THE OWS BIOREACTOR TECHNOLOGY FOR ANAEROBIC DIGESTION OF DIFFERENT WASTE STREAMS INTO BIOGAS

SYNPOL COURSE

INDUSTRIAL FERMENTATION PROCESSES

Valencia, 8 November 2013

Bruno DE WILDE
TOPICS

* OWS
* BASIC CONCEPTS
* FULL STREAM DIGESTION
* PARTIAL STREAM DIGESTION
* MBT – SORDISEP
* ENERGY CROPS
FIGURES
* DRANCO technology - UG, 1983 (pilot in 1984)
* FOUNDED IN 1988
* CONSOLIDATED SALES (2011-2013) : 19 MILLION €/YR
* EXPORT: 90%
* 70 EMPLOYEES

OFFICES
* HEAD OFFICE : GENT, BELGIUM
* AFFILIATES : OWS INC., DAYTON, OHIO, USA
  DRANCO nv
  BES GmbH, Germany
* PARTNER: DJK INTERNATIONAL, TOKYO, JAPAN
<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Year</th>
<th>Capacity (tpy)</th>
<th>Waste Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BRECHT I (Belgium)</td>
<td>1992</td>
<td>20,000</td>
<td>Biowaste</td>
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<tr>
<td>2.</td>
<td>SALZBURG (Austria)</td>
<td>1993</td>
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<td>3.</td>
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<td>1997</td>
<td>105,000</td>
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<td>1999</td>
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<td>6.</td>
<td>VILLENEUVE (Switzerland)</td>
<td>1999</td>
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<tr>
<td>7.</td>
<td>BRECHT II (Belgium)</td>
<td>2000</td>
<td>50,000</td>
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<td>8.</td>
<td>ROME (Italy)</td>
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<td>PUSAN (South Korea)</td>
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<td>11.</td>
<td>HILLE (Germany)</td>
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<td>100,000</td>
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<td>MÜNSTER (Germany)</td>
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<td>2006</td>
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<td>VITORIA (Spain)</td>
<td>2007</td>
<td>120,000</td>
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<td>HOTAKA (Japan)</td>
<td>2008</td>
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<td>16.</td>
<td>ALICANTE (Spain)</td>
<td>2008</td>
<td>180,000</td>
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<td>KEMPTEN (Germany)</td>
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<td>LESZNO (Poland)</td>
<td>2010</td>
<td>50,000</td>
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<td>21.</td>
<td>HENGELO (The Netherlands)</td>
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<td>Biowaste</td>
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<td>MIRANDELA (Portugal)</td>
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<td>23.</td>
<td>WIJSTER (The Netherlands)</td>
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<td>Residual waste</td>
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<td>24.</td>
<td>WIJSTER (The Netherlands)</td>
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<td>Biowaste</td>
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<tr>
<td>25.</td>
<td>BOURG-EN-BRESSE (France)</td>
<td>2013</td>
<td>66,000</td>
<td>Mixed waste</td>
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<tr>
<td>26.</td>
<td>CHAGNY (France)</td>
<td>2013</td>
<td>73,000</td>
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<td>NORTH YORKSHIRE (UK)</td>
<td>2014</td>
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<td>NÜSTEDT (Germany)</td>
<td>2006</td>
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<td>29.</td>
<td>LANGENDORF (Germany)</td>
<td>2010</td>
<td></td>
<td>Wet post-digester</td>
</tr>
</tbody>
</table>
CONTRACT RESEARCH LABORATORY - BCE
(Biodegradability, Compostability & Ecotoxicity)

* ‘ONE-STOP’ LABORATORY FOR BIODEGRADABILITY AND COMPOSTABILITY TESTING

* STRICTLY INDEPENDANT
* QUALITY CONTROL: ISO 17025

* RECOGNIZED BY ALL CERTIFICATION BUREAUS

* ACTIVE IN STANDARDIZATION: CEN – ASTM – ISO
* MEMBER OF DIN-CERTCO CERTIFICATION COMMITTEE & SEVERAL INDUSTRIAL ASSOCIATIONS (EuBP)

* MORE THAN 20 YEARS OF EXPERIENCE
* 2500+ SAMPLES TESTED FOR 750+ CLIENTS
<table>
<thead>
<tr>
<th>Category</th>
<th>Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Polymers</td>
<td>BASF, DSM, Du Pont, FKuR, Metabolix, NatureWorks, Novamont, ...</td>
</tr>
<tr>
<td>Paper &amp; Board</td>
<td>Ahlstrom, Huhtamaki, Int. Paper, Kuan Chun Paper, Pactiv, UPM, ...</td>
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<tr>
<td>Packaging</td>
<td>Alcan Packaging, Amcor, Mondi Packaging, Sealed Air, Tetra Pak, ...</td>
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<tr>
<td>Consumer Goods</td>
<td>3M, Henkel, Kimberley Clark, Nestlé, P&amp;G, Sara Lee, SCA, Unilever, ...</td>
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<tr>
<td>Inks &amp; Masterbatches</td>
<td>Schulman Plastics, CIBA, Chimigraf, Flint, Sun Chemical, Wacker, ...</td>
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<tr>
<td>Films &amp; Bags</td>
<td>Because We Care, Cortec, Sabic, Sphere, WeiMon, Wuhan Huali, ...</td>
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<tr>
<td>Food Service Ware</td>
<td>Medac, Seda, Smurfit Kappa, Solo Cup, ...</td>
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<tr>
<td>Other categories</td>
<td>Smithers-Oasis, EuBP, ACCC, ...</td>
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<tr>
<td>Oxo-degradable</td>
<td>CIBA, Goody, Wells Plastics, Symphony, EPI, EconVerte, ...</td>
</tr>
<tr>
<td>Enzyme-mediated</td>
<td>Enzymoplast, ECM, Bio-Tec, ...</td>
</tr>
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</table>
CONTRACT RESEARCH LABORATORY - BCS
(Biogas, Consulting & Support)

‘ALLROUND’ CONSULTANCY & SUPPORT OF ANAEROBIC DIGESTION PROJECTS

* ANALYSES & LAB-SCALE DIGESTION TESTS
* PROCESS CONTROL & OPTIMISATION
* ELECTROMECHANICAL SUPPORT
* AUTOMATISATION
* FINANCIAL & PROCESS TECHNICAL ADVICE

BASED ON 25+ YEARS OF EXPERIENCE

* 20+ BIOGAS PLANTS WORLDWIDE
* TEAM: 7 (3 TECHNICIANS - 4 ENGINEERS)
* LARGE TESTING CAPACITY
  100+ BATCH REACTORS
  40+ SEMI-CONTINUOUS REACTORS
BIOGAS CONSULTING & SUPPORT

• FEASIBILITY TESTS FOR AD
  ✓ BIOGAS PRODUCTION POTENTIAL TEST
  ✓ CONTINUOUS FERMENTATION TEST
  ✓ BIOGAS OPTIMISATION TEST: SHORT TERM TEST

• ALL ROUND CONSULTANCY AND SUPPORT
  ✓ BIOLOGICAL SUPERVISION
  ✓ PROCESS CONTROL
  ✓ ELECTROMECHANICAL SUPERVISION
  ✓ AUTOMATION
ACS (Auditing, Controlling & Sorting)

WHAT?
* ADMINISTRATIVE & TECHNICAL AUDITS
* QUALITY CONTROLS & INSPECTIONS
  (ANALYSIS OF PURITY, FOLLOW-UP, EVALUATION)
* ANALYSIS OF COMPOSITION OF DIFFERENT WASTE FLOWS

WHERE & WHO?
* ANALYSIS ON LOCATION OR IN OWN LAB
* TEAM: 15 - 9 FULLTIME EQUIVALENTS
  (2/3 FULLTIME ACS, 1/3 PARTIAL)
* FULLY EQUIPPED SORTING TEAM
  → MINIMAL DISTURBANCE ON SITE

CLIENTS?
* PRIVATE COMPANIES, INTERMUNICIPAL AUTHORITIES,
  PROFESSIONAL ORGANISATIONS (e.g. Fost Plus, Valipac,...)
  & PUBLIC AUTHORITIES (e.g. IVC, OVAM,...)

MORE THAN 15 YEARS OF EXPERIENCE – ISO 17020
SAS (Sustainability Assessment Services)

WHAT?
* TRANSITION TO SUSTAINABLE GUIDANCE
* MEASURING IMPACT ON PEOPLE, PLANET, PROFIT
* COMPARE, IMPROVE &, IF POSSIBLE, COMPENSATE

METHODS
• ISO 14025: ENVIRONMENTAL PRODUCT DECLARATIONS
• ISO 14040/44: LCA
• PEF & OEF (EUROPEAN FOOTPRINT METHODOLOGIES): LCA
• ISO 14067, PAS 2050, BILAN CARBONE: CARBON FOOTPRINT
• PAS 2060: CO₂ NEUTRALITY
• SUSCHEMKOMPAS: ECO-EFFICIENCY

* DEVELOPMENT OF CUSTOM-TAILORED TOOLS & SUPPORT (e.g. CARBON MANAGEMENT PLAN)

CLIENTS?
* PRIVATE COMPANIES, PUBLIC AUTHORITIES, PROFESSIONAL ASSOCIATIONS (e.g. ESSENSCIA), REGIONS, CITY’S & MUNICIPALITIES, …

EXPERIENCE IN WIDE RANGE OF SECTORS: CHEMISTRY & PLASTICS, ENERGY, TRANSPORT, NUTRITION, WASTE TREATMENT, …
EU RESEARCH PROJECTS

**FORBIOPLAST**: 'Forest Resource Sustainability through Bio-based-Composite Development'
- **Website**: www.forbioplast.eu
- **Coordinator**: UNIPI (Italy)
- **Partners**: LPRT and PEMU (Hungary), IWC (Latvia), UAL (Spain), CARTIF (Spain), UASVM (Romania) and CRF (Italy)

**HYDRUS**: 'Development of cross-linked flexible bio-based and biodegradable pipe and drippers for micro-irrigation applications'
- **Website**: www.aimplas.es/proyectos/hydrus
- **Coordinator**: AIMPLAS (Spain)
- **Partners**: FKuR (Germany), EXTRULINE (Spain), TOTRA (Slovenia), BAIX (Spain), FORMFLEX, METAZET and TNO (Netherlands) and UNIPI (Italy)

**ECOBIONET**: 'Industrial implementation of biodegradable and compostable packaging nets for agricultural and shellfish products'
- **Website**: www.aimplas.es/proyectos/ecobionet
- **Coordinator**: AIMPLAS (Spain)
- **Partners**: TECNARO (Germany), MESEGUER and ECOPLAS (Spain)
What is KBBPPS

- Knowledge Based Bio-based Products' Pre-Standardization
- FP7 funded project duration: 3 years from 2012-08-01

<table>
<thead>
<tr>
<th>Organization</th>
<th>Country</th>
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<tbody>
<tr>
<td>NEN - Netherlands Standardization Institute</td>
<td>NL</td>
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<tr>
<td>ECN - Energy research Centre Netherlands</td>
<td>NL</td>
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<tr>
<td>Green Chemistry Centre of Excellence at the University of York</td>
<td>UK</td>
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<tr>
<td>nova-Institut</td>
<td>DE</td>
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<tr>
<td>OWS - Organic Waste Systems</td>
<td>BE</td>
</tr>
<tr>
<td>WUR - Wageningen University Research, Institute Food &amp; Bio-based Research</td>
<td>NL</td>
</tr>
<tr>
<td>Agricultural University of Athens</td>
<td>GR</td>
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</table>
AEROBIC COMPOSTING

ORGANIC MATTER

MICROBIAL POPULATION

CO₂ + H₂O + HUMUS + HEAT

O₂

70 °C
ANAEROBIC DIGESTION

ORGANIC MATTER

MICROBIAL POPULATION

35 - 55 °C

$\text{CH}_4 + \text{CO}_2 + \text{HUMUS} + \text{HEAT} = \text{BIOGAS}$
THE DRANCO TECHNOLOGY

DRANCO FERMENTER

STEAM

WASTE < 40 mm

MIXER

PUMP

DIGESTATE

TO POST-TREATMENT

BIOGAS

BIOGAS UTILIZATION
THE DRANCO TECHNOLOGY

Feeding tubes
Gas storage
Extraction screw
Feeding pump
Dosing screw
Dosing unit
THE DRANCO TECHNOLOGY

DRANCO DIGESTER
WITH EQUIPMENT
UNDER CONICAL OUTLET

Feeding tubes

Dosing screw

Gas storage

Feeding pump

Extraction pump

Hydraulic group
of the pumps
THE DRANCO DIGESTER

DRANCO plant on biowaste, Idelux (Belgium)
ADVANTAGES

- NO SCUM FORMATION, NO SETTLING IN TANK
- MINIMAL SURFACE AREA REQUIREMENTS
- MINIMAL HEAT REQUIREMENTS
- LESS INTENSIVE PRE-TREATMENT
- HIGH FLEXIBILITY (TS IN DIGESTER 15 TO 40%)
- NO MIXING INSIDE THE DIGESTER
- SIMPLE DIGESTER (CONICAL)
- AVOIDS OR MINIMIZES WASTEWATER PRODUCTION
- OPTIMAL PAPER DEGRADATION
* OWS
* BASIC CONCEPTS
* FULL STREAM DIGESTION
* PARTIAL STREAM DIGESTION
* MBT – SORDISEP
* ENERGY CROPS
FULL STREAM DIGESTION

MSW OR YARD / FOOD WASTE

METALS
RDF

DRY SORTING

BIOGAS

ANAEROBIC DIGESTION

PROCESS WATER

DEWATERING

WATER
CO₂

AEROBIC COMPOSTING / DRYING

COMPOST OR LANDFILL
CASE STUDY : BIOWASTE BRECHT I + II
CASE STUDY: BIOWASTE BRECHT II

<table>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>ton/year</td>
<td>50,000</td>
<td>5,000</td>
<td>45,000</td>
<td>1,000</td>
<td>6,600</td>
<td>39,400</td>
<td>3,000</td>
<td>15,200</td>
<td>2,500</td>
<td>17,500</td>
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<tr>
<td>TS (%)</td>
<td>40.0</td>
<td>45.0</td>
<td>39.5</td>
<td>---</td>
<td>90.5</td>
<td>30.7</td>
<td>1.8</td>
<td>2.5</td>
<td>40.0</td>
<td>52.0</td>
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</table>
CASE STUDY : BIOWASTE BRECHT II

• CAPACITY:
  - 50,000 TPY (± 1 MIO PEOPLE – 27 MUNICIPALITIES)

• DIGESTER VOLUME: 3,150 M³

• START-UP: 2000

• BIOGAS PRODUCTION: 125 M³/T
  - 100% GAS ENGINES

• DIGESTATE:
  - TOTAL SOLIDS-CONTENT: 30%
  - DEWATERING & COMPOSTING
* OWS
* BASIC CONCEPTS
* FULL STREAM DIGESTION
* PARTIAL STREAM DIGESTION
* MBT – SORDISEP
* ENERGY CROPS
EXPANSION OF EXISTING COMPOSTING SITES

- MANY COMPOSTING SITES IN EUROPE 15 TO 20 YEARS OLD: NEED RENOVATION
- MORE WASTE BUT NO ROOM FOR ADDITIONAL COMPOSTING
- INSERTION OF *PARTIAL STREAM DRY ANAEROBIC DIGESTION* CAN INCREASE EXISTING CAPACITY BY UP TO 50% WITH MINIMAL SURFACE REQUIREMENT
- ECONOMICALLY VERY ATTRACTIVE
- WATER BALANCE IS CRUCIAL: NO EXCESS WASTEWATER FOR DRY SYSTEMS
PARTIAL STREAM DIGESTION

- ONLY PART OF THE ORGANICS IS DIGESTED (UP TO 70%)
- OTHER PART (30%) BYPASSED AND NOT SUBJECTED TO DIGESTION
- DIGESTATE IS DIRECTLY MIXED WITH BYPASSED ORGANIC FRACTION *WITHOUT DEWATERING*
- NON-DIGESTED ORGANICS PROVIDE EXOTHERMIC ENERGY AND NEEDED STRUCTURE FOR AEROBIC POSTTREATMENT AND DRYING
PARTIAL STREAM DIGESTION

MSW OR YARD / FOOD WASTE

METALS
RDF

DRY SORTING

MIXER

AEROBIC COMPOSTING

CO₂
WATER

WATER

DRYING

UP TO 70 %

ANAEROBIC DIGESTION

BIOGAS

COMPOST OR LANDFILL
BENEFITS DRANCO PARTIAL STREAM DIGESTION

• PRODUCTION OF RENEWABLE ENERGY (~ ONLY COMPOSTING)

• > TS IN DIGESTATE: IDEAL FOR MIXING PRIOR TO COMPOSTING
  => NO COSTLY DEWATERING STEP & WATER TREATMENT

• REDUCTION OF ODOUR: AMOUNT OF VOC’S ↓

• SHORTER COMPOSTING TIME FOR DIGESTED WASTE
  ⇒ ADDITIONAL CAPACITY BECOMES AVAILABLE
  ⇒ INCREASED CAPACITY ON THE SAME SITE

• SAME ECOLOGICAL BENEFITS OF THE COMPOST

• ECONOMICALLY VERY INTERESTING
DISADVANTAGES DRANCO PARTIAL STREAM DIGESTION

- LESS ENERGY RECOVERY (↔ FULL STREAM DIGESTION)
- LONGER AEROBIC TREATMENT REQUIRED (↔ FULL STREAM DIGESTION)
PARTIAL STREAM DIGESTION: TENNEVILLE (BE)
PARTIAL STREAM DIGESTION: TENNEVILLE (BE)
PARTIAL STREAM DIGESTION: TENNEVILLE (BE)

- **SHREDDER 1**: Rotating sieve (60 mm)
- **MAGNET**
- **SHREDDER 2**
- **DOSING UNIT**
- **FEEDING PUMP**
- **DRANCO DIGESTER**: 3.150 m³
- **Biogas**
- **FLARE**
- **GAS STORAGE**
- **STEAM GENERATOR**
- **GAS ENGINES**: Electricity
- **Heat**
- **Sludge dryer Water treatment plant**

**Streams**
- **Biowaste (& pasty waste)**
- Structural material (yard waste)
- **MAGNET**: 60-150
- **ROTATING SIEVE (60 mm)**: < 60
- **MAGNET**: > 150
- **REJECTS**

**Processes**
- **Biogas**
- **Steam**
- **Residue**
- **Liquid waste streams**
- **Mixing**
- **Composting**

**Additional Notes**
- **Structural material + Yard waste**
- **Sludge dryer**
- **Water treatment plant**
PARTIAL STREAM DIGESTION: TENNEVILLE (BE)

- CAPACITY = 37,700 TPA BIOWASTE & GREEN WASTE + 1,300 TPY LIQUID ORGANIC WASTE
- DIGESTER VOLUME = 3,150M³
- START-UP: 2009
- ENERGY PRODUCTION
  - 9,750,000 KWH ELECTRICITY PER YEAR
  - 10,000,000 KWH HEAT PER YEAR
- DIGESTATE MIXED WITH (BYPASSED) FRESH YARD WASTE BEFORE AEROBIC COMPOSTING
* OWS
* BASIC CONCEPTS
* FULL STREAM DIGESTION
* PARTIAL STREAM DIGESTION
* MBT – SORDISEP
* ENERGY CROPS
SORtting - DIgestion - SEParation
INTEGRATION OF ANAEROBIC DIGESTION INTO MBT-PLANTS

PROCESS FLOW ANAEROBIC MBT-PLANT: FULL STREAM WITH MAXIMUM RECYCLING

RESIDUAL WASTE

METALS
RDF

DRY SORTING

BIOGAS

ANAEROBIC DIGESTION

SAND
FIBERS
INERTS

WET SEPARATION

WATER

DEWATERING / DRYING

LOW QUALITY COMPOST OR LANDFILL
BOURG-EN-BRESSE FRANCE
• CAPACITY: 90 000 T MSW + 15 000 T YARD WASTE
• HOMOGENIZING DRUMS: 2 DAYS
• SCREENING OVER 200 AND 50 MM
• TWO DIGESTERS OF 2 000 M³
• POSTCOMPOSTING DURING 6 WEEKS
• REMOVAL OF INERTS
* OWS
* BASIC CONCEPTS
* FULL STREAM DIGESTION
* PARTIAL STREAM DIGESTION
* MBT – SORDISEP
* ENERGY CROPS
• CAPACITY:
  - MAIZE: 20,000 TPY
  - CHICKEN MANURE: 1,700 TPY

• BIOGAS PRODUCTION:
  - >190 M³/T
  - USED IN 3 LOCAL GAS ENGINES & 2 GAS ENGINES > 1 KM

• DIGESTER VOLUME: 1,200 M³

• START-UP: 2006

• LOW PARASITICAL ELECTRICITY CONSUMPTION (~ 7%)

• VERY HIGH LOADING RATES (> 16 KG VS/M³_R·D) & BIOGAS PRODUCTIVITIES (> 11 NM³/M³_R·D)
CONCLUSION: FEEDSTOCKS for DRANCO AD

* BIOWASTE and BIOWASTE+
* ORGANIC FRACTION of REST and MIXED WASTE
* REST and MIXED WASTE
* ORGANIC FRACTION of INDUSTRIAL WASTE
* INDUSTRIAL WASTESTREAMS
* ENERGY CROPS
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THANK YOU!
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