necessary changes in legislation (waste / fertilizer)

Future Outlook – Holistic Ash-Cycle



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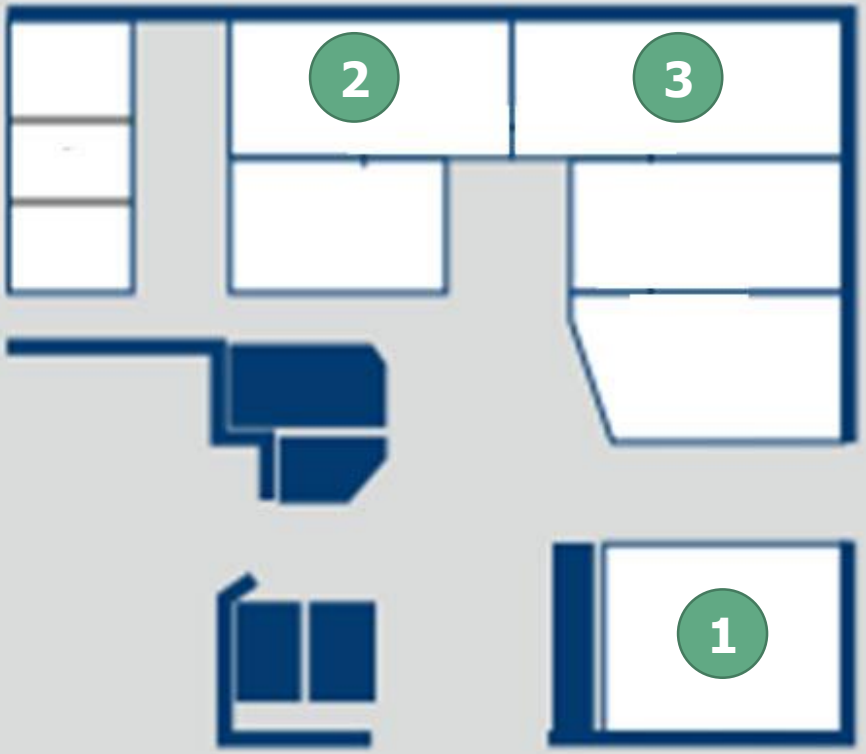
Breakout sessions

We are at the basement. Breakout sessions are at the ground floor.



Breakout session 1: Louise

Breakout session 2: Victoria

Breakout session 3:Elisabet

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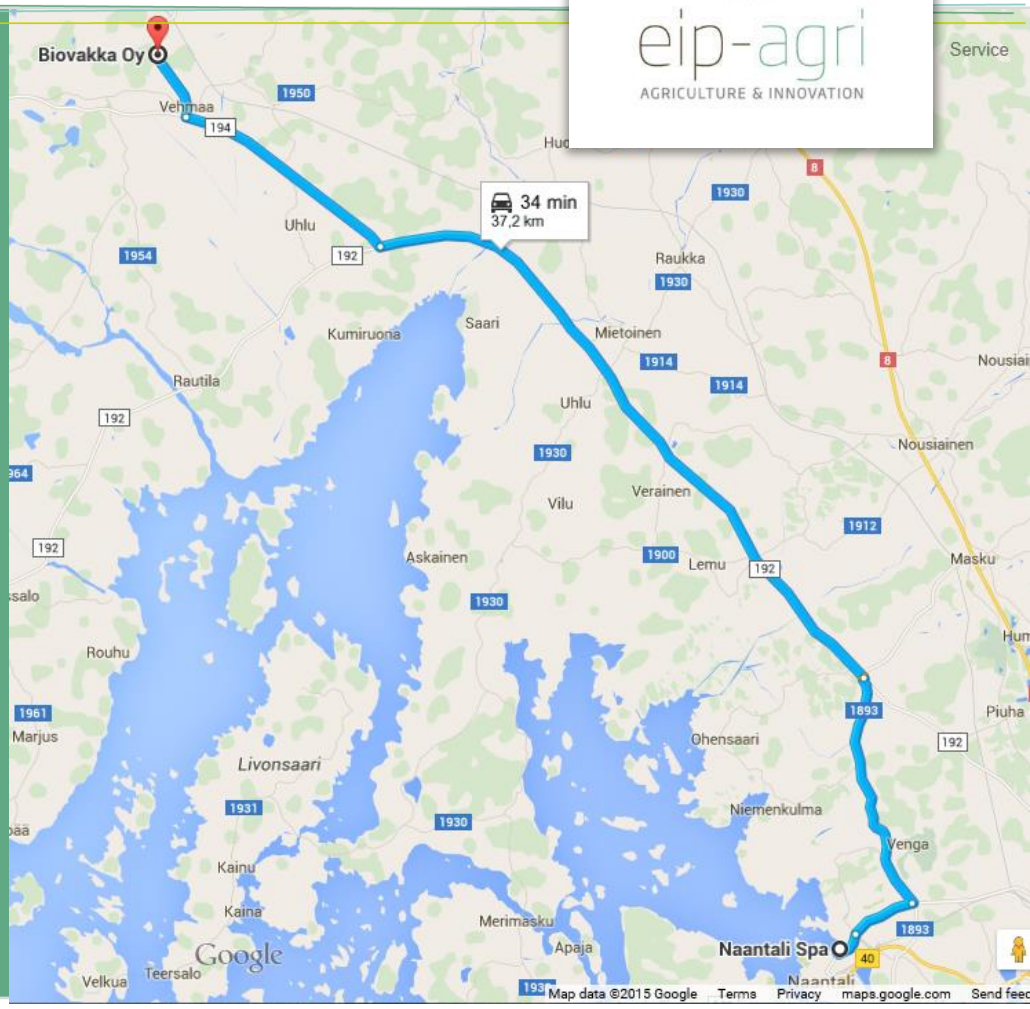
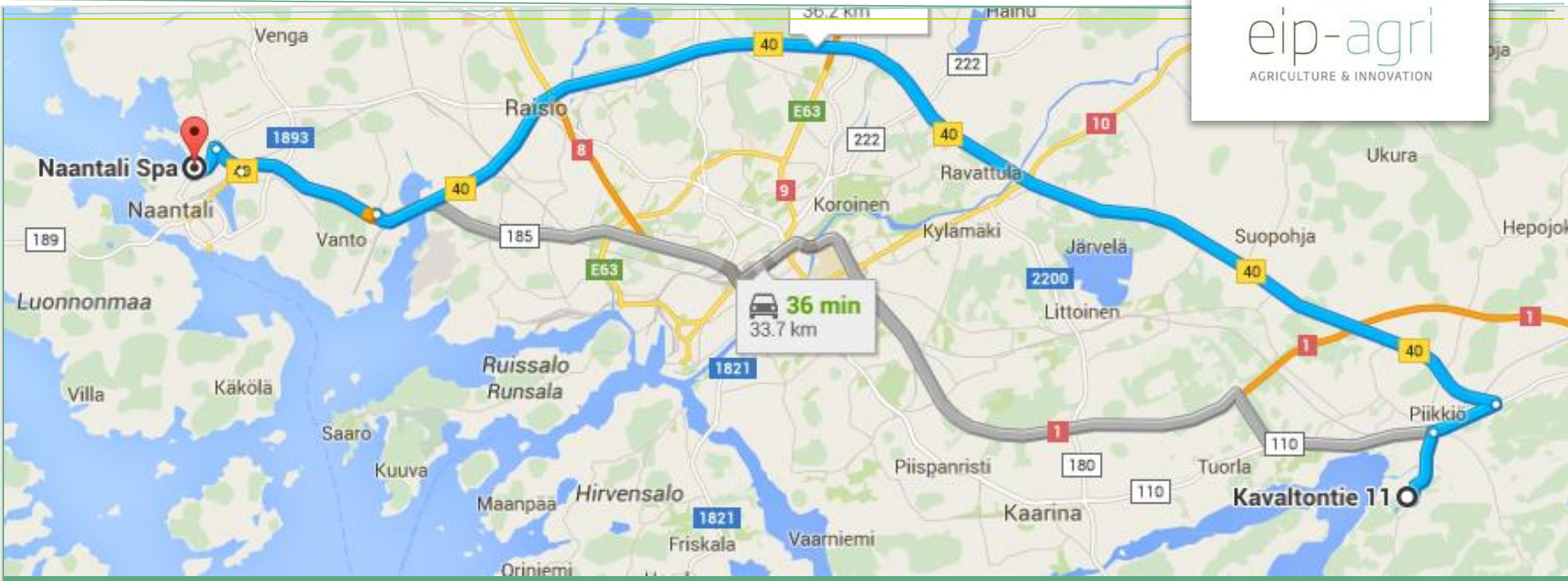
Session 3: Inspiration from practice
Field visit to Biovakka biogas plant Vehmaa

- Bus leaves at 14:20 in front of the hotel
- 30 – 45 minutes drive
- Networking game
- Plant visit in 4 groups
- We drive back at 16:45
- Back at the hotel at 17:30
- Come back to the front of the hotel at 17:50



Session 3: Inspiration from practice
Networking dinner offered by the Finnish National Rural Network



- Bus leaves at 18:00 - 30 minutes drive to Kavalto farm
- Back at the hotel 22:30 – 23:00

ADDRESS: KAVALTON TILA OY KAVALTONTIE 11 - 21500, PIIKKIÖ

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Biovakka Suomi Oy
Nutrient recovery and closing loops with biogas technology in Western Finland

Development manager Teija Paavola, Biovakka Suomi Oy

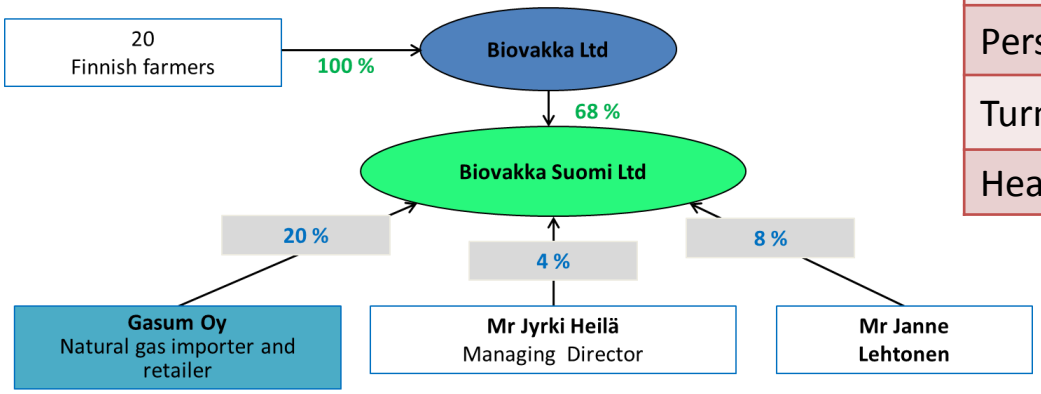
EIP-AGRI ”Workshop Opportunities for Agriculture and Forestry in the Circular Economy”, 28 October 2015, Naantali, Finland

Company Overview

- Established in 2002 by 21 farmers
- Original idea was to find a solution
  - To refine pig manure as an environmentally benign way
  - To enable enlargement of pig production
- Basis of the present operation is
  - To offer waste management service by processing variety of organic materials from agriculture, industry and municipalities
  - To produce biogas
  - To produce safe nutrient products
  - To build a network of biogas plants with nutrient recovery and concentration process

Biovakka was established in 2002 by Jyrki Heilä (CEO) and 20 farmers

Facts	Figures
Vehmaa plant in production	Since 2005
Turku plant in production	Since 2009
Personnel in 2015	13, indirectly 20
Turnover 2014	8,3 M€
Head office location	Turku, Finland



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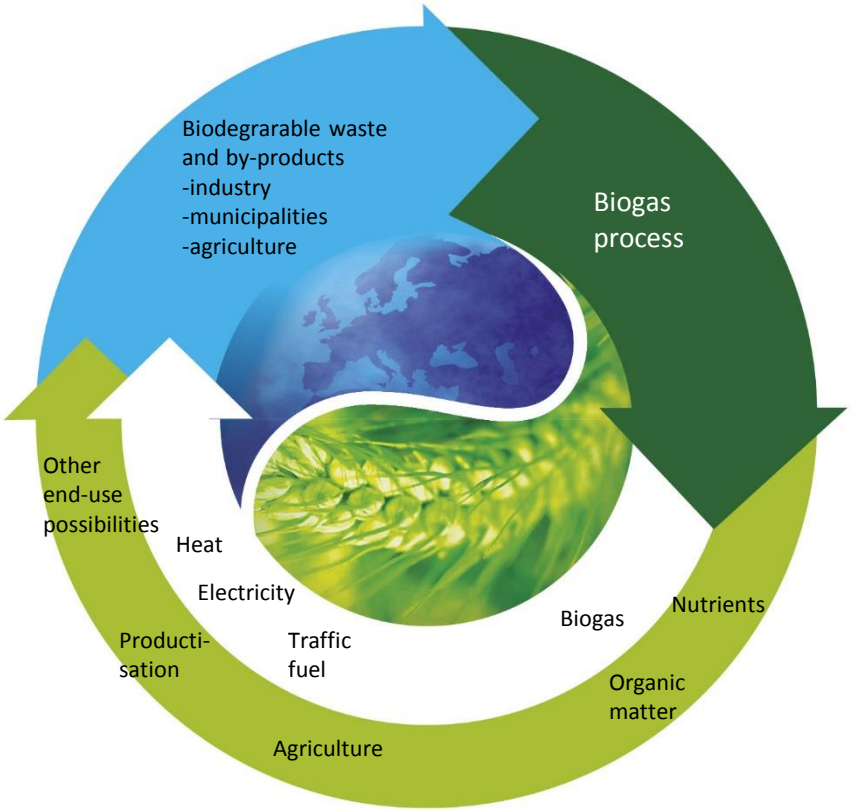
Closed loop with biogas technology

Reducing emissions from manure management

Replacing fossil fuels and reducing emissions



Reducing emissions from waste management

Recycling nutrients and organic matter

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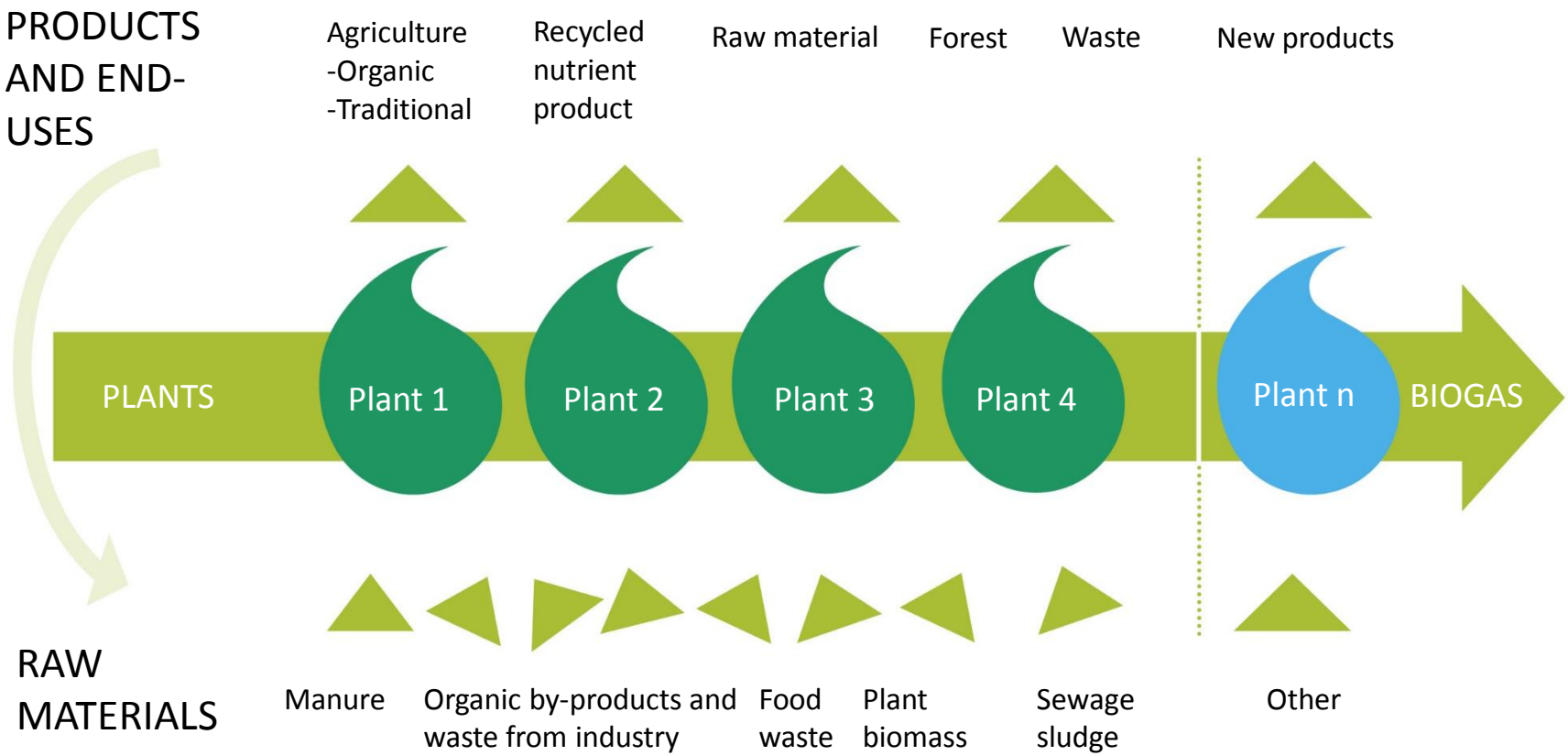
Company's strategy: From the end-use



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Production sites

Vehmaa biogas plant

- Operations started in 2005
- The first large-scale biogas plant in Finland
- Raw materials: pig slurry and industrial by-products from enzyme and food production
- Environmental permit: 120 000 tons/a
- Energy output: 4 MW (electricity and heat)
- Pasteurisation: 1 h at 70 °C before biogas process
- Biogas process: 41 °C, OLR ~2.1 kgVS/m^3d, HRT 20 – 25 d
  - High nitrogen concentration (N_{tot} 8 g/l, NH_4-N 6 – 7 g/l)
  - Specific methane production >500 m^3CH_4/t-VS_{add}
- Digestate post-treatment and productisation

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Turku biogas plant

- Operations started in 2009
- Raw materials: sewage sludge from municipal waste water treatment plants
- Environmental permit: 150 000 tons/a (in use: ~50%)
- Energy output: 4 MW (elec. and heat)
- The generated heat is supplied into the district heating network of the City of Turku
- Thermal hydrolysis, 20 min, 150 °C, 5-6 bar
- Biogas process: 52 – 53 °C, OLR ~4 kgVS/m^3d, HRT 17 – 21 d
  - Specific methane production 300 m^3CH_4/t-VS_{add}
- Solid fraction of the digestate is utilised in landscaping and agriculture (liquid fraction is directed to WWTP)
  - Nutrient recovery from the liquid fraction is under development

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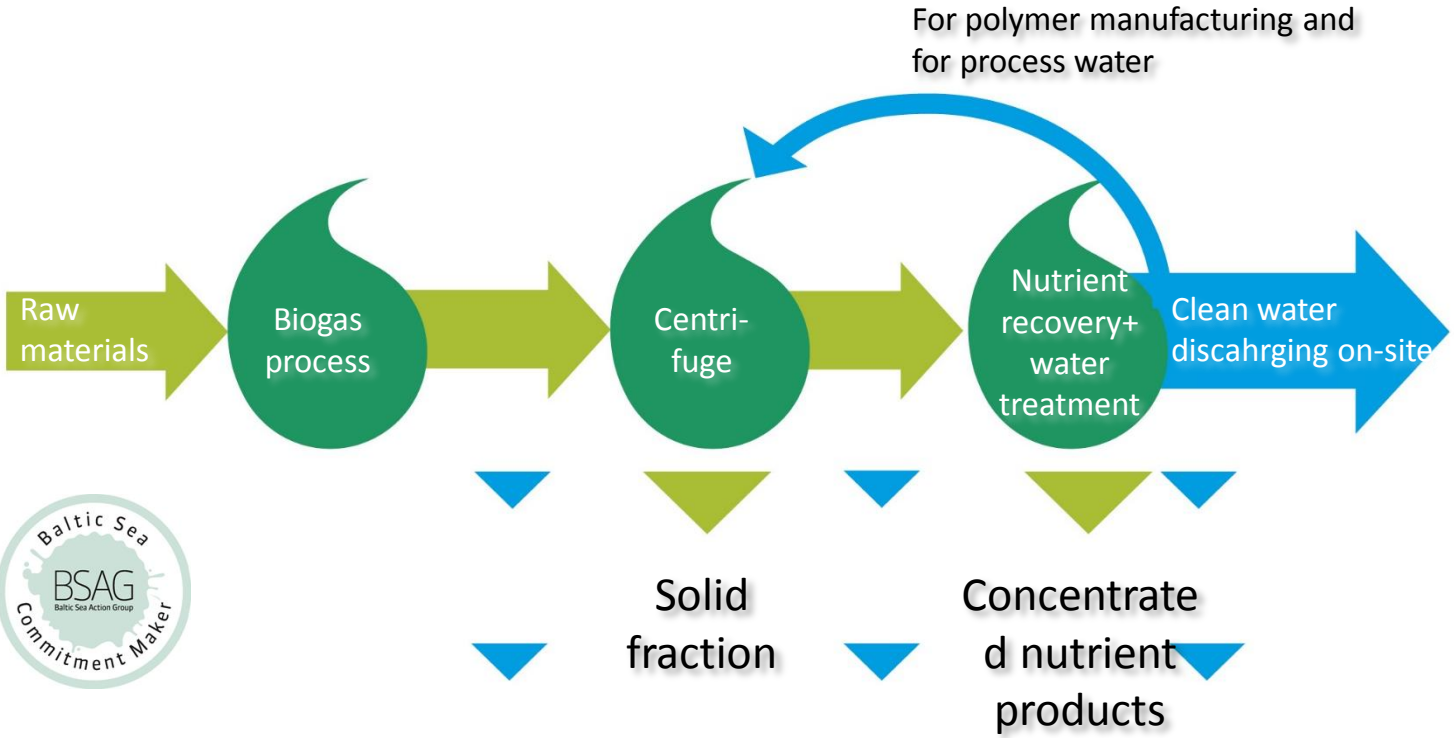
Nutrient recovery and concentration process



- **Nutrient recovery** from the digestate liquid fraction as a concentrated form and production of clean condensate (purified water), which can be discharged **directly into soil or waters** on-site
- Meets the demanding Northern climate conditions and environmental legislation
- **Major savings** in storage and logistics → **Solution for competition** against plants with feed-in tariff

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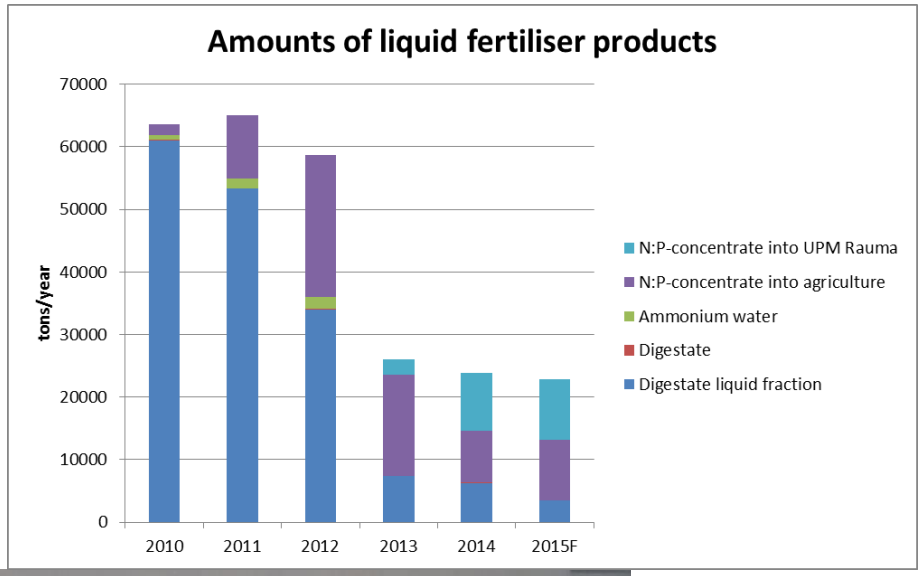
Purified water from digestate liquid fraction



Digestate liquid fraction

N:P Concentrate

Process water

Purified water

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Recycled nutrients in industrial use

- Use as a chemical
  - Replacing phosphoric acid and urea
- Security of supply
- Uniform quality
- Consumption all over the year

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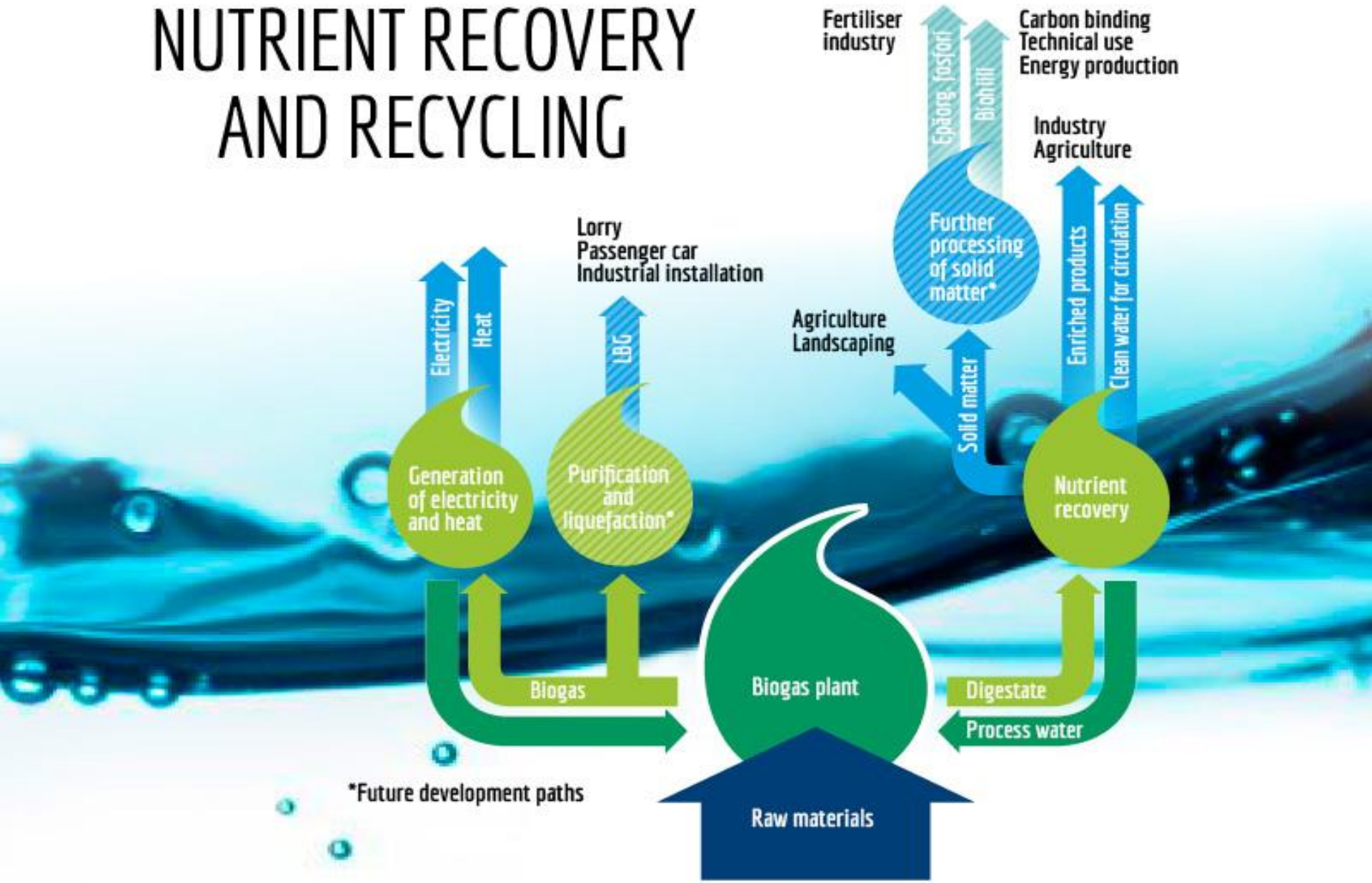
NUTRIENT RECOVERY AND RECYCLING



Competitive fuel for heavy traffic
Reduction of GHG emissions via LBG use

Source of energy in biogas plant	Transport of raw materials and digestate products by diesel trucks		Transport of raw materials and digestate products by LBG	
	vs. fossil diesel, %	vs. LNG, %	vs. fossil diesel, %	vs. LNG, %
Average electricity and natural gas	67	63	71	68
Average electricity and wood chips	82	80	87	85
Renewable electricity and natural gas	75	72	79	77
Renewable electricity and wood chips	90	88	95	94

LBG: liquefied biogas LNG: liquefied natural gas

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Luke LUONNONVARAKESKUS

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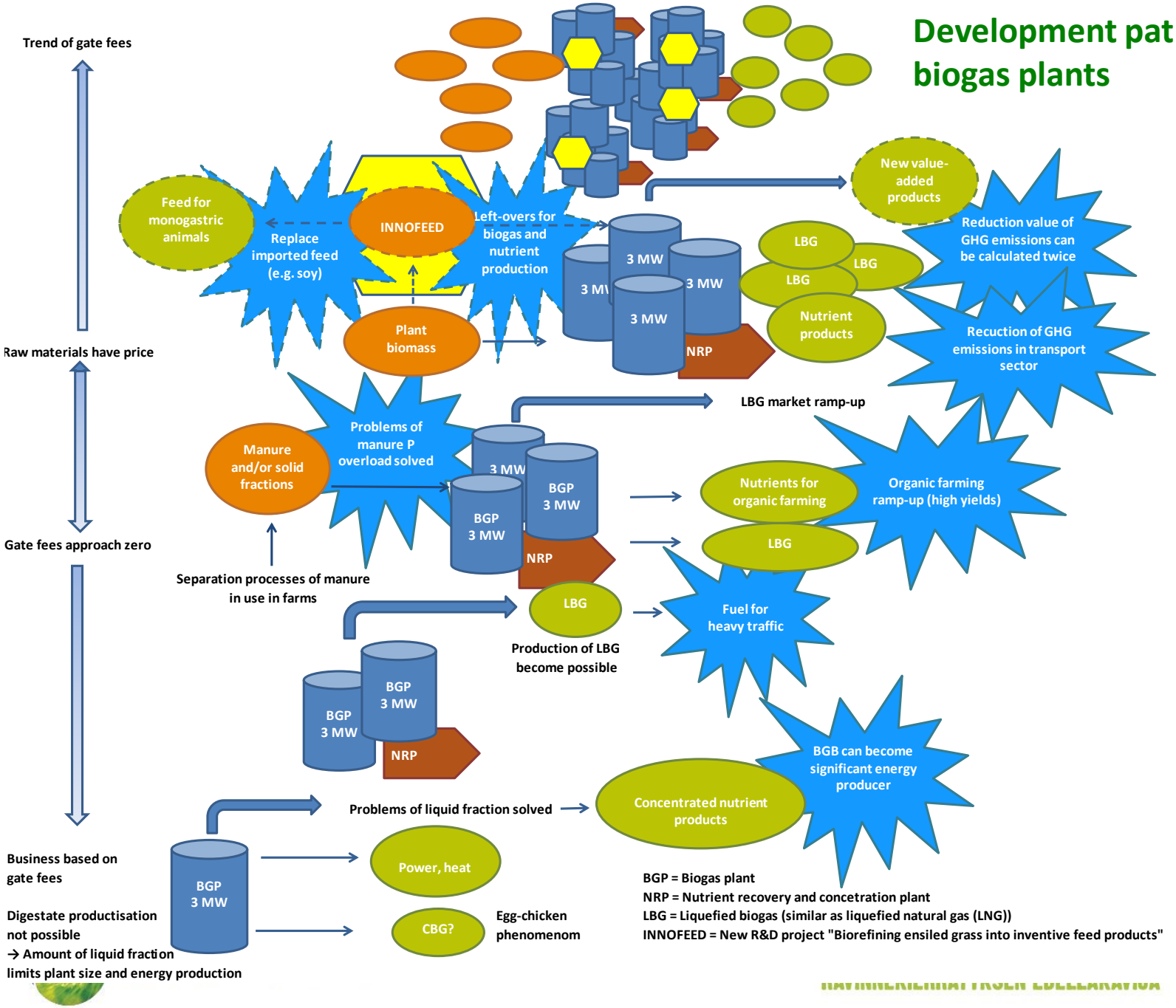
Development path of biogas plants



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Thank you for your attention

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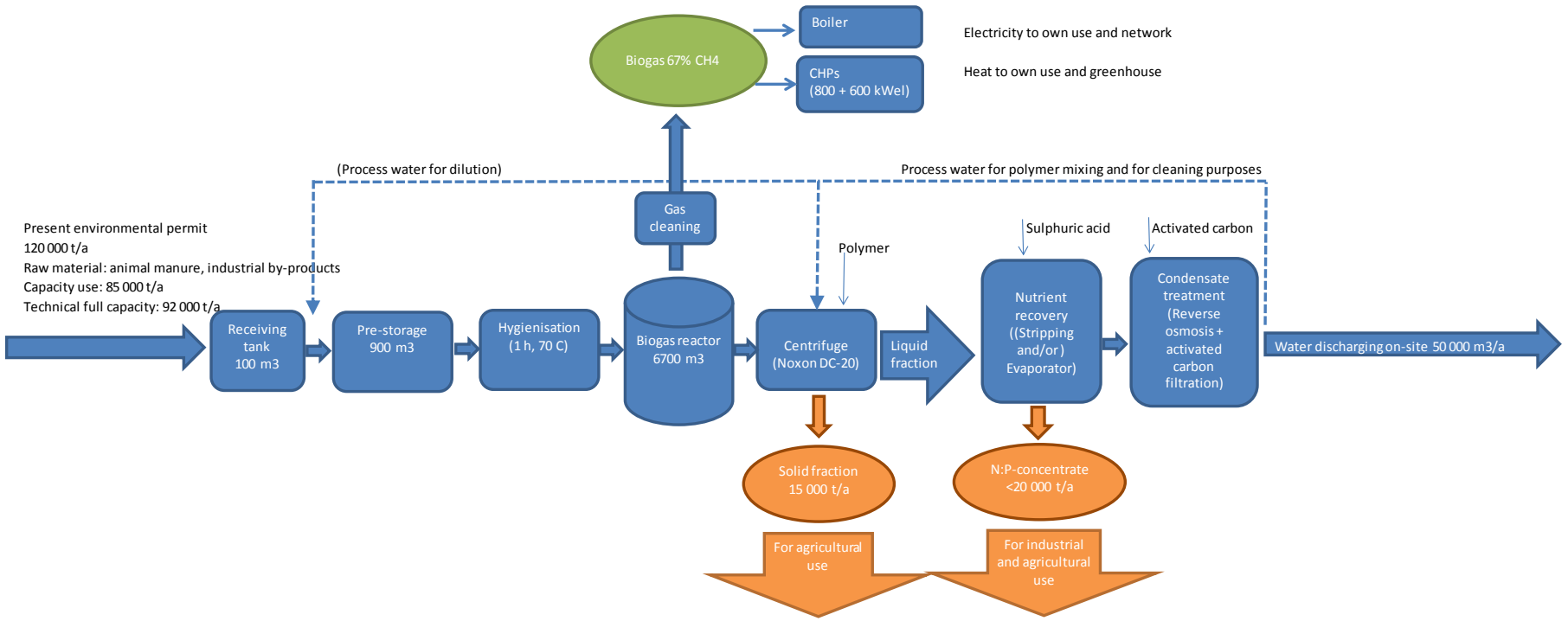
Additional information

Vehmaa plant: flow chart



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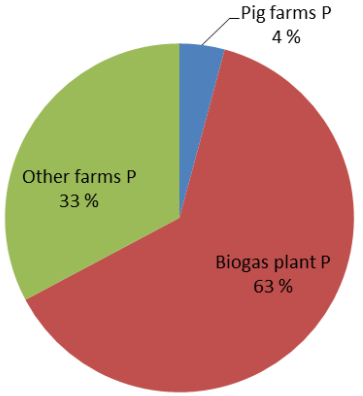
Target of Vehmaa biogas plant: A regional solution for managing environmental problems of manure

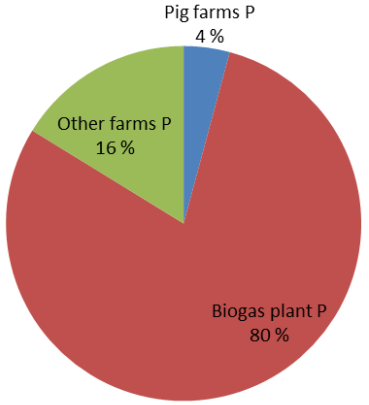
- Vakka-Suomi: 8 municipalities (Vehmaa, Taivassalo, Uusikaupunki, Mynämäki, Laitila, Masku, Nousiainen, Kustavi)
  - Pig slurry from Vehmaa and separated solid fraction from other municipalities → Redistribution of 60% of animal manure P and 90% of pig manure P
  - If additional 50 % of cow and chicken manure → Redistribution of 80% animal manure P

→Solution for regional and farm-scale problem of phosphorous overload

All manure: 382 tons of P
Pig manure: 257 tons of P



All manure: 382 tons of P
Pig manure+50% of cow manure+50% of chichen manure: 304 tons of P



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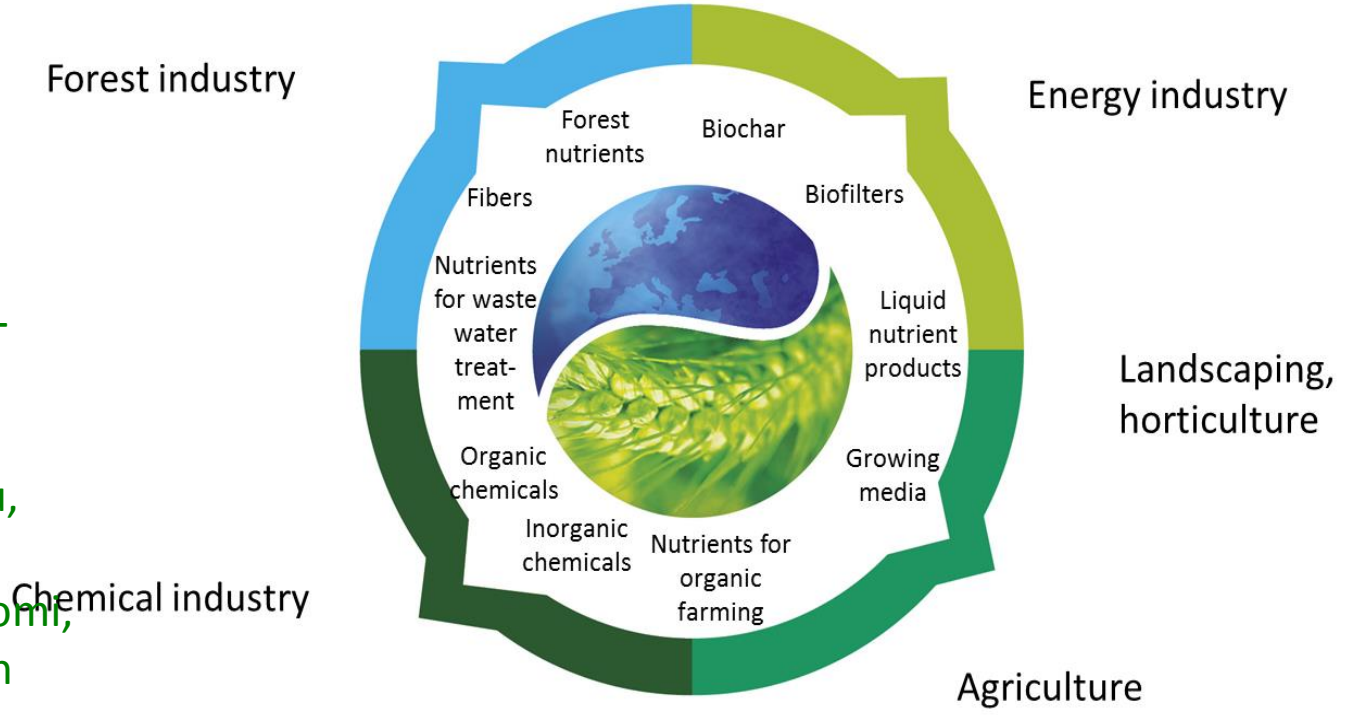
Preliminary results of R&D project LantaTeko

Future: Added value from new products and end-uses

New project:
Biorefining ensiled grass into inventive feed products ”INNOFEED” 2015 – 2018
Partners: VTT, Luke, Tekes, Valio, A-Rehu, Eastman, Pohjolan Maito, Biovakka Suomi, Pirteä Porsas, Pellon Group, Roal



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EIP-AGRI Workshop
'Biosecurity at farmlevel
Challenges for innovation'

We see you tomorrow at 08:45!

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