Anaerobic Digestion
Waste-to-Energy

South Africa - May 2016
Custom solutions - Flexible approach

Waste-to-Energy

Clear Industries

Water treatment

Waste water treatment, biogas systems
Waste-to-Energy

History

Start up 1973 of Chriwa

Chriwa today
• one of the leaders of German industry in the field of water treatment and waste water treatment. Our systems are in operation in more than 110 countries worldwide

• maintenance and after-sales services in Europe, Russia, Middle East, Central and South America, Africa and Asia

• more than 200 employees of the Chriwa group work worldwide.

• Chriwa - this is:  
  - more than 1,000 WTP working worldwide

• CUSS - this is:  
  - more than 140 WWTP working worldwide

• Price for international economic activity in 2010.
Waste-to-Energy
Scope of supply

Scope of supply Chriwa® group

• Project development
• Support for **finanzing**
• Design
• Prefabrication
• Construction
• Assembly
• Commissioning
• Training
• After-sales-service
Waste-to-Energy
Chriwa® group International

Offices in:
- Germany (Headquarters)
- Spain (Sales)
- Serbia (Service & Sales)
- Russia (Service & Sales)
- Vietnam (Technical Support)
- Mexico (Service & Sales)
- Colombia (Sales)
- Peru (Sales)
- Kenya (Service)
Waste-to-Energy
Focus on water recycling
Waste-to-Energy

Overview-working fields CHRIWA®

- Drinking Water for municipalities
- Detoxification Water & Decontaminated Soils
- Beverages, Brewing, Mineral Water and Soft-Drink Industries
- Seawater Desalination
- Food Industry
- Brackish Water Desalination
- Industrial- & Process Purpose
- Water Reuse & Recycling/ Recovery
Waste-to-Energy

Overview - working fields CUSS®

- Waste water treatment in brewing industry
- Waste water treatment in alcoholic beverage industry
- Waste water treatment in soft drink industry
- Industrial wastewater treatment
- Waste water treatment in food industry
- Anaerobic Digestion Plants / Waste to Energy
- Municipal waste water treatment
- Specially developed systems
Waste-to-Energy

Overview - working fields CUSS®

- Aerobic and Anaerobic industrial waste water treatment plants (WWTP)
- Municipal sewage plant and anaerobic digesting of surplus sludge
- Waste to Energy
  Solid or liquid residual materials like treacle, pomace, spent grains, slaughterhouse waste, cow and pig dung, bio-waste
**Out line data** (2014)

- ~ 8,000 Biogas plants
- Ø 460 kW
- 3,600 MW
- 3,500 - 6,000 €/kWh

Investments cost

**Characteristics of German ADP market**

Input Material is 90% from agriculture and more than 50% are renewable resource

**No** waste residuals at plants of agriculture

Only 300 anaerobic digestion plants (Waste to Energy)
Economical framework of German ADP

Feed-in remuneration

- Max.: ~ 22 €ct/kWh
- Average: 15 - 16 €ct/kWh

Cost of input material

- 30 - 33 €/t

500 kW plant

- 8.500 t/a corn silage

Costs

Electricity generation costs

- NaWaRo: 0.15 – 22 €ct/kWh
- Residuals: 0.8 – 0.13 €ct/kWh

Central and South America

- 0.15 – 0.35 €ct/kWh
### Waste-to-Energy

**Potential in South Africa**

<table>
<thead>
<tr>
<th>Material</th>
<th>DS %</th>
<th>oDS %</th>
<th>Biogas Nm³/t oTS</th>
<th>Methane content vol.-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow dung</td>
<td>25</td>
<td>80</td>
<td>450</td>
<td>55</td>
</tr>
<tr>
<td>Cow manure</td>
<td>8</td>
<td>80</td>
<td>370</td>
<td>55</td>
</tr>
<tr>
<td>Pig dung</td>
<td>23</td>
<td>82</td>
<td>400</td>
<td>60</td>
</tr>
<tr>
<td>Pig manure</td>
<td>6</td>
<td>80</td>
<td>400</td>
<td>55</td>
</tr>
<tr>
<td>Chicken manure</td>
<td>15</td>
<td>74</td>
<td>332</td>
<td>58</td>
</tr>
<tr>
<td>Slaughter waste</td>
<td>8</td>
<td>82</td>
<td>1,120</td>
<td>60</td>
</tr>
<tr>
<td>Bio-waste</td>
<td>40</td>
<td>50</td>
<td>615</td>
<td>60</td>
</tr>
<tr>
<td>Draff (spent grain)</td>
<td>24</td>
<td>96</td>
<td>530</td>
<td>59</td>
</tr>
<tr>
<td>Fruit pomace</td>
<td>22</td>
<td>98</td>
<td>520</td>
<td>52</td>
</tr>
<tr>
<td>Vegetable residues</td>
<td>15</td>
<td>76</td>
<td>500</td>
<td>56</td>
</tr>
<tr>
<td>Cheese residues</td>
<td>79</td>
<td>94</td>
<td>904</td>
<td>68</td>
</tr>
</tbody>
</table>

1 kg COD => 0,35 Nm³ CH₄ and COD > 1.000 mg/l
**Advantages for the national economy**

- Decentralised power generation
- Baseload power station
- Stabilisation of electrical grids
- Reduction of waste volume

**Advantages for the companies**

- Compensation of fluctuations at internal grid
- Parcial self-sufficiency with energy
- Reduction of waste volume for disposal
- Production of fertilizer
Waste-to-Energy

Municipal sewage treatment plant
Waste-to-Energy

Waste-to-Energy: Waste management - Peru
Setting of a Task:

Waste management company has to dispose the following wastes:

- Tined tuna: 48,000 t/a
- Fruit pulp incl. stone: 36,000 t/a
- Potato peels: 24,000 t/a
- Spent grains: 6,000 t/a
- Sewage sludge from brewery: 960 t/a
- Yeast from brewery: 480 t/a

Sum: 115,440 t/a

The main target is to produce energy and reduce the waste volume.
# Waste-to-Energy

## Waste-to-Energy: Waste management - Peru

<table>
<thead>
<tr>
<th>Material</th>
<th>DS %</th>
<th>oDS %</th>
<th>Spec. Biogas Nm³/t oTS</th>
<th>CH₄ content vol.-%</th>
<th>Gas yield Nm³/h</th>
<th>Primary energy kWh</th>
<th>Electrical energy kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuna</td>
<td>16</td>
<td>87</td>
<td>680</td>
<td>60</td>
<td>650</td>
<td>4.200</td>
<td>1.600</td>
</tr>
<tr>
<td>Fruit pulp</td>
<td>22</td>
<td>98</td>
<td>572</td>
<td>52</td>
<td>300</td>
<td>1.700</td>
<td>670</td>
</tr>
<tr>
<td>Potato peels</td>
<td>11</td>
<td>94</td>
<td>656</td>
<td>52</td>
<td>220</td>
<td>1.200</td>
<td>460</td>
</tr>
<tr>
<td>Spent grains</td>
<td>24</td>
<td>96</td>
<td>530</td>
<td>59</td>
<td>100</td>
<td>620</td>
<td>250</td>
</tr>
<tr>
<td>Sewage sludge</td>
<td>5</td>
<td>50</td>
<td>440</td>
<td>56</td>
<td>5</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>Yeast</td>
<td>6</td>
<td>92</td>
<td>662</td>
<td>62</td>
<td>4</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td><strong>Sum:</strong></td>
<td>16</td>
<td>91</td>
<td>632</td>
<td>56,5</td>
<td>1.310</td>
<td>8.005</td>
<td>3.266</td>
</tr>
</tbody>
</table>
Combination of plants

Mono digestion of substrate is difficult.

Depending on the production places waste streams should be summarized

For this project, we have assumed the following:

1st plant:
- Tuna: 48.000 t/a
- Potato peels: 24.000 t/a
- Sum: 72.000 t/a

2nd plant:
- Fruit pulp: (36.000 t/a) 18.000 t/a
- Brewery waste: 1.440 t/a
- Sum: 19.440 t/a
1st plant
Waste-to-Energy

Waste-to-Energy: Waste management - Peru

System engineering

Pre-treatment: Tin tuna separation and feeding system, potato peels feeding system, solid-liquid mixer

AD-system: Digester, gas holder

Sludge-treatment: Sludge thickener, lime silo, mixer

Gas technology: Desulphurisation, gas cooling system, compressor station, emergency flare

Gas consumer: CHP 2 x 1,063 MW, heat extraction

Miscellaneous: Control cabinet, laboratory
Waste-to-Energy: Waste management - Peru

1st plant

- Tinned tuna
- Sludge tank
- Secondary digester
- Main digester
- Potato peels
- Gas treatment
- CHP

Flow:
- Sludge treatment
- Liquid fertilizer
- Soil conditioner
- scrap metal
- Thermal energy
- Electrical energy
Investment costs:

Total investment: 3.500 – 4.500 €/kW

1st phase

Project development: 80.000 €

2nd phase

Design and approval: 525.000 €

3rd phase

Construction: 3.000 – 4.000 €/kW 6 – 8 Mio €
Waste-to-Energy: Waste management - Peru

**Revenues:**

**Electrical Energy:**
6 – 7 €ct/k

890,000 – 1,040,000 €/a

**Thermal Energy:**
15,442 GWh/a

**Possibility of utilization?**

**Scrap metal:**
80 – 120 €/t
420,000 - 630,000 €/a

**Liquid fertilizer:**
7 €/t
385,000 €/a

**Soil conditioner:**
50 €/t
464,000 €/a

Saving of disposal costs (7 – 9 €/t)
at 75% of commercialisation:
380,000 – 480,000 €/a

**Sum without fertilizer:**
1,690,000 – 2,150,000 €/a
Waste-to-Energy

Waste-to-Energy: Waste management - Peru

End products:

Biogas: 881 Nm³/h  6,17 Mio Nm³/a
Electrical energy*: 2.126 MWh  14.882 GWh/a
Thermal energy*: 2.206 MWh  15.442 GWh/a
Scrap metal**: 5.280 t/a
Liquid fertilizer (DS ≤ 2%):
  \( N_{\text{tot}}: \) 2,10 kg/t
  \( P_2O_5: \) 1,23 kg/t
  \( K_2O: \) 0,94 kg/t
Soil conditioner: (DS > 25%)  9.286 t/a
  \( N_{\text{tot}}: \) 26,25 kg/t
  \( P_2O_5: \) 15,43 kg/t
  \( K_2O: \) 11,75 kg/t

* Assumption: 7.000 full operation hours per year
** Assumption: 11% of the tinned tuna are metal
Waste-to-Energy

Waste-to-Energy: Waste management - Peru

2nd plant
System engineering

Pre-treatment: Input system, pomace, assumption sewage sludge, mixer unit, feeding device

AD-system: Digester, gas holder

Sludge-treatment: Sludge thickener, lime silo, mixer

Gas technology: Desulphurisation, gas cooling system, compressor station, emergency flare

Gas consumer: CHP 1 x 1,063 MW, heat extraction

Miscellaneous: Control cabinet, laboratory
**Waste-to-Energy**

**Waste-to-Energy: Waste management - Peru**

2nd plant

- **Fruit pulp**
  - Pre-treatment
    - Sludge
      - Gas treatment
      - Main digester
      - Secondary digester
      - Studge tank
    - Stosphate discharge
    - Sludge treatment
  - CHP
  - Soil conditioner
  - Stones / solid fuel
  - Electrical energy
  - Thermal energy
  - Liquid fertilizer

**Diagram Notes:**
- Steee. digestion
- Stophal fertilizer
- Soil conditioner
- Stones / solid fuel
## Waste-to-Energy

### Waste-to-Energy: Waste management - Peru

**End products:**

<table>
<thead>
<tr>
<th>Product</th>
<th>Production Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas</td>
<td>560 Nm³/h</td>
</tr>
<tr>
<td></td>
<td>6,23 Mio Nm³/a</td>
</tr>
<tr>
<td>Electrical energy*</td>
<td>1.063 MWh</td>
</tr>
<tr>
<td></td>
<td>7.363 GWh/a</td>
</tr>
<tr>
<td>Thermal energy*</td>
<td>1.103 MWh</td>
</tr>
<tr>
<td></td>
<td>7.632 GWh/a</td>
</tr>
<tr>
<td>Fruit stones / solid fuel**</td>
<td>18.000 t/a</td>
</tr>
<tr>
<td>Liquid fertilizer (DS ≤ 2%)</td>
<td>14.337 t/a</td>
</tr>
</tbody>
</table>

### End products continued:

- **Total-N:**
  - 2,10 kg/t
- **P₂O₅:**
  - 1,23 kg/t
- **K₂O:**
  - 0,94 kg/t

### Soil conditioner: (DS > 25%)

- **Total-N:**
  - 26,25 kg/t
- **P₂O₅:**
  - 15,43 kg/t
- **K₂O:**
  - 11,75 kg/t

* Assumption: 7.000 full operation hours per year
** Assumption: 50% of the fruit pulp are stones
Waste-to-Energy: Slaughterhouse - Russia

Waste water → Energy → ADP → Energy → Waste water

WWTP → Cleaned water → Slugde
Setting of a Task:

New slaughterhouse project, processing 12,000 pigs a day:

**WWTP**

Waste water: 6,000 m³/d

**ADP**

Manure: 1,030 t/a
Kitchen waste: 388 t/a
Scalping screen: 2,701 t/a
Stomach content: 13,928 t/a
Fat from fat trap: 1,008 t/a
Floated foam (WWTP): 33,828 t/a
Dewatered sludge (WWTP): 15,905 t/a
Sum of ADP input: 68,788 t/a
Waste-to-Energy: Slaughterhouse - Russia

Input system
Organic waste

BGP

WW

Inlet pump station

Pre-treatment

Neutralization

Neutralization

Hydrolysis

Methanization

Methanization

Sluge tank

Dewatering

Biogas treatment

CHP

Aerobization

Clear water

WATER

fertilizer

Th. Energy

El. Energy
Waste-to-Energy

Waste-to-Energy: Slaughterhouse - Russia

**WWTP**

**Clean water**
- Suspended solids: 3,0 mg/l
- Solid residue: 1,000 mg/l
- COD: 30 mg/l
- BOD₅: 2,0 mg/l
- Power consumption: -220 kW

**ADP**

- Biogas production: 740 m³/h
- Power production: 1,700 kW
- Consumption auxiliaries:
  - ADP: -140 kW
  - WWTP: -220 kW
- Surplus power: 1,360 kW
- Thermal energy: 1,870 kW
- Consumption ADP: -255 kW
- Surplus th. Energy: 1,619 kW
- Soil conditioner (DS ~28%): 15,806 t/a
Summary

CUSS connects the classic waste water treatment and the biogas technology to give our customers the best solution for their request.

CUSS develops the plants in a continuous process since founding. CUSS has this opportunity as a result of the good relationship to his customers.

CUSS/Chriwa group has more than 25 years experience in the business of international plant engineering and construction.

We build individual plants according to our customer's requests for YOU!
These and many other satisfied customers worldwide
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