

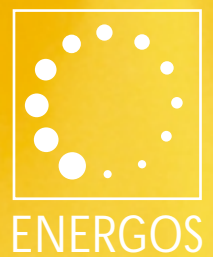
ENERGY FROM WASTE



commercially proven energy recovery



advanced conversion technology



THE ENER·G GROUP

At ENER·G we deliver sustainable and energy efficiency technologies for customers around the world. Our four key businesses offer an energy solution for all markets:

Cogeneration

On site generation of electricity, heat and/or cooling for the public and private sector.

Renewable Energy

Utilising biogas and biomass to produce 'green' electricity for our clients worldwide.

Energy Management

Using intelligent building controls and other innovative technologies, we provide risk free energy management with guaranteed savings.

Energy from Waste

Energy recovery of post recycling waste residue – an alternative to landfill.



ENERGY FROM WASTE

Fossil fuels are rapidly being used up. Fact.

Waste disposal is a global environmental problem. Fact.

Energy from waste, as an alternative to fossil fuels, provides an important contribution towards the reduction in landfill disposal and global warming.

The ENER·G Group employs clean, sustainable, energy efficient technologies, and has a strong history of providing more sustainable solutions to environmental problems, including utilisation of landfill gas, to provide renewable energy. Its innovative approach is further demonstrated by the addition of proven gasification and pyrolysis technologies to the Group's energy from waste capability.

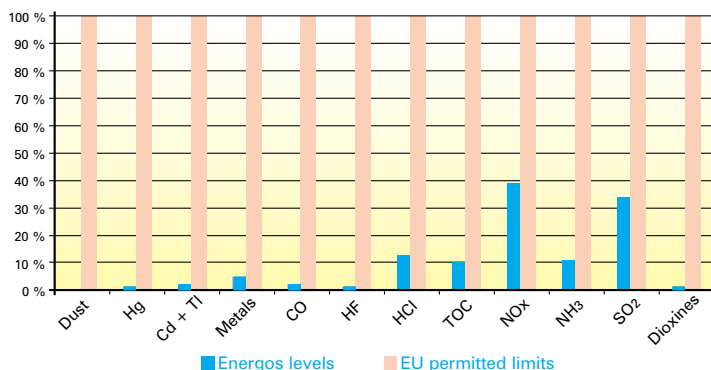
GASIFICATION TECHNOLOGY FROM ENER·G



Based in Norway, Energos is The ENER·G Group's specialist in gasification technology and is a leading supplier of small scale energy from waste plants, which provide a local solution for local waste problems. Its proven and patented technology is designed to minimise emissions. Energos plants are sized for local communities,

"The claim by Energos that the process is 'environmentally friendly' is backed up by the very low pollutant emission levels measured at Hurum and Averøy. These emissions are probably the lowest measured anywhere for this type of process, particularly the NOx figures which can only be achieved by competing

This chart contains emission measurements from the Energos Sarpsborg Energy Recovery Plant, Norway, May 2003 by an independent environmental agency for regulation purposes. All measurements refer to an O₂ content of 11% dry flue-gas



converting between 30,000 and 80,000 tonnes pa of post recycled waste residue into more environmentally friendly "green" electricity and/or heat – delivered for local use.

"Every kWh from an Energos plant replaces a kWh that would have been produced from fossil fuels."

These small scale Energos plants offer a number of benefits:

- The small size of the building (1,500 – 2,300 sqms) is designed to reduce visual impact
- Transport of waste is minimised
- Inherently low emissions – at a fraction of EU permitted levels (thanks to the Energos patented technology and advanced control of the two-stage process)

technologies with the application of end-of-pipe de-NOx systems. These emission levels have been achieved by paying significant attention to the process control of the two-stage combustion process and the management of the difficult products of the combustion process within the downstream energy recovery and gas cleaning process"

*Juniper Consultants,
Biffa Waste Services Ltd,
Future Perfect Report 2003*

In combination with a local recycling facility the Energos plant receives only waste that cannot be effectively recycled (and would otherwise go to landfill). This complies with UK Government and EU policy on the waste management hierarchy.



GASIFICATION SOLUTIONS

An alternative to mass-burn incineration!

Energos technology provides a well proven solution for the conversion of waste that cannot be recycled. Energos plants offer:

- Lower capital costs
- Faster construction time
- Lower waste transport costs
- Minimal impact on the local environment
- Enhancement of recycling

Gasification

Energos has a patented design for the thermal conversion of waste in its process, controlled by proprietary Energos software. This thermal conversion process reduces the need to invest in high-cost flue-gas cleaning systems, which makes Energos technology a cost-competitive, efficient and environmentally compliant solution for local waste.

Technology

The Energos thermal conversion unit consists of two chambers:



- Primary chamber – for gasification of the treated waste
- Secondary chamber – for high temperature oxidation of fuel gas produced in the primary chamber

The hot flue-gas from the secondary chamber is passed through a heat recovery stage.

The Energos design makes it possible to simultaneously achieve:

- Low carbon content in the bottom ash (less than 3%)
- Low and stable Nitrogen Oxides (NO_x), Carbon Monoxide (CO) and Total Organic Carbon (TOC)
- Qualification as Renewable Energy (UK and EU Directive)

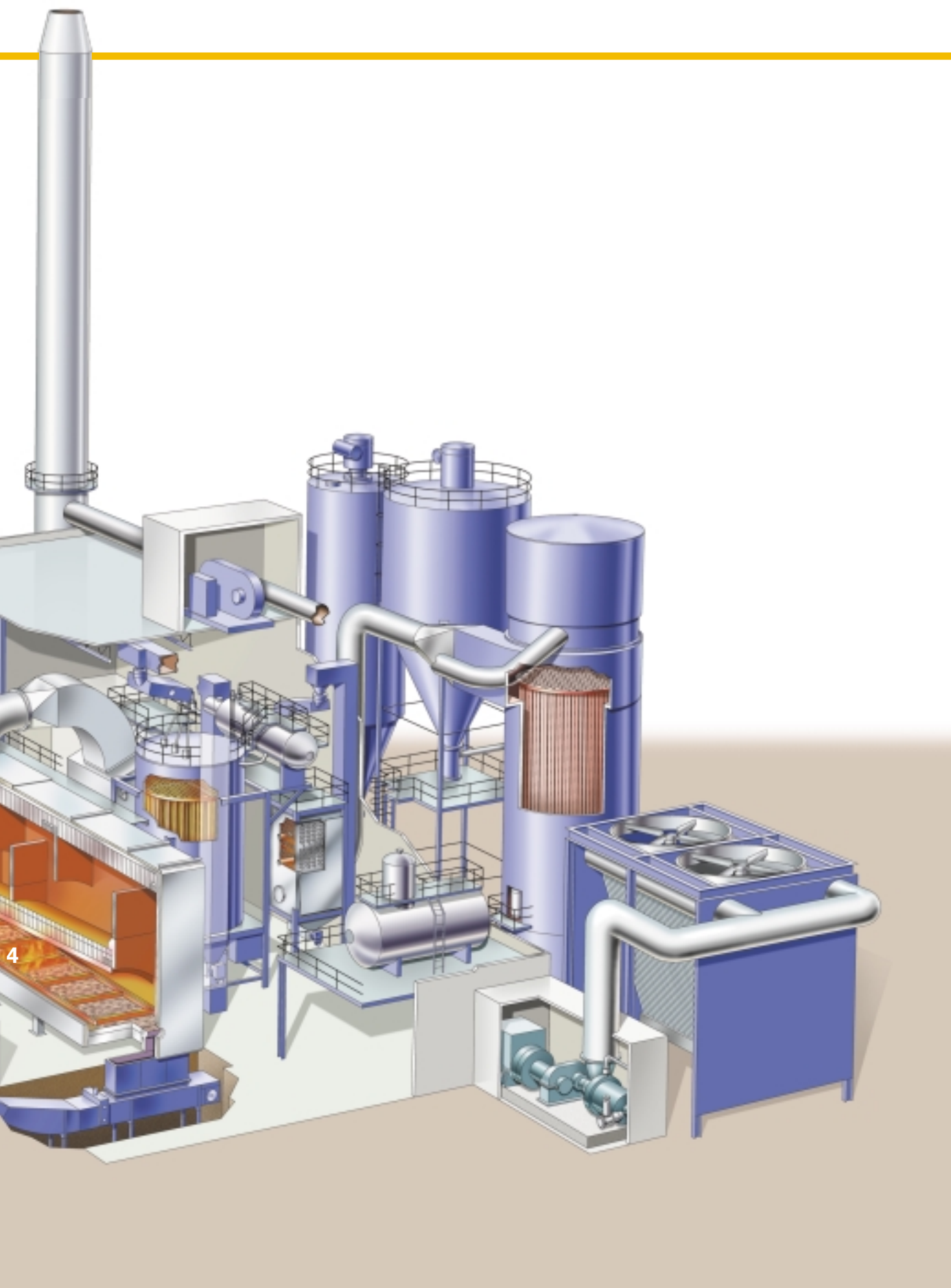
The Energos Plant is an **Advanced Conversion Technology** and the electricity produced from the biomass fraction of the waste will qualify for UK Renewable Obligation Certificates (ROCs).



ENERGY FROM WASTE PLANT

- 1 Fuel bunker
- 2 Fuel crane
- 3 Screw conveyer
- 4 Primary chamber (Gasification)
- 5 Secondary chamber (High temperature oxidation)
- 6 Heat recovery steam generator (HRSG)
- 7 Lime and carbon silo
- 8 Bag house filter
- 9 Fly ash silo
- 10 Flue-gas fan
- 11 Chimney
- 12 Bottom ash extraction
- 13 Steam turbine
- 14 Air cooled condenser





Gasification takes place in a controlled, reduced oxygen environment, whilst pyrolysis occurs in the complete absence of oxygen. Like gasification, pyrolysis is classed as an **Advanced Conversion Technology**, and has the ability to produce a clean, high calorific value fuel gas from a wide variety of waste and biomass streams. The hydrocarbon content of the waste is converted into a gas fuel, suitable for either electricity generation or to provide heat in boiler applications – with no need for flue-gas treatment.

The Benefits

Commercial

- Energy produced qualifies for UK Renewable Obligation Certificates (ROCs)
- The fuel can be utilised in Combined Heat and Power (CHP) applications to efficiently produce both electricity & heat
- The gas is rich in Hydrogen, an increasingly valuable resource



Operational

- The residual output of solid char from the process can also be used as a fuel or as a feedstock for other petrochemical processes
- Requires no flue-gas clean up as the gas produced is treated prior to use as a fuel
- Plant size is significantly smaller than alternative treatment and visually unimposing

Environmental

- Produces renewable energy
- Alternative solution to landfill
- Displaces the use of fossil fuels
- Local treatment – reduced transport emissions
- Reduced CO₂ and other Green House Gas emissions



PYROLYSIS SOLUTIONS

The pyrolysis process is capable of treating many different solid hydrocarbon based wastes whilst producing a clean fuel gas with a high calorific value. This gas will typically have a calorific value of 22–30MJ/m³ depending on the waste material being processed.

A lower calorific value will be provided by predominantly biomass waste, a higher calorific value is provided by wastes such as sewage sludge or wastes containing significant quantities of synthetic materials like rubber and plastics.

Solid char is also produced from the process, which contains both carbon and the mineral content of the original feed material. The char can either be further processed onsite to release the energy content of the carbon, or utilised offsite.

Environmental Performance

“Energy from waste can make an important contribution towards sustainable development as a source of renewable energy, reducing the use of fossil fuel and cutting emissions of greenhouse gases.”

(2000) UK Government, 'Waste not, Want not'



Emissions from the process are better than all the latest European standards, without the need for post process flue-gas treatment. Flue-gases are continuously monitored in line with the latest requirements of the Environment Agency under their PPC process.

Applications

The pyrolysis plant is intended to act as a local small-scale waste disposal solution and whilst this could include pre-sorted municipal waste, other suitable fuels include:

- Shredded Rubber
- Clinical Waste
- Sewage Sludge
- Wood Wastes
- Chicken Litter

The pyrolysis plant can be located on industrial sites with the benefit of its small size and low profile; providing industry with an immediate on-site solution to waste problems, reducing disposal costs and providing energy. This technology offers a cost-effective and environmentally attractive package for waste disposal in both the public and private sectors.





ENERGOS PLANTS

Ranheim Plant

Location: Norway
Commissioned: 1997
Fuel capacity: 10,000 tonnes/year
Energy production:
25 GWh (thermal)/year

Averøy Plant

Location: Norway
Commissioned: 2000
Fuel capacity: 34,000 tonnes/year
Energy production: CHP
65 GWh (thermal)/year

Hurum Plant

Location: Norway
Commissioned: 2001
Fuel capacity: 36,000 tonnes/year
Energy production:
90 GWh (thermal)/year

Minden Plant

Location: Germany
Commissioned: 2001
Fuel capacity: 37,000 tonnes/year
Energy production:
100 GWh (thermal)/year

Forus Plant

Location: Norway
Commissioned: 2002
Fuel capacity: 38,000 tonnes/year
Energy production: CHP
100 GWh (thermal)/year

Sarpsborg1 Plant

Location: Norway
Commissioned: 2002
Fuel capacity: 75,000 tonnes/year
Energy production:
190 GWh (thermal)/year

ENERGY FROM WASTE

THE ENER•G GROUP WHAT MAKES US NUMBER ONE

- We are world leaders in the field of delivering sustainable and energy efficient technologies with a wealth of experience and a proven track record
- Our unique combination of in house technology and services gives us great flexibility to optimise solutions for each customer requirement
- From energy efficient generation to management of energy consumption we have a solution to help your business
- Our financial stability offers you long-term security
- We are able to offer the best financial, operational and environmental benefits with or without capital investment
- Continual Research and Development means we offer the very latest technology in the industry



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