

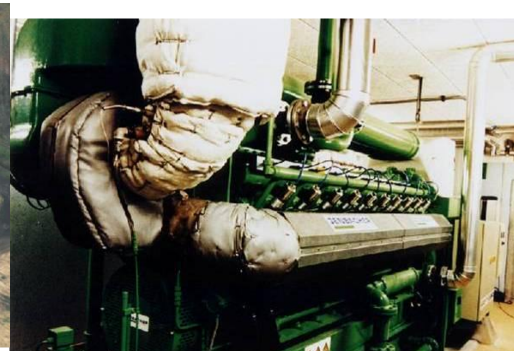
EnviTec Biogas

METHANE to MARKETS CONFERENCE

4th MARCH 2010

BIO WASTE to BIO ENERGY & ORGANIC FERTILISER

ENSURING SUSTAINABLE SOCIAL , ENVIRONMENTAL & ECONOMIC VALUE

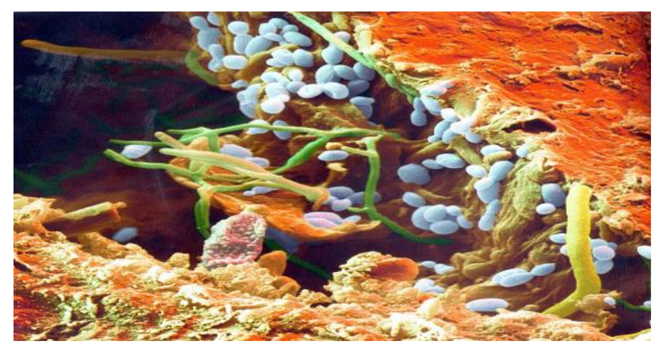

Organic Fertilizer

K.Krishan

MATTER OF PERCEPTION

- *Conventional Approach* : Waste is a source of pollution and technology/ investment focus is on treating the waste and ensuring that "discharges" are within norms stipulated for air and water quality by respective "Pollution Control Boards"

- *Emerging Approach* : Waste contains organic matter which can be a renewable (as well as cost efficient) resource for producing energy and organic fertiliser



Methane Bacteria

“A clever man ***solves*** *problems,*
a wise man ***avoids*** *them “*

(*Chinese proverb*)

Biological treatment for organic waste

INDIAN BIO WASTE to ENERGY POTENTIAL

India has 141 million hectares of ararble land

> 1.5 billion MT/year of food + agri residues is produced,

hence a large amount of bio waste at fields & Agri processing units

LARGE POTENTIAL FOR CROPS OF SHORT CYCLE CELLULOSIC BIOMASS

40 % of arable land is under 1 season mono cropping

India has 58 million hectares of grazing land.

ANIMAL WASTE IS A SOURCE FOR BIO ENERGY

INDIA HAS AROUND 500 Mill POULTRY BIRDS & 250 Mill BOVINE ANIMALS

Cow dung & Poultry litter are available in large quantities

<u>Tropical Sugarbeet</u>

- The normally, temperate zone crop (cultivated in areas with latitudes up to 26^{o}) has been developed as hybrid varieties, suitable for cultivation in tropical areas.
- Trials carried out ,in India (plains of Tamil Nadu, Karnataka, Rajasthan, Andhra Pradesh, Punjab, Haryana, Uttar Pradesh and Maharashtra) have given ***<u>yields of up to 80 MTs / hectare</u>***
- It is a short duration (5 to 6 months) crop and hence can be integrated with rotation crop of maize/ sorghum silage…. ***<u>Total yield of 120 – 140 MT/ hectare</u>***

Napier Grass - Yield data

Station Trial at Mandya	139.2 Tons /Ha
MLT during 2007-08 for green forage yield	135.9 Tons / Ha
Average yield	***125 – 140 Tons / Ha***

Data on other Characteristics

Plant Height	135.1 Cm
Leaf Stem Ration	1.6
Dry Matter Yield	20.85 Tons / Ha
Per day Dry matter production	0.011 tons/ha/day
Per day Green Forage production	0.45 Tons/Ha/Day

Source:
The above details for Napier Grass was obtained during the trial test by All India Coordinated Research Project on Forage Crops by Zonal Agricultural Research Station, VC Farm, Mandya, University of Agricultural Sciences, Bangalore

Hybrids of traditional Crops – for yield improvements

<u>**Cassava**</u> **(*Manihot esculanta*) is tolerant to dry spells and grows well under irrigation. Adequate yields can be obtained even from poor soil.**
Cassava (or Tapioca) <u>*yields could be enhanced to between 45-60 tons/ hectare*</u>, for rain fed and irrigated land respectively.

CASSAVA

<u>**Sorghum**</u> **(*Sorgum bicolor*) is known as a grain crop and has a variety that is used as livestock fodder. Its high rate of photosynthesis produces leafy stalks up to 5 metres tall that make excellent silage. Sweet sorghum has a wide adaptability, a marked resistance to drought and saline-alkaline soils, and fodder sorghum has tolerance to water logging.**
Sorghum <u>*yields are of the order of 100 -120 MT/hectare*</u> with irrigation

SORGHUM

IMPROVING FARM PRODUCTIVITY

CASSAVA GROWTH ON UNCLEARED LAND

CASSAVA GROWTH ON CLEARED LAND

CASSAVA GROWTH WITH DISKING & PLOUGHING + FERTLISER & IRRIGATION

Need for Silage Preparation & Storage

Silage Pile

Horizontal Silo's (Bunkers)

Silo Bag

Wrapped Bales

India's current fodder consumption (green + dry) is around 1 billion MT.
With improved species of forage crops, the output can be increased to 2 billion MT … meeting needs of Animal feed as well as Bio-energy .

Need for increasing Horticulture activity

India uses 6.4 mill ha to grow 113.5 mill MT of Vegetables (30 % that of China) & 122 mill ha to grow 210-230 mill MT of grain.
China's vegetable output is 330 kg per capita > twice the world average

Cold Storage

Tomato Puree

- **Farmers tend to cultivate grains (even with sub optimal returns) as they are not perishable.**
- **FoodProcessing/Preservation infrastructure would (a) stimulate non grain farming (b) enhance farmers income (c) meet nutrition needs of the community (d) open up significant opportunities for exports**
- ***CHP schemes, firing biomass, provide the energy component, which is a key deterrent for establishment of "Cold Chain"***
- ***Organic fertliser is, generally, well accepted in horticulture sector***

Cut Vegetables

Mango Pulp

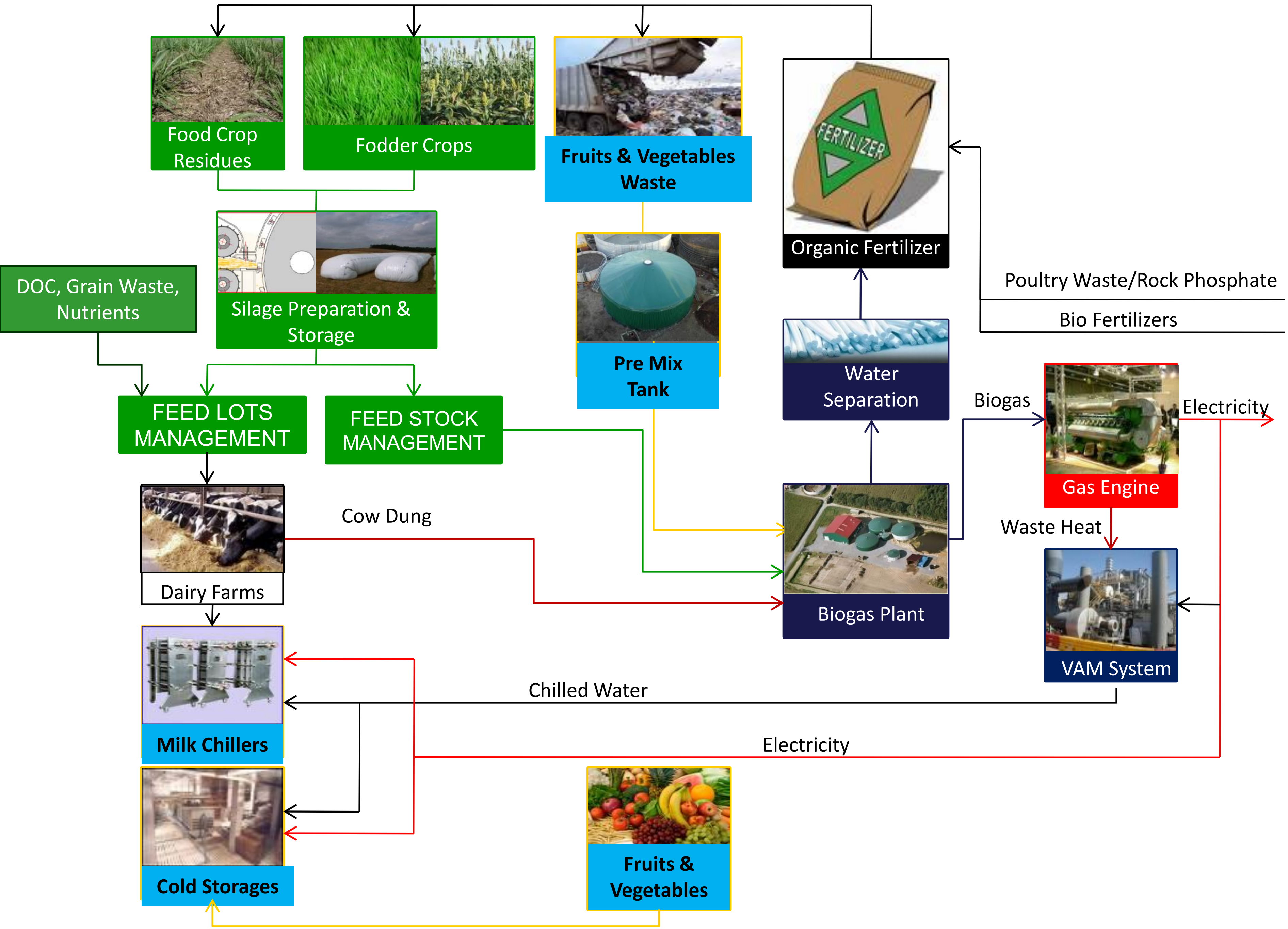
Reducing Energy need for fertilizer production

- To produce 1 kg of nitrogen fertilizer on fossil base most efficient plants use 0,75 kg of natural gas as energy and hydrogen source with an equivalent of 0,8 litres mineral oil.
- One litre of fossil fuel produces 2,6 kg of CO_2-emissions
- ***One ton of nitrogen in the organic fertilizer reduces therefore 2,6 t CO_2***

Best practice - using digester effluent as fertilizer

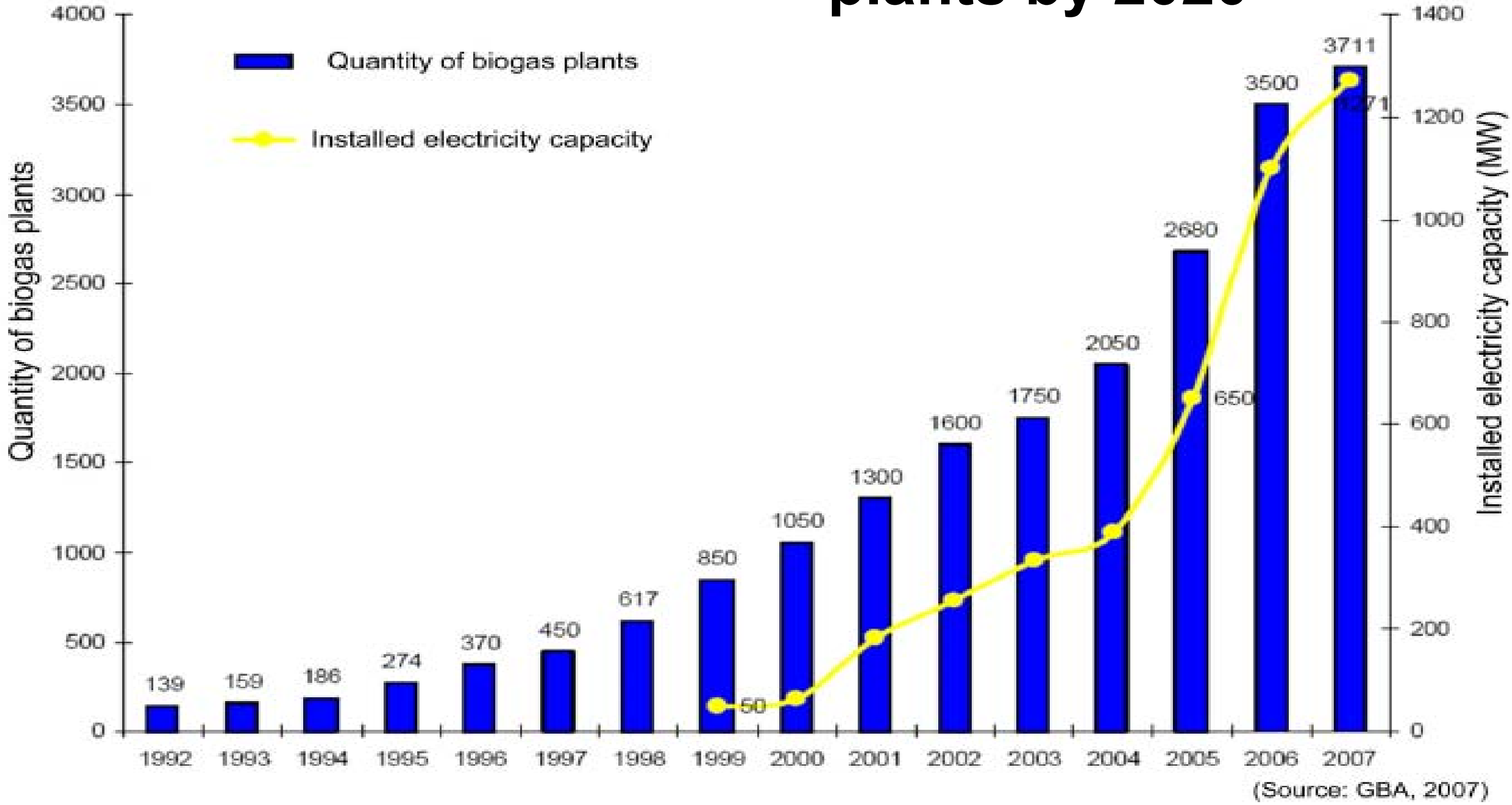
- **General positive impacts on environment**
  - **Decrease of odour of manure**
  - **Less CH_4 emissions**
  - **Reduces ground water contamination**
- **Close nutrient cycle with using biogas plant effluent as fertilizer**
  - **Nutrients in feedstock of biogas plants can be reused after anaerobic digestion**
  - **Only very few losses of nutrients during storage, transport and biogas process itself**
- **Improvements on manure quality with anaerobic digestion**
  - **Degradation of cells, organic acids and long chain organic matter (which helps the young plant)**
  - **Increase of availability of nutrients (especially nitrogen)**
  - **Increase of humus on the fields (compared to combustion)**

Integrated Environment + Energy + Agriculture Project

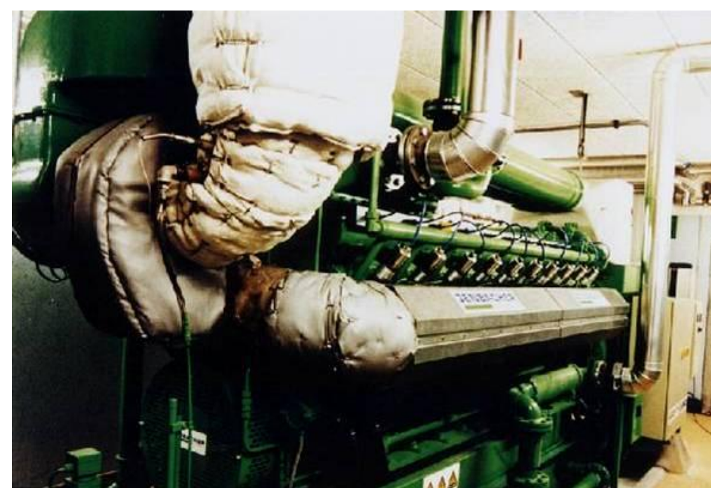


Biogas plants in Germany

Target 10.000 biogas plants by 2020

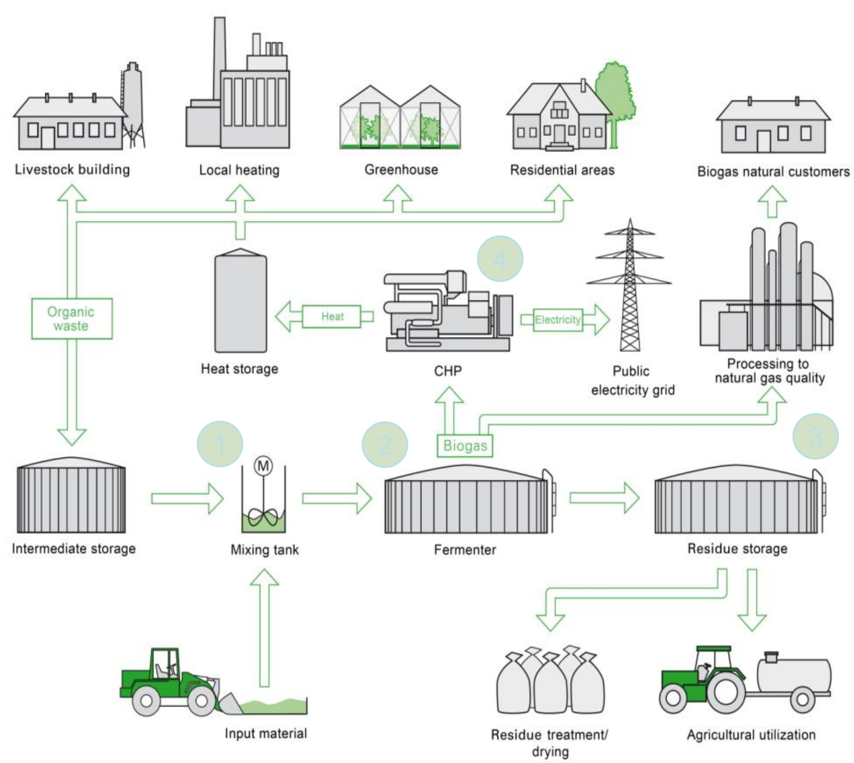


MODULAR BIOMASS POWER PLANTS
(OTTO CYCLE)
BASED ON AGRICULTURE/ ANIMAL/ HORTICULTURE WASTE



Construction of a biogas plant

Process steps



(1) Organic dry matter

- Preparation and pre-treatment of feedstock
  - Feedstock blending
  - Crushing
  - Separation of contaminants before inserting into the fermenter
  - Recirculation from digester
- Biogas production through fermentation (system tank)
  - Wet fermentation
  - Mesophilic process
  - Fully blended system
  - Retention time of 60 – 70 days of feedstock inside the fermenter
  - Volume load <3 kg oDM[(1)] / m^3 per day
- Fermented residue storage
  - Usage of fermented slurry as fertilizer
- Biogas utilization (CHP)
  - Electricity and heat generation

Biological service

Trouble-free operation

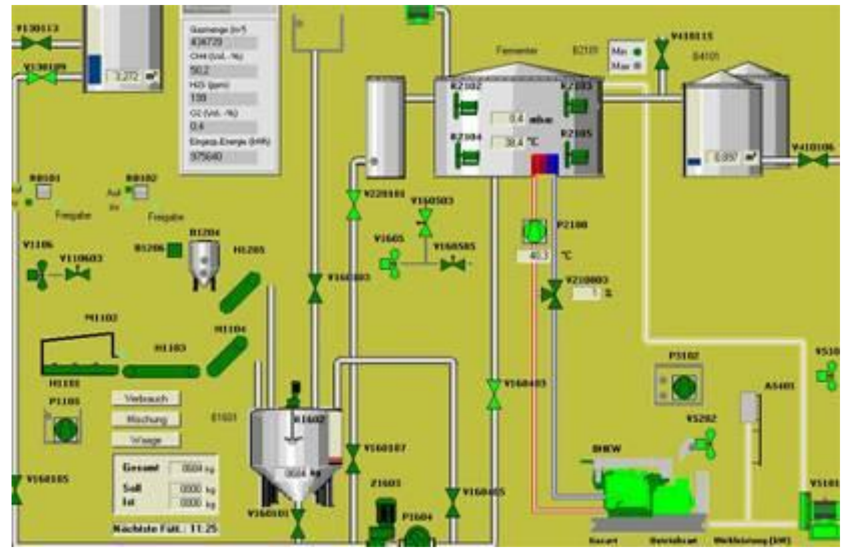
> **Our scientific specialists support you before and during the commissioning of your plant, and train your employees**

> **During operation the biological processes are monitored online daily**

> **In our laboratory we examine the substrates and residual effluents, as well as gas production and the capacity utilization of your plant**

> **Based on this data we develop individual mixing and recipe suggestions and thus ensure ongoing optimization of plant operation**

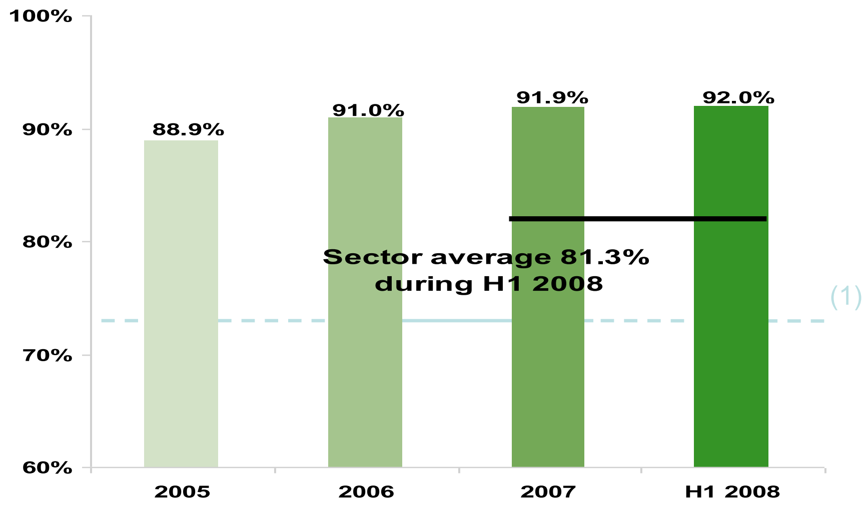
Monitoring and control



Source: EnviTec

Biogas Plant - Management / Service

Plant efficiency of over 90% achieved



Reasons

- Single-stage, mesophile (35°-38°C), fully mixed process
- Accurate weighing of feedstock
- Daily variance analysis and calibration of gas production
- High quality and standardized construction of components
- Consistent implementation of the process requirements

Potential for efficiency improvements

Substrate enhancements

- Improvements with regards to the cultivation and harvest of energy crops used for the production of biogas

Digestion rate in cows & biogas plant digester is similar- Catalyses improvements in Fodder management

Fermented residue processing

- Development of installations to create nutrient concentrates and water for farmland usage with high efficiency and low energy requirements

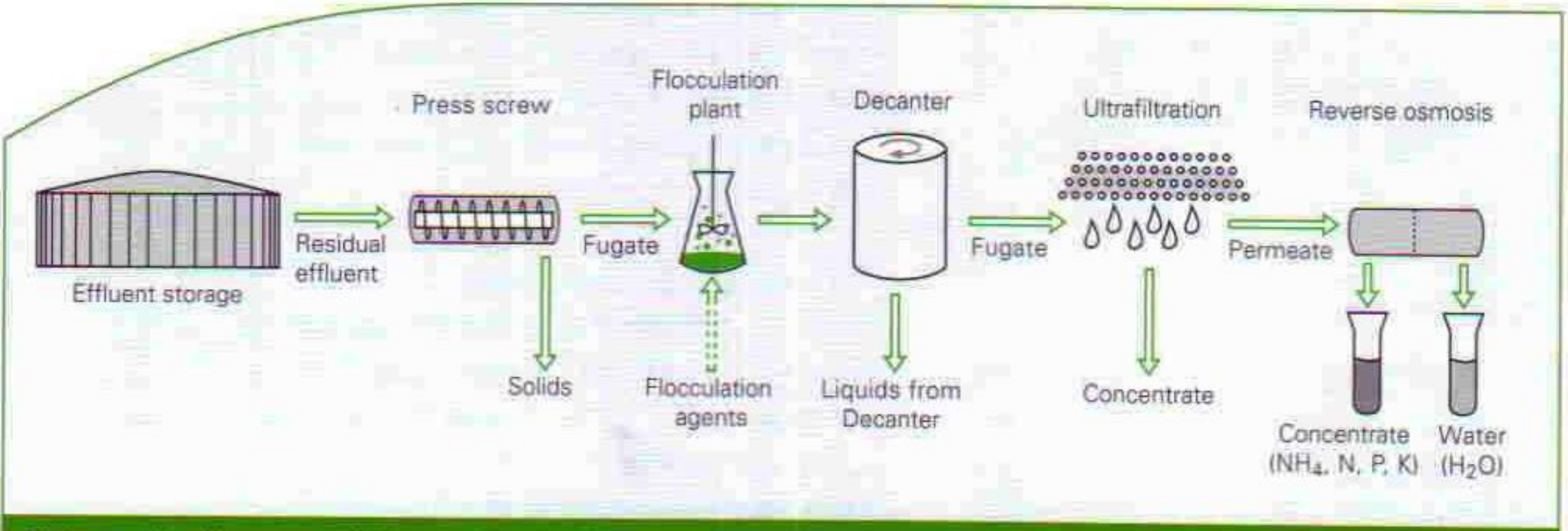
Industrial approach to Organic Farming - Ensures Soil fertility

Biogas processing to natural gas quality

- Combination of biogas processing and biogas production
- Process optimization through heat recovery (energy efficiency) and measures to reduce emissions

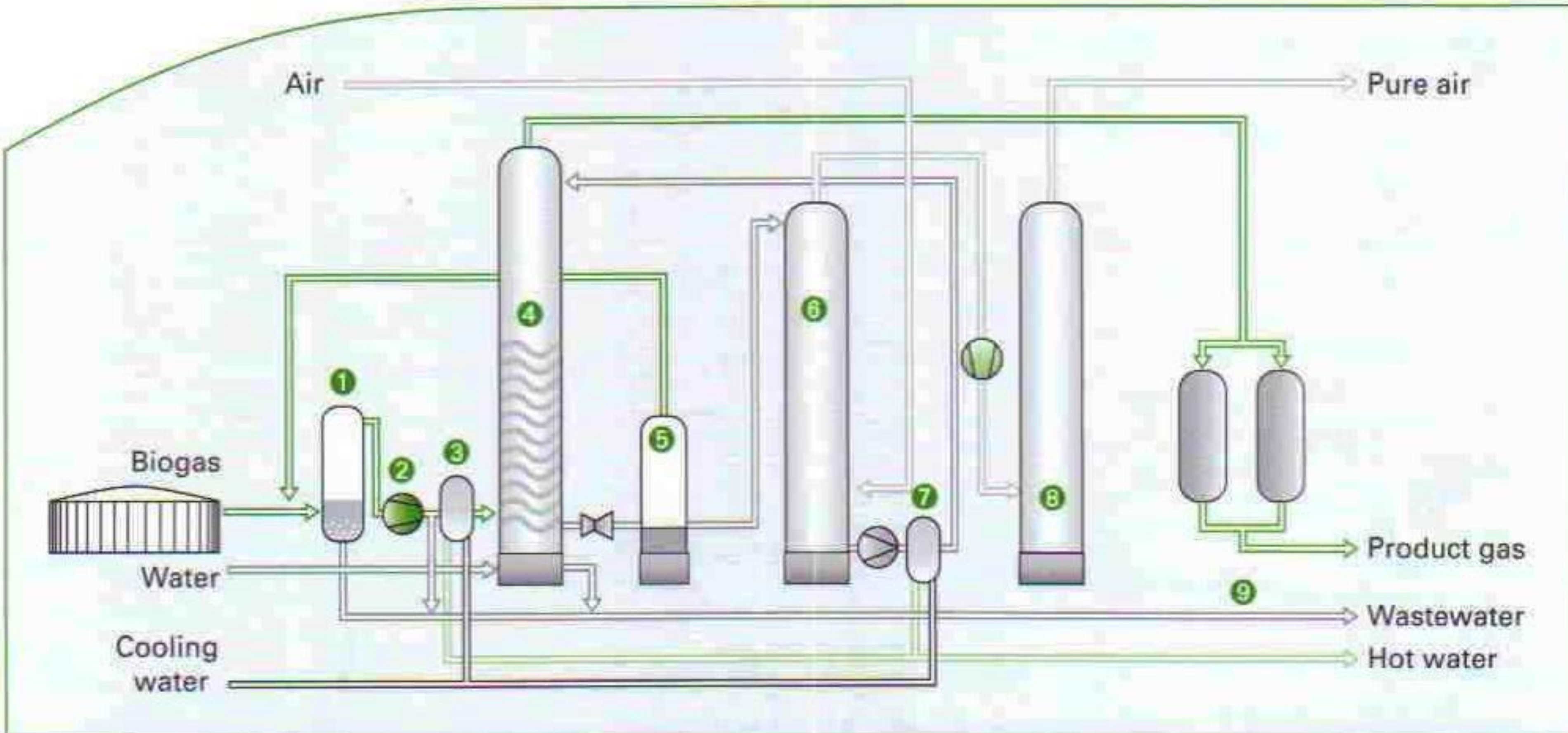
Enables "Off Site" applications - Contributes to Energy security

Biogas Plant - Digester Effluent treatment



Schematic diagram of the residual effluent treatment

Biogas Plant – Upgrade to Natural Gas quality



Schematic diagram of the natural gas treatment

1 Droplet separation
2 Compression
3 Cooling
4 Absorption
5 Intermediate tension relief
6 Desorption
7 Cooling
8 Exhaust air treatment
9 Drying

Organic Fertilizer

CASE STUDY - 2 MW BIOGAS PLANT

FROM POULTRY LITTER & AGRI WASTE

Feed Stock Mix & Biogas Yield

Project: Namakkal 2 MW version 2 maize

Projct No: xxx

Date: 21-8-2009

Wir geben Bio Gas. EnviTec Biogas.

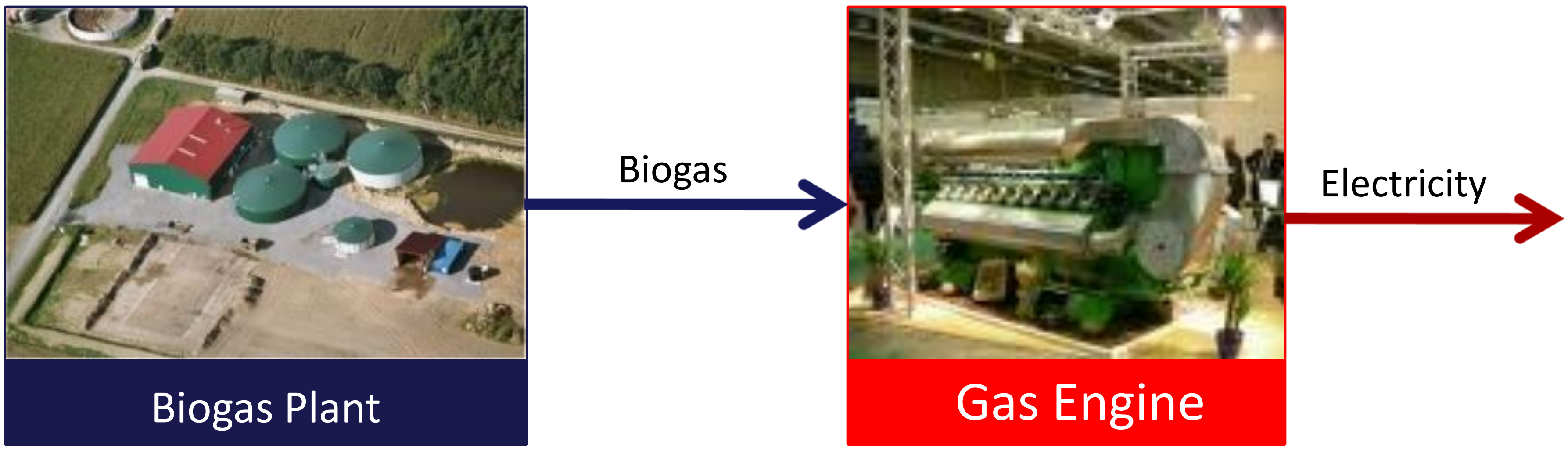
Gas production data	Unit	No.	No. tot	Solids/No to/(No.x a)	Input S to/a	Input S to/d	Inputmixture %	DS %	o DS %	DS to/a	N tot g/kgDS	N tot g/kg S	N tot kg/a	NH4-N kg/a	oDS to/a	doDS to/a	oTSab %	Gas Quantity Nm³/a	Gas Quantity Nm³/d	sp. Gas Q. Nm³/to S	Gasd. kg/m³	Prim energy kWh/a
Natural dung																						
Poultry dung	Plätze	0	0	0,05	6.000	16,50	6%	75,0	70,0	4.500	50	37,50	225.000	146.265	3.150	2.048	65	1.719.900	4.712,10	287	1,19	10.319.400
Agriculture waste																						
Cassava industrial screenings					12.000	32,90	13%	32,0	85,0	3.840	15	5	57.600	50.320	3.264	2.851	87	2.165.760	5.933,60	180	1,32	10.828.800
Napier grass					0	0,00	0%	45,0	90,0	0	27	12	0	0	0	0	0	0	0,00	133	1,32	0
Cane trash					6.000	16,50	6%	55,0	85,0	3.300	9	5	29.700	21.162	2.805	1.999	71	1.518.000	4.159,00	253	1,32	7.590.000
Vegetable pulp					4.000	11,00	4%	14,0	90,0	560	4	1	2.240	1.638	504	369	73	280.000	767,20	70	1,32	1.400.000
Maize silage	ha	0		50	12.000	32,90	13%	32,0	98,0	3.840	12,2	4	46.848	38.953	3.763	3.129	83	2.496.000	6.838,40	208	1,25	13.728.000
Water																						
Muddy water recirculate					0	0,00	0%	6,0	65,0	0	0	0,00	0	0	0	0	0	0	0,00	9	1,25	0
Water / rainwater					56.000	153,50	58%	0,0	0,0	0	0	0	0	0	0	0	0	0	0,00			0
Input mix					96.000	263,10	100%	16,7		16.040	23	3,76	361.388	258.337	13.486	10.395	77,1	8.179.660	22.410,10			43.866.200
Output					85.605	234,60		7,56	54,8	5.645		4										

Muddy water recirculate					0	0,00	0%	7,5	65,0	0	0	0,00	0	0	0	0	0	0	0,00	11	1,25	0
Effluent separation digester					0	0,00	0%	4,0	0,0	0	0	0	0	0	0	0	0	0	0,00			0
Input mix					96.000	263,10	0%	16,7														
Output					85.605	234,60																

Gas density 1,29 kg/m³ — Ammonium 2,15 g/kg FS

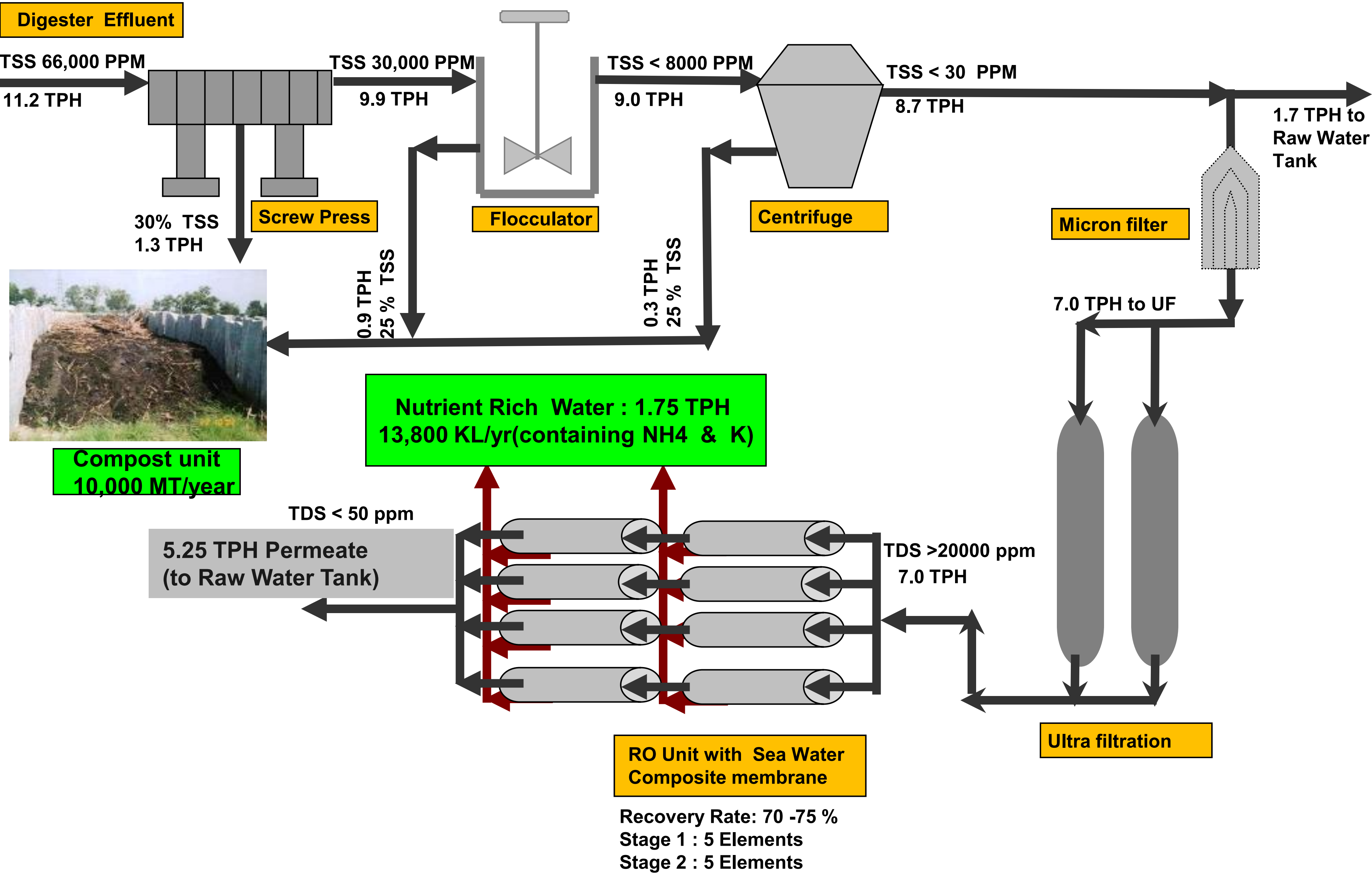
Spec. Energy contente: 5,36 kWh/m³ — **Laufleistung BHKW 21,48 Std/d** — Ammonium im Kreislauf 3,02 g/kg FS

Electricity Supplies (2 MW Module)

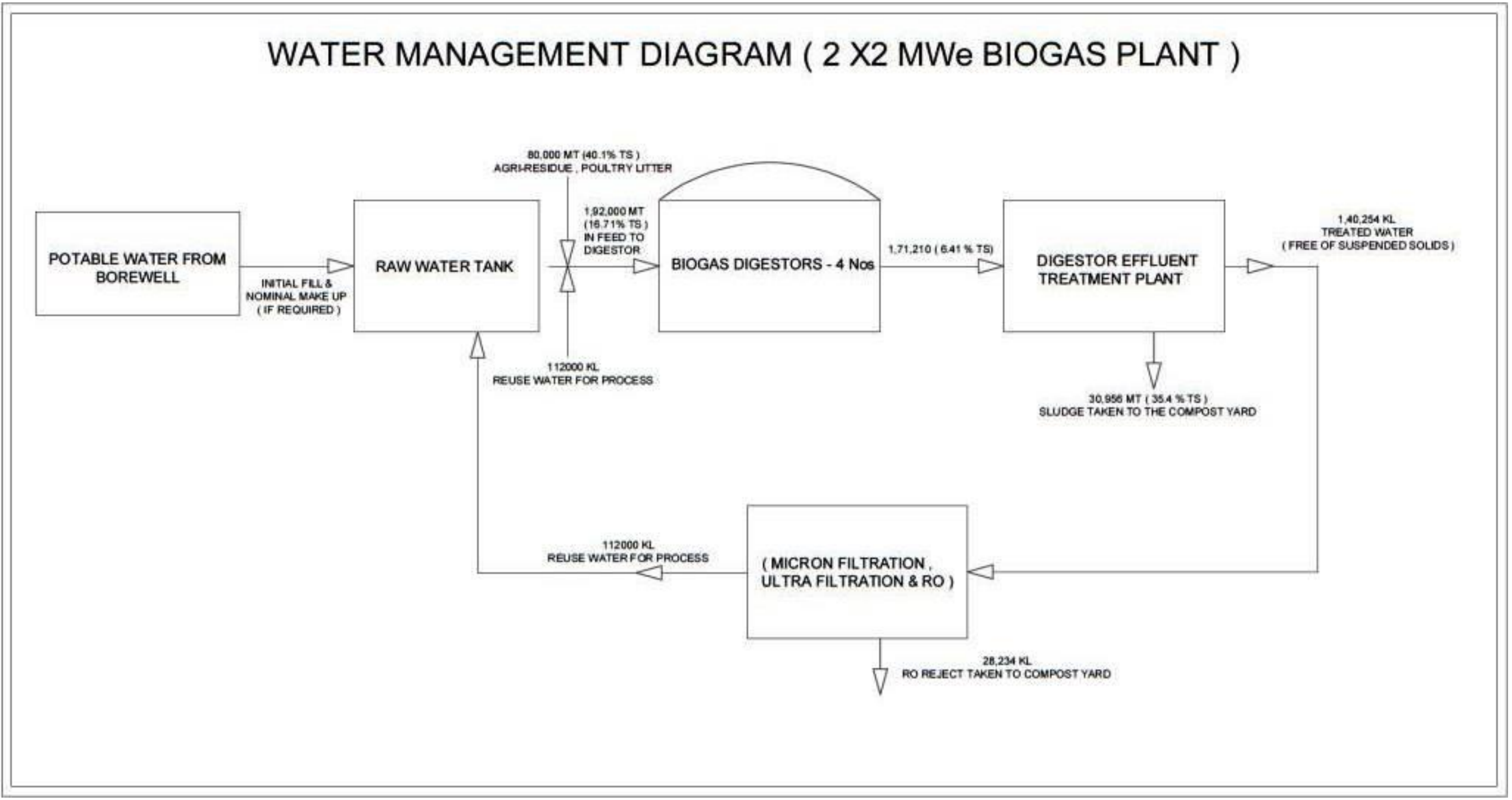


15 million KWh/year power export to rural electric grids ..
Typically, adequate for needs of 20 to 30 Villages

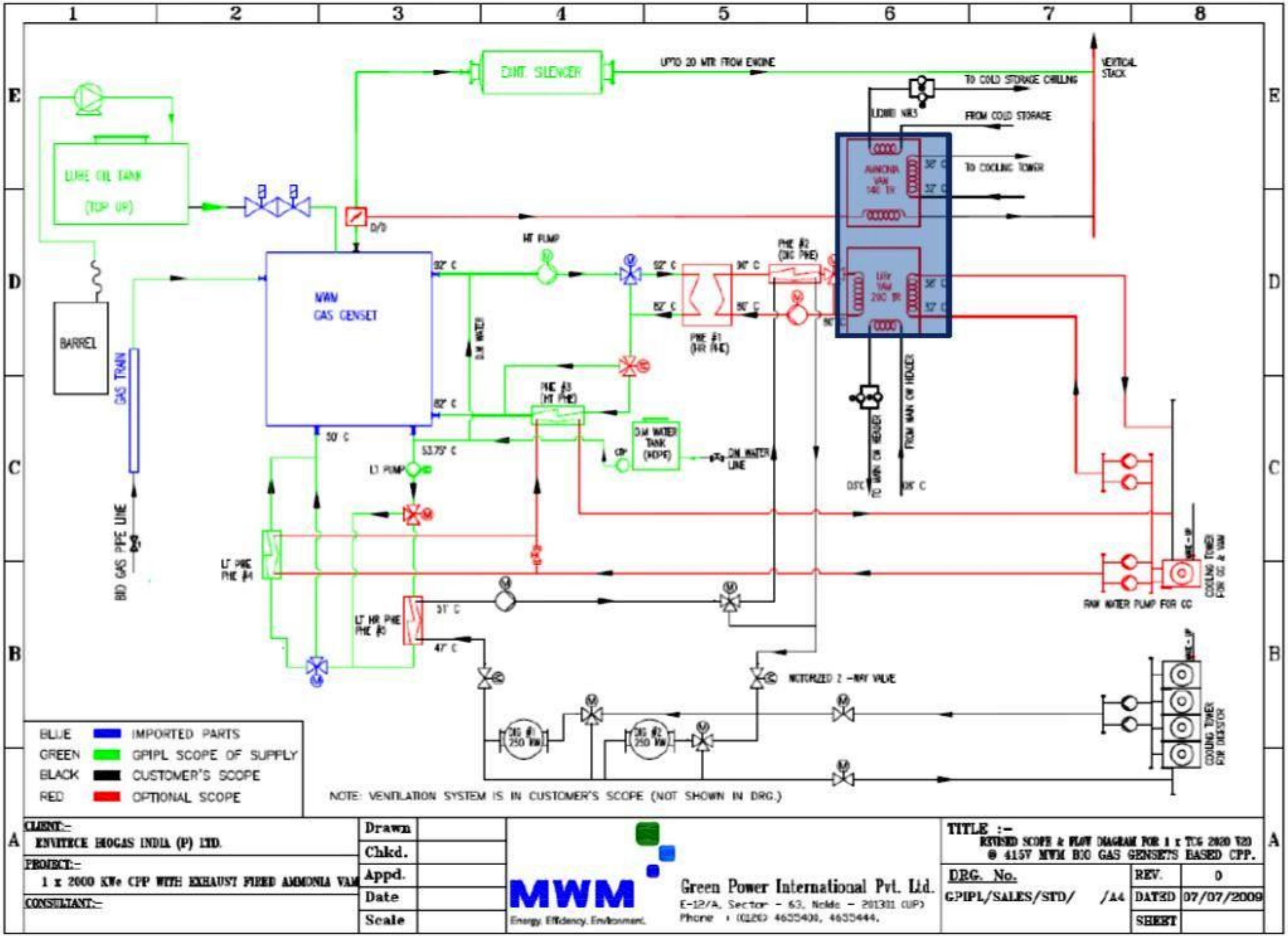
Schematic for Digester Effluent Processing (2 MW)



2X2 MW Water Balance



Cold Storage from Waste Heat Recovery



Organic Fertilizer

CASE STUDY - 1 MWe or 2x347 kWe BIOGAS PLANTS FROM STARCH & SAGO MILLS EFFLUENT

EnviTec Biogas

Waste generation in Sago & Starch industry (100 Tons/Day Cassava processing unit)

1) **Solid waste*** ➔ 30 Tons/Day.

*(Generated at the process of peeling and rasping)

2) **Liquid Waste#** ➔ 300 KL/Day.

#(Generated at the process of setting and Cleaning)

However, most Sago Mills are operating only at 70% capacity and for 250 days/year, generating around 50,000 KL effluent/year (100 TPD Mill)

Test Results of liquid effluent		
Parameters	**Actual**	**Desired Limit**
BOD	4000 -5000	100 PPM
COD	5000 - 10000	-
TDS	1500 - 2500	2100 PPM
TSS	400-500	100 PPM
Calcium	With in Limits	-
Magnesium		-
% Sodium		60 PPM
TKN		-
Chlorides		600 PPM
Sulphates		1000 PPM
Phosphates		-
pH	3.5- 4	5.5 – 9

Source :TNPCB, Attur

Current Practice of Effluent Disposal - 1

EnviTec Biogas

Used for agricultural irrigation (after lagoon stabilization).

(>70% of the total industries follows)

Advantages

- Low cost
- Energy independent

Disadvantages

- Ground water contamination
- **Degradation of land***
- Loss of water

*(which otherwise can be recycled)

**Note: Degradation of land due to*

- *Increase in soil pH*
- *Loss of soil porosity*
- *Nitrogen loss*

Current Practice of Effluent Disposal - 2

EnviTec Biogas

Source: *http://www.swarajequipment.com/services.html*

UASB process

(<=30% of the total industries follows)

Advantages

- Low cost system
- Easy to construct

Disadvantages

- Safety issues due to exposure of biogas balloon to sunlight
- Low biogas yield
- Incomplete effluent stabilization
- ***High maintenance cost***

Note: High maintenance cost due to

- Replacement of balloon periodically
- Engine corrosion due to H_2S.

Biogas Plant based on Mesophillic process
2x 347 KWe – Sago Mill Effluent + Thippi + Poultry litter

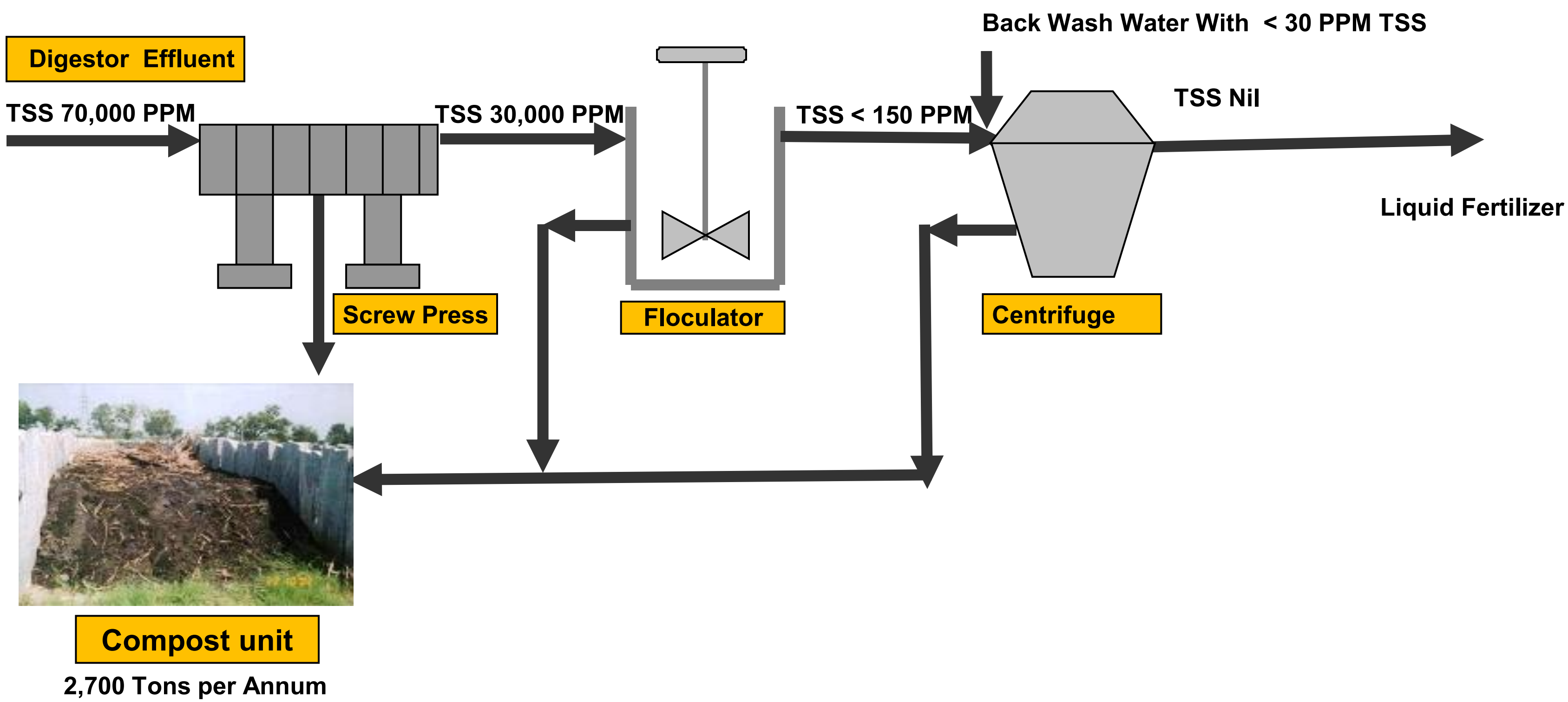
Project:
Projct No:
Date:

Wir geben Bio Gas. EnviTec Biogas.

Gas production data	Input S to/a	Input S to/d	DS %	o DS %	doDS to/a	oTSab %	Gas Quantity Nm³/a	Gas Quantity Nm³/d	sp. Gas Q. Nm³/to S	Prim energy kWh/a
Natural dung										
Poultry dung	1.800	5,00	75,0	70,0	614	65	515.970	1.413,70	287	3.095.820
Cow dung	0	0,00	30,0	75,0	0	0	0	0,00	96	0
Agriculture waste										
Cassava industrial screenings	8.000	22,00	32,0	85,0	1.901	87	1.443.840	3.955,80	180	7.219.200
Cassava sludge	50.000	137,00	3,5	90,0	1.299	83	987.000	2.704,20	20	4.935.000
Input mix	**59.800**	**163,90**	**9,5**		**3.815**	**81,2**	**2.946.810**	**8.073,50**		**15.250.020**
Output	**55.985**	**153,40**	4,26	47,8						

Schematic for 2x347 Organic Fertilizer Unit

EnviTec Biogas



1 MWe – Sago Mill Effluent + Thippi + Poultry litter

Project:
Projct No:
Date:

Wir geben Bio Gas. EnviTec Biogas.

Gas production data	Input S to/a	Input S to/d	DS %	o DS %	doDS to/a	oTSab %	Gas Quantity Nm³/a	Gas Quantity Nm³/d	sp. Gas Q. Nm³/to S	Prim energy kWh/a
Natural dung										
Poultry dung	5.700	15,70	75,0	70,0	1.945	65	1.633.905	4.476,50	287	9.803.430
Cow dung	0	0,00	30,0	75,0	0	0	0	0,00	96	0
Agriculture waste										
Cassava industrial screenings	8.000	22,00	32,0	85,0	1.901	87	1.443.840	3.955,80	180	7.219.200
Cassava sludge	50.000	137,00	3,5	90,0	1.299	83	987.000	2.704,20	20	4.935.000
Input mix	**63.700**	**174,60**	**13,5**		**5.146**	**76,3**	**4.064.745**	**11.136,30**		**21.957.630**
Output	**58.554**	**160,50**	6,82	46,5						

1 MWe – Sago Mill Effluent + Poultry litter

Project:
Projct No:
Date:

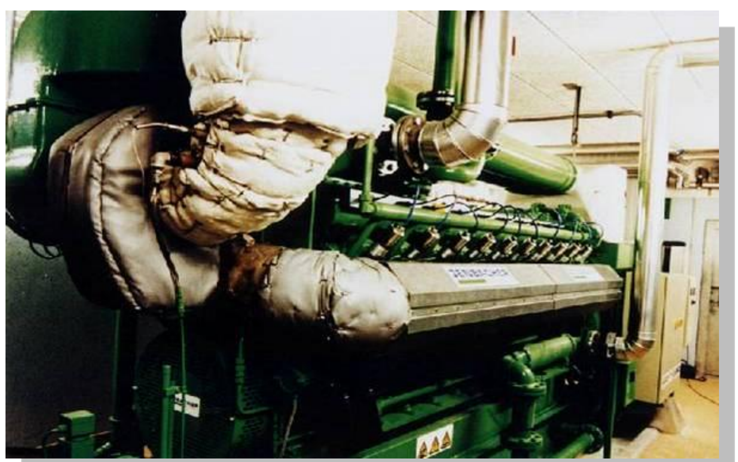
Wir geben Bio Gas. EnviTec Biogas.

Gas production data	Input S to/a	Input S to/d	DS %	o DS %	doDS to/a	oTSab %	Gas Quantity Nm³/a	Gas Quantity Nm³/d	sp. Gas Q. Nm³/to S	Prim energy kWh/a
Natural dung										
Poultry dung	9.200	25,30	75,0	70,0	3.140	65	2.637.180	7.225,20	287	15.823.080
Cow dung	0	0,00	30,0	75,0	0	0	0	0,00	96	0
Agriculture waste										
Cassava industrial screenings	0	0,00	32,0	85,0	0	0	0	0,00	180	0
Cassava sludge	62.500	171,30	3,5	90,0	1.624	83	1.233.750	3.380,20	20	6.168.750
Input mix	**71.700**	**196,50**	**12,7**		**4.764**	**70,1**	**3.870.930**	**10.605,30**		**21.991.830**
Output	**66.936**	**183,40**	7,44	47,1						

Organic Fertilizer

BIOGAS PLANTS & CHP SCHEMES

CARBON INCOME



Financing with carbon trading

Potential Contributions to Project Cash Flow

Technology	Δ IRR %
Energy Eff.-District Heating	2.0
Wind	0.9-1.3
Hydro	1.2-2.6
Bagasse	0.5-3.5
Biomass with methane kick	**Up to 5.0**
Municipal Solid Waste with methane kick	**>5.0**

Source: Prototype Carbon Fund (World Bank), 2001 (preliminary data)