Biomass Combined Heat & Power (CHP)
Generate your own heat and power from wood fuel: save, earn and reduce your carbon footprint.

Wood Energy in partnership with Binder GmbH have developed a range of CHP systems using either ORC (Organic Rankine Cycle) technology utilising HTHW, Hot clean gas or thermal oil and Screw Expanders, utilising steam or low temperature hot water which have the following advantages:

- High Return on Investment
- High efficiency electrical generator producing up to circa 18% electrical output
- Safe environmentally friendly working fluid
- Simple operating procedure
- Automatic and continuous operation
- Simple maintenance procedure
- No operator attendance required (except steam boilers which requires 72hr attendance)
- Long Plant Life (20 years +) complete with 20 year guarantees
- No specialist water treatment required (except steam)
- Operates using standard fuels to EN41961 and doesn't require specialised, difficult to obtain fuels
Businesses are continually searching for technologies to help them improve efficiencies, save money, or even earn money.

Over the past few years, the biomass industry has grown significantly. The commercial sector has embraced this technology and has already received billions of pounds through incentives.

Until recently, most biomass systems have only produced heat.

Wood Energy have now launched their combined heat and power units, which not only produce heat, but also generates electricity using the same wood fuel.

The biomass industry is now well established market in the UK and there are many biofuel companies providing a consistent supply of quality wood fuel; including Wood Energy Ltd via our in-house company Chip Chip Ltd see www.chipchip.co.uk.

Biomass heating has now became popular in the UK, and biomass CHP is also rapidly gaining traction. Biomass CHP has been available across Europe for a number of years and is a well-established technology. Business across the UK are installing biomass CHP units to provide heat and electricity to reduce their bills, generate significant income from the incentives and reduce the amount of CO₂ they produce.

With Carbon taxes already in place, business owners are rushing to take advantage of the incentives at their peak to maximise their returns, and avoid paying even more significant carbon tax bills in the future.
Biomass combined heat & power:  
A cleaner alternative

Biomass CHP systems are much less carbon intensive than gas or coal-powered plant, as they use a lower-carbon, more sustainable fuel source.

There are several hundred biomass-fuelled CHP plants in operation on the continent – the majority using solid biomass. Sizes vary, but most installations have a rated boiler output of more than 5MWth, with only a few generating at below 50kWe. These systems tend to use a mature combustion technology such as a steam turbine but systems using the Organic Rankine Cycle (ORC) are increasingly common.

Types of CHP

There are three main medium-scale Biomass CHP options offered by Wood Energy Ltd – each depending on the applications and individual site requirements. There are variants on the options listed below, and these can be incorporated once specific and detailed information has been determined.

- Steam boiler with screw expander up to 500kWe
- Hot air boiler with ORC (Organic Rankine Cycle) up to 250kWe
- Thermal oil boiler with ORC up to 1MWe
- Steam boiler with steam turbine up to 1MWe

Screw expanders have an approximate efficiency of c.6% and c.18% for applications incorporating ORC.
As easy as 1,2,3…

1. Heating Only
   A traditional biomass heating system which produces hot water typically 85°C but can be much higher and can include steam production.

2. Heating & Electricity
   (also known as Co-Generation)
   Uses biomass as above but Co-generation is still common in pulp and paper mills, refineries and chemical plants. In this “industrial co-generation/CHP”, the heat is typically recovered at higher temperatures (above 100°C though not always) and used for process steam or drying duties. This is more valuable and flexible than low-grade waste heat, but there is a slight loss of power generation. The increased focus on sustainability as well as Government incentives in the form of RHI and ROCs has made industrial CHP more attractive. It substantially reduces carbon footprint compared to generating steam or burning fuel on-site and importing electric power from the grid.

3. Heating, Electricity & Cooling
   (also known as Tri-Generation or Poly-Generation)
   Is as described above but has the benefit of also delivering cooling via absorption chillers.
Low Temperature – CHP Generation
(Organic Rankine Cycle or ORC)

The Rankine Cycle uses water as the working fluid which is heated to produce high pressure steam which is passed through a steam turbine which provides the motive force to turn a generator to create electricity.

The Organic Rankine Cycle works on the same principle as the Rankine Cycle but instead of using water as the working fluid is uses an organic fluid with a low boiling point in a closed loop. Therefore the ORC system can generate electricity using modern efficient turbo generator technology but using the output temperatures generated from a biomass boiler without having to requirement to generate high pressure steam.

80 per cent of the world’s electricity is generated using a process called The Rankine Cycle, named after Scottish Engineer, William Rankine, who is regarded as the father of Thermodynamic science who also developed the theory of the steam engine.
Steam – CHP Generation
(Screw Expander)

Biomass Steam Combined Heat & Power (CHP) solution from Wood Energy. The Biomass Steam Boiler produces steam, which is used to drive a turbine; providing heat and power for your business. The pressure differential across the system is what generates the electricity. This system works Combined with the mass flow rate of the steam and so produces best results when there is a high pressure created at the boiler, compared to the working pressure at the user interface.

The technology attracts significant incentives and helps you to reduce your bills and carbon footprint.

Depending upon pressure difference and run hours, benefits include:
- Annual benefit £500,000 – £800,000
- 1 to 2 year payback
- Up to 100% ROI in year one
- Total benefit of up to £20 million over 20 years
- 25% moisture content wood fuel and can use higher moisture content wood fuels up to 50% moisture content
- Relatively low maintenance (compared to gasification CHP)
- 20 year warranty, operation and maintenance support to safeguard your RHI

Steam – CHP Generation
(Screw Expander)
The Biomass Steam CHP is aimed at high energy consumers. The Binder 1.65MW Biomass Steam CHP unit has the capacity to generate over 11,000MWh of heat 600MWh of electricity. This would allow large scale consumers to save up to £275,000 per annum on heating bills (based on displacing gas @ 2.5p per kWh), and up to £54,000 on electricity bills (@ 9p per kWh).

The Biomass Steam CHP unit allows for the combined production of electricity and thermal energy from standard wood chips. Unlike, more complicated gasification CHP units, the Biomass Steam CHP units do not require you to dry your wood fuel below 25% moisture content. This can save you a significant amount of time and money.

Biomass CHP can supplement or replace boilers for commercial, industrial and agricultural production cycles and produce electricity from renewable sources. Operation and maintenance is relatively straightforward, so 8,000 operation hours per annum is achievable.

### Potential Thermal Output (@ 8,000 hours):

- **Biomass Steam Boiler**
  - 1.65MW
  - $1.65 \times 8,000$ hours
  - 85% efficiency due to energy transfers
  - $11,220$MWhth

### Potential Electrical Output (@ 8,000 hours):

- **Steam Expander**
  - 118kW
  - Less parasitic loads = from $80kW$ to $100kW$
  - $80kW \times 8,000$ hours
  - $640$MWhel

When the electrical load is not being used, a power purchase agreement can be established with your electricity provider, usually at a minimum of 4.5p per kWh. Alternatively, the electricity you produce can be traded much like a commodity. When additional loads are required, the customer will continue to pay existing rates for electricity.

The heat generated from CHP units must be used at all times to ensure continuation of electrical output at 118kW. When this does not happen, the system will modulate to a lower output; reducing electrical output, thermal output and resultant incentives.
Incentives

- Maximise earning through the renewable heat incentive Renewable Heat Incentive (RHI)
- Maximise earning through the generation of your own electricity through the Renewable Obligation Scheme (ROCS)
- Maximise savings through displacement of fossil fuels and electricity bills
- Export excess electricity to the grid (Power Purchase Agreements)
- Minimise carbon taxation and reduce your business rates by embracing renewable technologies

Running Hours

With adequate on site experience and the right operation and maintenance package in place, CHP units should be capable of running for up to 8,000 hours.

Return on Investment

If you are a high energy consumer, with heating and electricity bills totalling £250,000; you could realise a 100% return on your investment in year 1, with a total benefit of up to £20 million over 20 years. Just imagine what that extra investment could do for your business.

Servicing, Maintenance & Warranty CHP Units

(Particularly those driven by steam) require regular checks and inspections. A full list of maintenance requirements available upon request. Indicative annual servicing costs of £10,000 – £50,000/yr are advised, (depending of system type and size), which will normally include an extended warranty of 20 years for all supplied and installed equipment including a full parts and labour package.
# Steam Biomass CHP

## Example Financial Projections

### 1.65MWt Biomass Boiler & 131kWe Screw Expander

## Project:

### Plant Nursery

### Customer Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price paid for electricity</td>
<td>£0.085/kWh</td>
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<tr>
<td>Price paid for gas</td>
<td>£0.02/kWh</td>
</tr>
<tr>
<td><strong>Total annual cost of gas</strong></td>
<td><strong>£240,000</strong></td>
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</table>

### Operating Assumptions – Biomass Boiler

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating hours</td>
<td>6,182 h/A</td>
</tr>
<tr>
<td>Biomass Boiler efficiency</td>
<td>85%</td>
</tr>
<tr>
<td>Total net heat produced per annum</td>
<td>10,200MWh</td>
</tr>
<tr>
<td>Total amount of wood-chip consumed</td>
<td>3,243 tonnes</td>
</tr>
<tr>
<td>Price paid for Biomass fuel per tonne</td>
<td>£65</td>
</tr>
<tr>
<td><strong>Total annual cost of Biomass fuel</strong></td>
<td><strong>£210,795</strong></td>
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### Operating Assumptions – Screw Expander

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating hours</td>
<td>6,182 h/A</td>
</tr>
<tr>
<td>Total electrical shaft power output</td>
<td>131kW</td>
</tr>
<tr>
<td>Net H P electrical power output</td>
<td>118 kW</td>
</tr>
<tr>
<td><strong>Total electrical power produced per annum</strong></td>
<td><strong>729,476 kWh</strong></td>
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### CAPEX & OPEX

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Total installation cost</td>
<td>£1,300,000</td>
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<tr>
<td>Genset annual service cost (1 visit plus 3 quarterly visits)</td>
<td>– £/A</td>
</tr>
<tr>
<td>Biomass Boiler annual service costs</td>
<td>– £/A</td>
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<tr>
<td><strong>Total Opex</strong></td>
<td><strong>£40,000</strong></td>
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### Year One Project Performance

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Electricity saving</td>
<td>62,005</td>
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<tr>
<td>Electricity Incentive (ROCs at 1.4 x output @ £43 per MW)</td>
<td>43,914</td>
</tr>
<tr>
<td>RHI – Large commercial</td>
<td>–</td>
</tr>
<tr>
<td>RHI – Biomass CHP (4.22p per kWh)</td>
<td>430,440</td>
</tr>
<tr>
<td>Fuel saving on heat</td>
<td>29,204</td>
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<tr>
<td><strong>Total Revenues</strong></td>
<td><strong>£565,563</strong></td>
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<tr>
<td><strong>Total OPEX</strong></td>
<td><strong>(40,000)</strong></td>
</tr>
<tr>
<td><strong>Net Revenue</strong></td>
<td><strong>£525,563</strong></td>
</tr>
<tr>
<td><strong>Simple payback</strong></td>
<td><strong>2.47 years</strong></td>
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</tbody>
</table>
3MWt Biomass Boiler & 149kWe Screw Expander

Project: Hospital

Customer Data
- Total annual electrical consumption: 10,750MWh
- Price paid for electricity: £0.082/kWh
- Total annual cost of electricity: £881,500
- Total annual gas consumption: 13,500MWh
- Price paid for gas: £0.02/kWh
- Total annual cost of gas: £270,000

Operating Assumptions – Biomass Boiler
- Operating hours: 3,825 h/A
- Biomass Boiler efficiency: 85%
- Total net heat produced per annum: 11,475MWh
- Total amount of woodchip consumed: 3,446 tonnes
- Price paid for Biomass fuel per tonne: £85
- Total annual cost of Biomass fuel: £292,910

Operating Assumptions – Screw Expander
- Operating hours: 3,825 h/A
- Net H P electrical power output: 149 kW
- Total electrical power produced per annum: 569,925 kWh

CAPEX & OPEX
- Total installation cost: £1,500,000
- Genset annual service cost (1 visit plus 3 quarterly visits): £3,500 /A
- Biomass Boiler annual service costs: £35,500 /A

Year One Project Performance (£)
- Electricity saving: 46,734
- Electricity Incentive (ROCs at 1.4 x output @ £43 per MWh): 34,309
- RHI – Large commercial: -
- RHI – Biomass CHP (4.22p per kWh): 484,245
- Fuel saving/(increase) on heat: (22,910)
- Total Revenues: 490,916
- Total OPEX: (39,000)
- Net Revenue: 503,368
- Total Installation Cost: 1,500,000
- Simple payback: 2.98 years
# Steam Biomass CHP
## Example Financial Projections

### 7MWt Biomass Boiler & 500kWe Screw Expander

**Project:** Distillery

<table>
<thead>
<tr>
<th><strong>Customer Data</strong></th>
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<tbody>
<tr>
<td>Total annual electrical consumption</td>
<td>813,077 kWh</td>
</tr>
<tr>
<td>Price paid for electricity</td>
<td>£0.082/kWh</td>
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<tr>
<td>Total annual cost of electricity</td>
<td>£66,672</td>
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<tr>
<td>Total annual oil consumption</td>
<td>23,254 MWh</td>
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<tr>
<td>Price paid for oil</td>
<td>£0.48/kWh</td>
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<tr>
<td><strong>Total annual cost of oil</strong></td>
<td>£759,325</td>
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### Operating Assumptions – Biomass Boiler

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating hours</td>
<td>2,824 h/A</td>
</tr>
<tr>
<td>Biomass Boiler efficiency</td>
<td>85%</td>
</tr>
<tr>
<td>Total net heat produced per annum</td>
<td>19,766 MWh</td>
</tr>
<tr>
<td>Total amount of woodchip consumed</td>
<td>6,285 tonnes</td>
</tr>
<tr>
<td>Price paid for Biomass fuel per tonne</td>
<td>£85</td>
</tr>
<tr>
<td><strong>Total annual cost of Biomass fuel</strong></td>
<td>£534,225</td>
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</table>

### Operating Assumptions – Screw Expander

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating hours</td>
<td>2,824 h/A</td>
</tr>
<tr>
<td>Net H P electrical power output</td>
<td>500 kW</td>
</tr>
<tr>
<td><strong>Total electrical power produced per annum</strong></td>
<td>1,412 MWh</td>
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### CAPEX & OPEX

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total installation cost</td>
<td>£2,223,000</td>
</tr>
</tbody>
</table>
| Genset annual service cost | £3,500 /
| (1 visit plus 3 quarterly visits) |
| **Biomass Boiler annual service costs** | £35,500 /
| **Year One Project Performance** | £ |
| Electricity saving | 66,672 |
| Electricity exported under PPA (599 Mwh @4.5p/kWh) | 26,955 |
| Electricity Incentive (ROCs at 1.4 x output @ £43 per MWh) | 85,002 |
| RHI – Large commercial | - |
| RHI – Biomass CHP (4.22p per kWh) | 834,125 |
| Fuel saving/(increase) on heat | 225,000 |
| Total Revenues | 1,237,754 |
| Total OPEX | (89,000) |
| **Net Revenue** | 1,148,754 |
| **Total Installation Cost** | 2,223,000 |
| **Simple payback** | 1.94 years |
Finance Options

Your financing options for CHP can be divided into two key groups – those that appear on your balance sheet and those that don’t.

Capital purchase or ‘on balance sheet’ financing

| Financed by: |
| Internal Funding |
| Debt Finance |
| Leasing |

Operating lease or ‘off balance sheet’ financing

| Financed by: |
| Equipment Supplier |
| Energy Services Company (ESCO) |
| Private Finance Initiative |

Capital purchase or ESCO arrangement – which is best?

The most common way of financing for biomass CHP seems to be via an ESCO arrangement.

Although you will not benefit from the RHI and ROCs payments, you will save on your energy bills and not be left with any responsibility for service and maintenance and ongoing operational issues should they arise.

Wood Energy Ltd can arrange an ESCO offer. We have created an extensive network of stable, experienced ESCO providers who can quickly provide the offer and contract once we have create a detailed costing and IRR (internal rate of return) for them.

Capital purchase

Advantages:
- The equipment is yours
- You benefit from fuel savings
- You benefit from the RHI and ROCs payments

Disadvantages:
- You have to raise the capital, which may be needed for other areas or the business
- You will have to service and maintain the equipment at your cost
- You will have to provide the fuel at the correct specification

ESCO arrangement

Advantages:
- You do not have to raise any capital to pay for the equipment – meaning you can use funds for other areas of your business.
- The equipment is yours after the term (10 yrs or 20 yrs)
- You benefit from fuel savings
- You benefit from full service and maintenance regime at zero cost to you
- You do not need to be submerged in detailed design decisions and choosing the correct the specification for the equipment. This responsibility rests with the supplier (Wood Energy) and the ESCO provider.

Disadvantages:
- You do not receive any of the RHI or ROCs payments
- You must agree to take a minimum annual amount of heat and / or electricity that the equipment generates.

What next?

We will provide you with a free consultation, desktop study followed by an on-site survey to establish the suitability of your site.
Biomass / CHP Questionnaire

To help us to provide you with the most suitable solution, please answer as many of the following questions as possible.

Customer information
Name of business: ________________________________________________________________
Contact name: ________________________________________________________________
Address: ________________________________________________________________
Postcode: ________________________________________________________________
Telephone number (Mobile): ______________________________________________________
Landline: ________________________________________________________________
Email: ________________________________________________________________
Website: ________________________________________________________________

Part 1 Site / Process Description
A Please provide a general description of the on-site heating and electrical equipment giving details of space heating/hot water/process heating and electrical equipment (e.g. chillers/ dryers etc.):

B What is the size of the existing/proposed boiler(s) (kW)? If multiple boilers please provide information about the configuration (e.g. duty, back-up, redundancy etc.):

C What are the temperatures required for all the downstream requirements (if steam provide mass flow rate (kg/hr)), pressure (bar) and temperature (°C)?

D What fuels are currently being used on site?

E What is the availability required and is a back-up boiler required?

Part 2 Thermal Consumption
A What is the total annual thermal consumption for the site (kWht)?

B What is the profile of the heat load (i.e. base load, peak load working hours (Mon-Fri, 7 days etc.))?

C If possible please provide an indication of what percentage of the overall heat load is attributable to space heating, hot water or any other down-stream processes etc.:

D What are the historic/current costs of fossil fuels?

E Is any planned additional thermal capacity required?

Part 3 Electrical Consumption
A What is the total annual thermal consumption for the site (kWhe)?

B What is the profile of the electrical load (i.e. base load, off-peak, peak load working hours (Mon-Fri, 7 days etc.))? 

C If possible please provide an indication of what percentage of the electrical load is attributable to lighting, space heating, cooling or any other processes:

D What are the historic/ current costs of electricity?

E What is the current electrical power supply (3 Phase) and capacity?

F Is there any planned additional electrical consumption on site?

G Is there a requirement for essential supply and is there a generator on site (provide details KVA)?

H Is there an existing CHP system on site?

Please detach this form and return to the Wood Energy address shown overleaf. Alternatively, scan and email the completed form to marketing@strongenergy.com
Your Local Registered Installer:

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www.strongenergy.com

The Strong Energy Group of Companies