Organic waste to biogas – The Kompogas system

More than 500 years of operational experience
Hitachi Zosen Inova

Waste is our Energy

- Proprietary EfW, AD & biogas upgrading technologies
- Complete turnkey plants and system solutions
- Operation, maintenance & service business
- 600+ employees in Switzerland, Germany, UK & USA
- More than 600 reference projects worldwide
  - > 500 thermal Energy from Waste plants
  - > 75 biological Energy from Waste plants
  - > 50 biogas-to-methane upgrading plants
- A Hitachi Zosen Corporation subsidiary
More than 80 years experience in Energy from Waste plants
More than 600 projects delivered

1881
Establishment of Osaka Iron Works

1933
Construction of first waste incineration plant in Dordrecht, Netherlands

1937/39
Establishment of „L. von Roll company for communal facilities

1960
Beginning of long-term partnership

License Agreement
deRoll-type grate incinerator completed for Osaka municipality

Integration
Kompogas® Technology
BioMethan® Technology

2014/2015
since December 20th a company of Hitachi Zosen Corporation
Legal structure and revenues Hitachi Zosen Inova AG

Revenues (CHF million)

- 2011: 238
- 2012: 286
- 2013/14*: 421
- 2015: 531
AD and thermal EfW integrated in a sustainable waste management

SSO: Source separated organics, MSO: Mechanically separated organics
Energy from Waste – HZI’s contribution to a circular economy

Energy & Compost from bio-waste with anaerobic digestion

Energy & Material from non recyclable waste with thermal treatment

Recycling
- Compost & fertilizer

Direct Recycling
- Glass, paper, metals

Recycling
- Metals & minerals
Kompogas AD and BioMethan gas upgrading
First class technologies combined with HZI turn-key capability

Proprietary Technology from HZI

Engineered by HZI

Managed by HZI

Project, Site and Construction Management

Feeding System

Digester

Discharge System

Dewatering

Gas Upgrading

Electrical, Instrumentation and Controls

Balance of Plant and Energy Utilization

Site and Building Services

Civil

Integrated Solution

Maximized Efficiency

Reliable Execution
Why organics recycling with AD?
Closing the nutrient cycle while generating energy

≈ 30-60% organics

Organic waste

Biogas + Compost/Fertilizer

≈ 1 hour of light + 50 BTU of heat

1 ton organic waste ≈ 20 gal gasoline fuel equivalent

1 ton food waste ≈ 600 miles car trip

Nutrients source (N, P, K, etc.) + soil conditioner
Avenues for organics recycling
Source segregated collection vs. mechanical separation of MSW

**Avenue 1: SSO**
Collection of source segregated organic waste and processing in a bio-waste Anaerobic Digestion plant

**Avenue 2: OF MSW**
Collection of MSW and separation of organics in a Mechanical-Biological Treatment (MBT) plant, incl. AD system
Kompogas dry AD
Designed for a large variety of input materials

- Green waste
- Household bio-waste
- Catering and kitchen waste
- Market and vegetable waste
- Organic fraction of MSW / residual waste
- Expired food from supermarkets
Kompogas dry AD
Designed for a large variety of input materials
Kompogas dry AD
The plug-flow advantage

- Retention time 14 days @ 131° F → sanitized fertilizer products
- Inoculation allows fastest process start, defined & specialized process conditions allow highest conversion efficiency → highest biogas production and quality
Kompogas steel digester
Robust and reliable, available in various sizes

- Digester sizes: PF1200, PF1500, PF1800, further sizes on request
- Modular design for fast installation
- High and constant biogas yield from anaerobic degradable inputs
- Continuous process and stable biology
- Safe and emissions-free
Steel digester PF1500

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Feedstock capacity</td>
<td>~30,000 t/y</td>
</tr>
<tr>
<td>Biogas production</td>
<td>~100 Million scf per year (~200 scfm)</td>
</tr>
<tr>
<td>If converted in a gas engine</td>
<td>~700 kW electricity &amp; 2.4 MMBTU/hr heat</td>
</tr>
<tr>
<td>If used as biogas</td>
<td>~50,000 MMBTU/year biogas energy content</td>
</tr>
<tr>
<td></td>
<td>~500,000 GGE/year (Gasoline Gallon Equ.)</td>
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<tr>
<td></td>
<td>~440,000 DGE/year (Diesel Gallon Equ.)</td>
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</table>
Kompogas Process – Full stream

Pit / flat bunker

- Reception
- Pre-treatment
- Intermediate storage
- Anaerobic Digestion
- Liquid-solid separation

Liquid digestate

- Sedimentation
- Liquid digestate storage
- Liquid fertilizer

Solid digestate

- Aerobization
- Post-rotting
- Compost

Impurities

Biogas
Kompogas Process – Partial stream

- Reception
- Pre-treatment
- Intermediate Storage
- Anaerobic Digestion
- Mixing
- Solid Digestate
  - >40% DM, compostable
- Aerobization
- Post-rotting
- Compost

Pit / flat bunker

Impurities

Biogas
Technology – Reception
Technology – Pre-treatment
Technology – Intermediate storage & Digester feeding
Technology – Kompogas digester

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Length</td>
<td>33.8 m</td>
</tr>
<tr>
<td>Diameter</td>
<td>8.5 m</td>
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<tr>
<td>Nominal volume</td>
<td>1500 m³</td>
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</tbody>
</table>
Technology – Extraction & liquid-solid separation
Kompogas Process – Full stream

- Reception
- Pre-treatment
- Intermediate storage
- Anaerobic Digestion
- Liquid-solid separation
- Impurities
- Biogas

- Liquid digestate
  - Sedimentation
  - Liquid digestate storage
  - Liquid fertilizer

- Solid digestate
  - Aerobization
  - Post-rotting
  - Compost
Technology – Liquid-solid separation & liquid storage
Technology – Liquid-solid separation & Aerobization
Kompogas Process – Partial stream

- Reception
- Pre-treatment
- Intermediate Storage
- Anaerobic Digestion
- Impurities
- Biogas

- Pit / flat bunker
- Mixing
- Solid Digestate
  - >40% DM, compostable
- Aerobization
- Post-rotting
- Compost
Technology – Mixing & Aerobization
San Luis Obispo Anaerobic Digester Project

**Project Background**

- SLO county needs to achieve 75% diversion goal (state mandate by 2020)
- IWMA manager knows and prefers Kompogas
- Alternative is composting in neighboring counties (with rising compliance requirements in California for open composting)
- HZI is selected by WC to develop a FDBOO project

**Project Key Data**

<table>
<thead>
<tr>
<th>Remarks</th>
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<tbody>
<tr>
<td>Technology</td>
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<tr>
<td>Project Type</td>
</tr>
<tr>
<td>Subsidy</td>
</tr>
<tr>
<td>EPC</td>
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<tr>
<td>O&amp;M</td>
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<tr>
<td>Customer</td>
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<tr>
<td>Feedstock</td>
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<tr>
<td>Property</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Power</td>
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<tr>
<td>Compost &amp; Liquid Digestate Sales</td>
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</table>

**Project Set-up**

- SLO has 24’000 t/a of yard waste (currently composted/ disposed) and want to include 3’500 t/a food waste in the future
- Waste Connections (WC) provides disposal services for SLO
- WC owns a site with office, workshops and truck parking which is foreseen and permitted for composting/ digestion operation
- SLO waste disposal agreement with WC is extended (min. 15 years) based on AD investment (Plant) required to fulfill new CA 75% diversion rate requirements by 2020 (actual 68%)
- WC not interested in ‘technology projects’ – look for third party to finance-design-build-operate the Plant → waste supply and land lease contract with WC
San Luis Obispo Anaerobic Digester Project

- Design, Build, Own, Operate
  - In house financing
  - Full EPC
  - In house operations for 20 years

- Full Permitting
  - CUP
  - CEQA
  - Building permits

- 33,000 tpy organics inc. yardwaste, commercial and residential foodwaste

- 20 year community commitment, including rate increases and 20 year franchise extension agreements
San Luis Obispo Anaerobic Digester Project

Existing Site Configuration
San Luis Obispo Anaerobic Digester Project

Proposed site configuration
San Luis Obispo Anaerobic Digester Project
San Luis Obispo Anaerobic Digester Project
Selected references of >75 Kompogas plants in operation worldwide

The first

Rümlang (CH)
built 1991

The most ecological

Rijsenhout (NL)
Recovering CH₄ and CO₂ for greenhouses

The largest

Doha (Qatar)
15 digesters for 301’400 t/y (OFMSW & SSO)

The compact

Winterthur (CH)
PF1500 steel digester & biogas upgrading
Typical Swiss Kompogas dry AD plant, with pit bunker reception and high automation level

EPC turnkey contract for complete plant incl. civil works

Located close to living areas (requiring sound odour control) and a river

Biogas is upgraded and injected into the gas grid, enough to heat 3’000 homes

Full use of liquid and solid fertilizer, thereby closing nutrient cycle 100%

First Kompogas steel digester PF1500 delivered to private client
Backnang, Germany

- Typical German Kompogas dry AD plant, with flat bunker reception and high level of automation
- EPC turnkey contract for complete plant incl. civil works
- Use of excess heat capacity for waste water treatment sludge drying
- Full use of liquid and solid fertilizer, thereby closing nutrient cycle 100%

Client
Start-up
AWG Rems-Murr-Kreis mbH
2012

Technology
Plant type
Biowaste plant
Input material
Comingled green and food waste
Digester type
PF1300-2 concrete/steel digester
Biogas usage
CHP

Technical Data
Plant Capacity
36,000 Mg/a
Biogas production
4,300,000 Nm³/a
Electricity production
10,200,000 kWh/a
CHP installed:
2 x 800 kWel
Solid digestate
10,000 Mg/a
Liquid digestate
15,000 Mg/a
Rijesenhout, Netherlands

- Partial stream Kompogas process (patented), hence no liquid digestate
- Biogas upgrading to 99.5% CH₄ content and grid injection
- CO₂ capturing while biogas upgrading and reuse in neighbouring greenhouses
- Use of condensate water from composting tunnels for street cleaning and surplus heat for neighbouring greenhouses
- On site CNG fuelling station for Meerlanden’s own garbage trucks

**Client**
- **Start-up**
  - Meerlanden Holding eV
  - 2010

**Technology**
- **Plant type**
  - Biowaste plant
- **Input material**
  - GFT (green & kitchen waste), grease
- **Digester type**
  - PF1300-2 concrete/steel digester
- **Biogas usage**
  - Biomethane & grid injection

**Technical Data**
- **Plant Capacity**
  - 48'000 Mg/a
- **Biogas production**
  - 2'600'000 Nm³/a
- **Biomethane production**
  - 12'200'000 Nm³/a
- **Energy content**
  - 12'200'000 kWh
- **Solid digestate**
  - 40'000 Mg/a
- **Liquid digestate**
  - 5'000 Mg/a
Botarell, Spain

- EPC delivery of AD plant incl. intermediate storage, automatic feeding and dewatering system
- High impurity content in organic fraction sorted from MSW
- High energy yield: in average 160 Nm$^3$ (5,418 SCF) of biogas per metric ton (short ton) input material
- Dewatering system with centrifuge and subsequent water treatment plant
- Full-fledged composting plant, using composting tunnels

**Client**
Baix Camp Serveis Comarsals Mediambientals SA

**Start-up**
2010

**Technology**
- **Plant type**: MBT plant
- **Input material**: MSW / Organic Fraction of MSW
- **Digester type**: PF1300-3 concrete digester
- **Biogas usage**: CHP

**Technical Data**
- **Plant Capacity**
  - AD: 54,000 Mg/a
  - GC: 110,230 ton/y
- **Biogas production**
  - 4,300,000 Nm$^3$/a (160.5 MMSCF/y)
- **Electricity production**
  - 9,900,000 kWh/a
- **Solid digestate**
  - 40,000 Mg/a (44,092 ton/y)
- **Liquid digestate**
  - none
Montpellier, France

- Largest AD plant in Europe, being integral part of an MBT
- High impurity content in organic fraction sorted from MSW
- High energy yield: in average 140 Nm³ (4,740 SCF) of biogas per metric ton (short ton) input material
- Dewatering system with centrifuge and subsequent water treatment plant
- Full-fledged composting plant, using tunnels and covered windrows
- Odor treatment with water/acid scrubbing system, fully enclosed biofilter and activated carbon

<table>
<thead>
<tr>
<th><strong>Client</strong></th>
<th>Montpellier Agglomération</th>
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<tbody>
<tr>
<td><strong>Start-up</strong></td>
<td>2008</td>
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</table>

**Technology**

- **Plant type**: MBT plant
- **Input material**: MSW / Organic Fraction of MSW
- **Digester type**: 4 x PF1300-2 concrete digester
- **Biogas usage**: CHP

**Technical Data**

- **Plant Capacity**: 203’000 Mg/a (AD: 105’000 Mg/a), 223,770 ton/y (AD: 115,743 ton/y)
- **Biogas production**: 14’400’000 Nm³/a (537 MMSCF/y)
- **Electricity production**: 30’000’000 kWh/a
- **Solid digestate**: 28’000 Mg/a (30,865 ton/y)
- **Liquid digestate**: none
Doha, Qatar

- Large integral waste processing plant combining mechanical sorting, Kompogas dry AD and thermal treatment systems
- Largest Kompogas dry AD plant in the world with 15 x PF1300 concrete digesters operating in parallel, i.e. 12 x OFMSW + 3 x SSO (Source Segregated Organics)
- Main driver for dry AD: production of compost
- Biogas usage in Combined Heat and Power (CHP) plant

**Client**
- Ministry of Municipality & Urban Planning

**Start-up**
- 2011

**Technology**
- **Plant type**: Integrated MSW Management Centre
- **Input material**: MSW / Organic Fraction of MSW, green waste
- **Digester type**: 5xPF1300-3 concrete digester
- **Biogas usage**: CHP

**Technical Data**
- **Plant Capacity**: 840’000 Mg/a (AD: 274’000 Mg/a) / 925,942 ton/y (AD: 302,033 ton/y)
- **Biogas production**: 24’200’000 Nm³/a (903 MMSCF/y)
- **Electricity production**: 56’900’000 kWh/a
Waste is our Energy.

Engineering is our Business.

Sustainable Solutions are our Mission.