

BIOMASS CHP

Biomass Cogeneration/Trigeneration

Sustainable and cost-effective solutions for heating, cooling, and electrical power generation using:

Biomass steam and hot water boilers with

- ORC [Organic Rankine Cycle] CHP modules
- Screw expander + generator systems



Why Biomass CHP?

Considering using biomass energy for heating or hot water generation? If your business or process has high electrical and heat demands, then it makes sense to look at biomass CHP which can generate savings as well as reduce your carbon footprint.

In Biomass CHP systems, heat energy from the boiler or plant process is captured and recycled as energy to drive a generator for your own local electrical supply.

You save money when you generate your own electrical power and you make money supplying back to the grid any power you don't need. Depending on the power purchase agreement you make with your energy company, this can be between 4p and 7p per kilowatt hour.

And CHP systems are eligible for generous government backed RHI (Renewable Heat Incentive) payments of up to 4.22 p/kWh_{th} (Jan 2017).

- Increase overall plant efficiency
- Rapid ROI, often < 3 years
- Reduce electricity costs or sell back to grid
- Fuel may be recycled from process (e.g. wood chips, poultry waste, waste wood, sawdust etc.)
- Effective even in part load
- Displace fossil fuels and minimise carbon taxation
- Using locally generated electricity means less waste

Why pay ~10 p/kWh for mains electricity if you can use waste heat to generate your own?

And if you don't need all you generate, sell it back to the grid.

A 2.8 MW_{th}/210 kW_e Biomass CHP system* could generate

> **£180,000** in annual electricity savings, and

> **£560,000** in annual RHI payments
(*operating 8000 hrs/year)





Why Myriad?

At Myriad Heat and Power we have been designing and installing commercial and industrial Biomass heating systems for over 15 years with over 1500 boilers installed.

Drawing on a wealth of experience in the supply and installation of energy-efficient biomass solutions, we have the know-how to develop bespoke CHP solutions tailored to your application.

We can create systems to suit your requirements and scale of operation, drawing from a wide range of available CHP equipment including biomass boilers from 500 kW_{th} to 10 MW_{th}

and associated fuel storage systems, ORC units, steam screw expanders and turbines, drying floors, blowers and more.

We only use proven quality brands such as Herz and Zuccato (we are their exclusive UK distributors), Wolf, Heliex, etc., so you can be assured of a robust, reliable and efficient system with worry-free operation.

We can help manage and support you through every stage of the process from conception to installation, and also provide ongoing maintenance support.

We can also provide attractive financing options for on- or off-balance sheet funding of your CHP project.

Myriad Heat and Power offer a range of efficient and environmentally friendly CHP equipment for electrical generation, heating and cooling including:

- Biomass hot water and steam boilers
- Gas CHP boilers
- Biomass fuel storage and delivery systems

With our expertise, we can help you choose the right equipment to maximize your energy savings.



Is my Application Suitable for CHP?

Biomass CHP systems are best suited for applications where there is a high heating demand in order to maintain a constant electrical power output.

Systems with a continuous heating and electrical demand will yield a high financial return, particularly if the electricity generated is to be used locally rather than supplied to the grid.

In more fluctuating load scenarios CHP can still be advantageous, but if boiler heating is modulated down then there will be a proportional attenuation of the electrical power output. This means less heat produced and consequently less electricity generated. Of course, savings will be made by using less fuel overall, but bear in mind this means there will be less income from incentives and also more power may be required from the grid to maintain a steady power level.

The best way to be sure that an energy saving CHP system is for you is to contact Myriad Heat and Power. We can discuss your needs and evaluate your project to see how best to achieve the savings you are looking for and help maximise your return on investment.

If we can demonstrate that biomass CHP offers tangible benefits for your project, we can then offer a variety of bespoke and off-the shelf solutions to suit your application and can guide you through every stage of the process to implement your biomass CHP system.

To help us help you, we have included a questionnaire on page 11 as a starting point for discussion.

Please copy, complete and email this to us at:

info@myriadproducts.co.uk

or call us on **0203 189 0665** to discuss your project.

Here are just a few examples of typical applications that benefit from implementing biomass CHP:

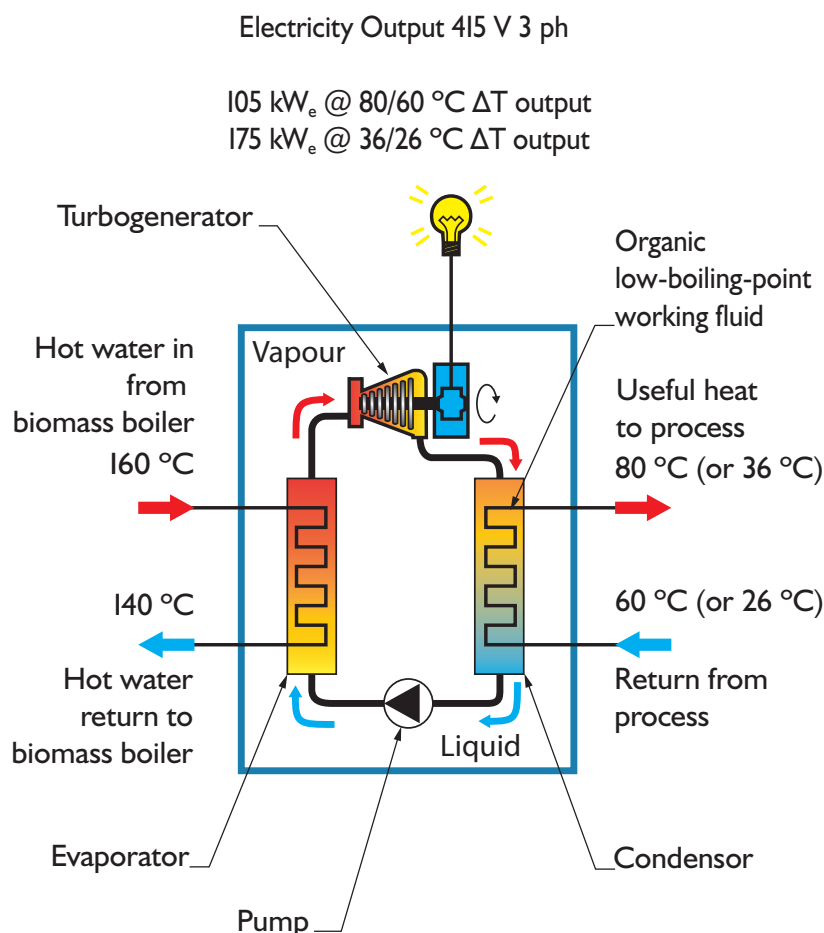
What Systems are Available?

ORC

For biomass hot water boiler systems, hot water from 60 °C to 165 °C is typically converted to electricity and low grade heat using a low-temperature ORC [Organic Rankine Cycle] unit.

ORC units are also able to recover waste heat directly from flue gases to generate electricity, e.g. from a blast furnace flue.

ORC [Organic Rankine Cycle] Unit



How the ORC works

The ORC Unit includes an evaporator, an ORC turbine (turbogenerator), a condenser and pump in a closed circuit. It uses a non-toxic, ozone friendly, biodegradable and inherently safe organic fluid with a low boiling point as the working fluid instead of steam (used in a normal Rankine Cycle turbine system).

Heat from the biomass boiler flue, or heat diverted from the boiler's output, is transferred via a heat exchanger to the ORC circuit fluid.

As the fluid heats up it vaporises and expands on the input side of the turbine and as the vapour leaves the turbine it passes through a condenser, cools and returns to a liquid. This process creates a pressure drop across the turbine, which provides the motive force to drive the turbine.

The turbine rotates and drives a directly-coupled generator which then generates electrical power to an inverter which outputs 415 V/50 Hz.

The water supplied to the condenser takes in energy from the condensing process and outputs water at a higher temperature. This useful heat output can be used for another process, e.g. it can be supplied to the heat exchanger of a commercial dryer to provide warm air for a drying floor.

Alternatively it could be supplied to an absorption chiller for a cooling process. If the heat is not required it can be dissipated using a compact cooling tower.

What Systems are Available?

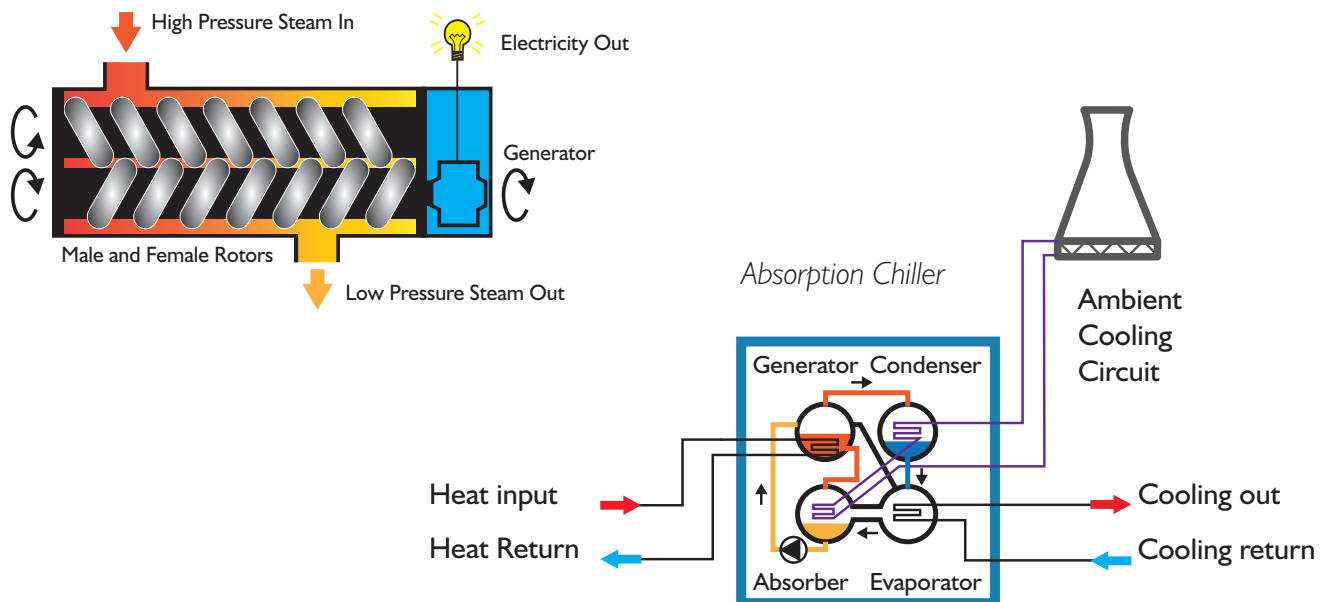
Steam Screw Expander

A steam screw expander is used to generate electricity typically where low-pressure steam is needed for an end process.

A high pressure saturated steam feed from the boiler turns the steam screw expander, which in turn drives an electric generator to provide electricity for the grid or for local use.

Using appropriate pressure regulation, the low pressure steam output from the screw expander can also be used as the low-pressure steam supply to a process.

Steam Screw Expander



Absorption Chiller

Further energy savings may be made using heat rather than electricity to provide cooling for a process.

An absorption chiller uses heat, typically in the form of steam, as heat input to power its vapour absorption cycle to produce its cooling output. It also uses a small amount of electricity to power its liquid pump. In contrast, a conventional chiller uses much more electricity to power a mechanical compressor, in order to power its vapour compression refrigeration cycle to produce a cooling output. The absorption chiller also uses a different working fluid which is CFC free.

However, both refrigeration systems are similar in that heat removal is via evaporation of a refrigerant at low pressure and heat rejection through condensation of the refrigerant at a higher pressure.

As absorption chillers require little work input, and heat input rather than electricity, they become very attractive where low cost heat or waste heat sources are available.

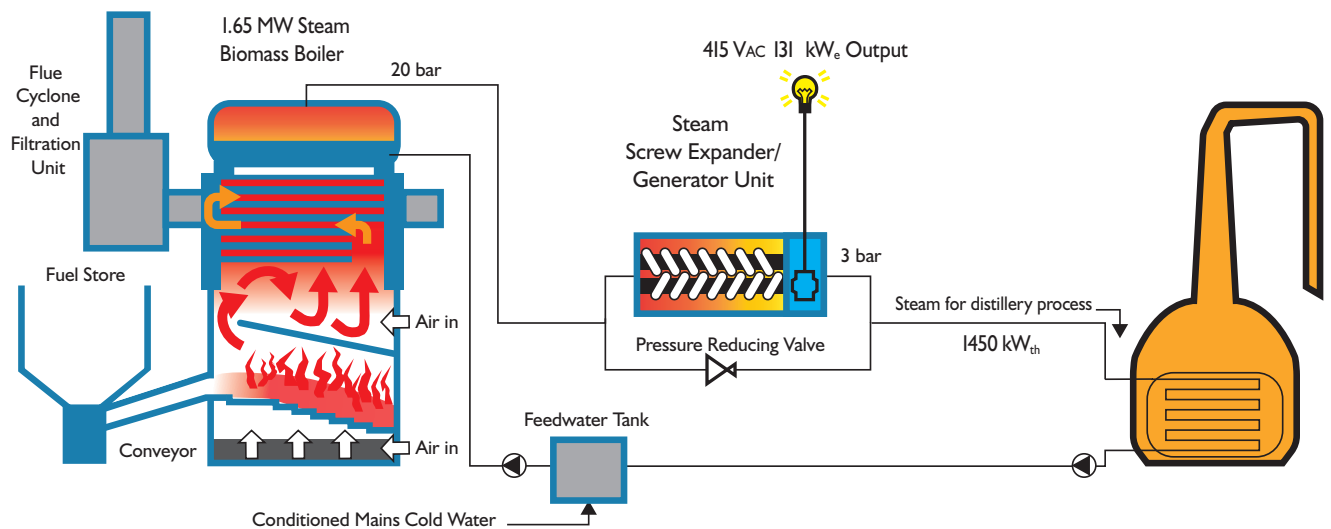
They are now widely accepted for use alongside cogeneration systems, to provide even greater overall energy savings. Such systems (with heating, cooling and electrical generation) are often referred to as trigeneration systems.

Example A: Distillery

Biomass Steam Boiler and Steam Screw Expander

- ~£370k / year RHI income
- ~£100k / year electricity saving (local use) or
- ~£38k / year income if supplied to grid

Simple Payback: 3-4 years



In Example A, a 1.65 MW_{th} output biomass steam boiler uses around 1.94 MW_{th} of heat input power per hour, and the screw expander/generator unit produces 130 kW_e of electricity per hour as well as 1.45 MW_{th} of heat per hour for the distillery processes such as providing steam to heat the still pot, or for drying the by-products of fermentation which can then be recycled as feedstock.

| New CHP System | Useful Heat | Electric |
|-----------------------|---------------------------|--------------------------|
| Biomass boiler output | 1.65 MWh _{th} | -30 kW _e |
| Screw expander output | 1.45 MWh _{th} | 131 kW _e |
| Energy generated/yr | 11.4 GWh _{th} | 0.9 MWh _e |
| Unit price | £ 0.03p/kWh _{th} | £ 0.12p/kWh _e |
| Total energy costs/yr | £ 342,000 | £ 100,000 |
| OPEX service costs/yr | | £ 40,000 |

| First Year Performance Estimates | |
|--|-----------|
| RHI payments | £ 370,000 |
| Electricity saving (if local use) | £ 100,000 |
| Electricity income (if sold back to grid)* | £ 38,000 |
| Simple payback of CHP system | 3-4 years |

*Power Purchase Agreement @ 4p/kWh.

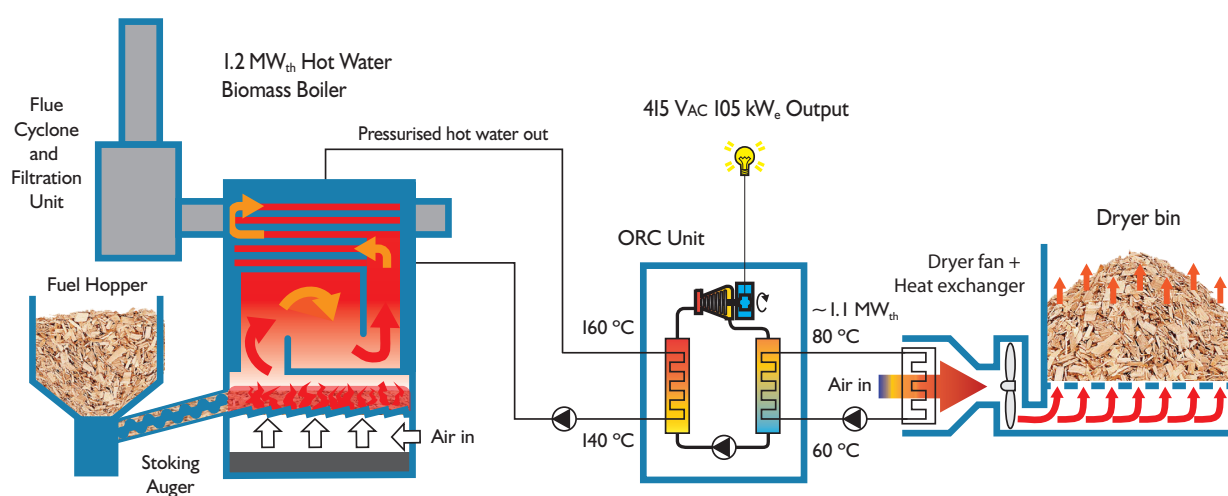
Example B:

Dryer in Wood-Manufacturing Process

Biomass Hot Water Boiler with ORC/Blower,

- £300k / year RHI income
- £90k / year electricity saving (local use) or
- ~£34k / year income if supplied to grid
- No dump charges: waste wood used as fuel

Simple Payback: 3-4 years



In Example B, a 1.2 MW_{th} output biomass hot water boiler requires around 1.4 MW_{th} of heat input power per hour and the ORC unit produces 105 kW_e of electricity per hour as well as 1.157 MW_{th} heat for the dryer. The biomass boiler burns dried waste wood from the manufacturing process, saving on fuel costs and minimising tipping charges.

| New CHP System | Useful Heat | Electric |
|-----------------------|--------------------------|-------------------------|
| Biomass boiler output | 1.2 MW _{th} | -30 kW _e |
| ORC unit output | 1.1 MW _{th} | 105 kW _e |
| Energy generated/yr | 8.2 GWh _{th} | 0.8 MWh _e |
| Unit price | £0.03p/kWh _{th} | £0.12p/kWh _e |
| Total energy costs/yr | £ 246,000 | £ 90,000 |
| OPEX service costs/yr | | £ 35,000 |

| First Year Performance Estimates | |
|--|-----------|
| RHI payments | £ 300,000 |
| Electricity saving (if local use) | £ 90,000 |
| Electricity income (if sold back to grid)* | £ 34,000 |
| Simple payback of CHP system | 3-4 years |

*Power Purchase Agreement @ 4.5p/kWh.

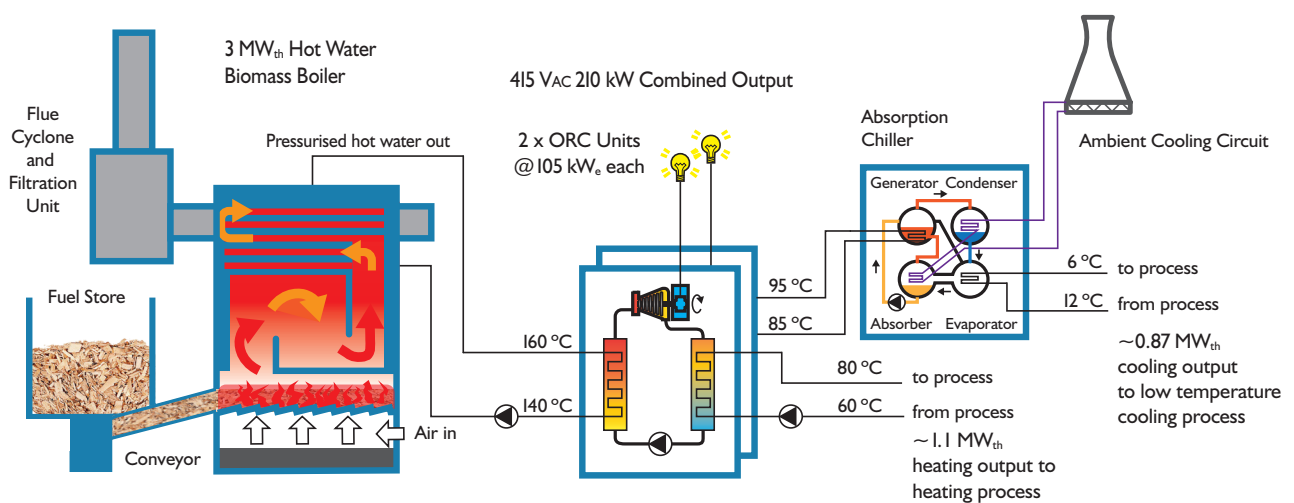
Example C:

Food Processing

Biomass Hot Water Boiler with ORC and Absorption Chiller (Trigeneration)

- ~£560k / year RHI income
- ~£820k / year saving in cooling costs
- £180k / year electricity saving (local use) or
- ~£67 K/year income if supplied to grid

Simple Payback: 2-3 years



In Example C, a 3 MW_{th} biomass hot water boiler requires around 3.5 MW_{th} of heat input per hour, and two ORC units at 80/60 ΔT output each produce 105 kW_e per hour.

One ORC unit provides 1157 kW_{th} per hour of heat for use in a food manufacturing process, and another ORC unit provides 1157 kW_{th} per hour of heat to an absorption chiller. The absorption chiller produces around 868 kW_{th} per hour of cooling for use in another food manufacturing process.

With absorption chillers using typically 2 to 10 % of the electricity of a traditional electrical chiller, once again savings are to be made in the overall energy bill.

| New CHP System | Useful Heat | Electric |
|-----------------------|-------------------------|------------------------|
| Biomass boiler output | 3 MW _{th} | -40kW _e |
| ORC + ORC/Chiller | 1.97 MW _{th} | 210 kW _{th} |
| Energy generated/yr | 15.5 GWh _{th} | 1.5 MWh _e |
| Unit price | £0.03p/kW _{th} | £0.12p/kW _e |
| Total energy costs/yr | £ 465,000 | £ 180,000 |
| OPEX service costs/yr | | £ 50,000 |

| First Year Performance Estimates | |
|--|-----------|
| RHI payments | £ 560,000 |
| Electricity saving (if local use) | £ 180,000 |
| Electricity income (if sold back to grid)* | £ 67,000 |
| Absorption chiller electricity saving | £ 820,000 |
| Simple payback of CHP system | 2-3 years |

*Power Purchase Agreement @ 4.5 p/kW_h.

Financing

For some businesses with the capital to invest directly, Biomass CHP can be self-funded, and with the RHI solid biomass CHP tariff payments eligible for 20 years, a rapid return on investment is possible, often in less than 3 years. For other businesses, a financing solution is preferred.

Working in partnership with leading financial providers, Myriad can offer a finance package that will work for you and enable you to invest in renewable energy. You can even benefit from cheaper heating, cooling and electricity without any upfront capital costs.

- Access to specialist finance for green technologies
- ESCO (Energy Service Company) and Asset Finance available
- Installation costs can be included
- No impact on your working capital
- Fast – credit approval within 24 hours

Myriad's Finance Options:

Asset Finance—(Assets on-balance, typically 5-7 years term)

The finance company purchases the CHP assets on behalf of the customer. In an Asset Finance arrangement, the whole amount borrowed is paid back at a given rate of interest and the finance company retains the title to the equipment until the final instalment is paid, at which point the customer takes the title to the equipment.

- The customer usually pays for infrastructure costs but these may be covered in the financial agreement
- Any capital allowances are claimed by the customer
- Up to 100% of the project value may be borrowed
- The customer benefits from RHI payments
- Admin fee and deposit required to set up
- The customer own the assets at the end of the term

ESCO—(Assets off-balance, typically 10-15 years term)

A financial arrangement is made with Myriad Heat and Power where they fund the supply, installation, operation, servicing and maintenance of the CHP system. The customer then buys their heating energy and electricity directly from Myriad Heat and Power over a predetermined period.

- Myriad covers infrastructure costs
- Any capital allowances are claimed by Myriad
- The customer pays a lower price for energy but Myriad keeps the RHI payments
- No set-up or ongoing maintenance costs
- The customer can own the assets at the end of the term
- The customer must guarantee a minimum amount of annual heat and/or electricity generation

Note. All finance options mentioned are subject to credit approval and contract.

Maintenance and Servicing

Properly maintained solid biomass CHP systems should benefit from around 8000 hours operation per year. Biomass boilers and their fuel delivery systems will require routine and periodic maintenance, typically 3 to 4 services per year. However ORC units and screw expander units are sealed systems which require little servicing. RHI metering conformity checks will be required annually.

Remote monitoring functionality is available which negates the need for daily on-site supervision, except in the case of steam plant where a suitably trained "competent person" is required on-site during the hours of boiler operation, and regular periodic inspection and test must be carried out in line with the manufacturer's instructions and in line with relevant standards such as HSE BG01.

Myriad Heat and Power can offer a range of service and maintenance contracts through Myriad Plantroom Services with packages tailored to suit your CHP system. These include full service and safety inspections, with a choice of service levels.

| Service Level Options | 3 Star | 4 Star | 5 Star | 5 Star+ |
|--|--------|--------|--------|---------|
| Full Service and Safety Inspection | ✓ | ✓ | ✓ | ✓ |
| Interim Service | - | ✓ | ✓ | ✓ |
| Weekday Technical Phone Support | ✓ | ✓ | ✓ | ✓ |
| Boiler Heat Meter Check | - | ✓ | ✓ | ✓ |
| Flue Cleaning | - | - | ✓ | ✓ |
| Monthly Maintenance Inspections | - | - | ✓ | ✓ |
| SMS Text Remote Monitoring Service | - | - | ✓ | ✓ |
| Out of Hours Phone Support | - | - | ✓ | ✓ |
| Extended Warranty Available | - | - | ✓ | ✓ |
| Discount on Spares & Additional Services | 5% | 10% | 15% | 15% |
| RHI Payments Guaranteed | | | | ✓ |

Myriad Plantroom Services can also offer:

Remote Monitoring & Optimisation System for real-time 24/7 cloud-based monitoring of your system via PC tablet or smartphone.

- Boiler combustion optimisation
- Operator training
- Fuel brokerage from approved local suppliers

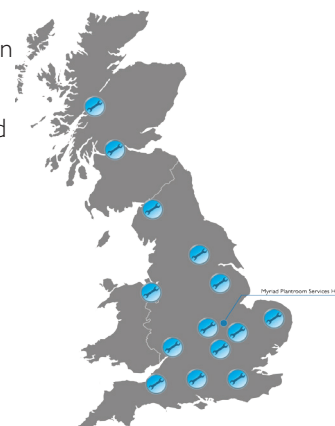
For more information see

www.myriadservice.co.uk

or please call Myriad Plantroom Services on: **0203 189 0666**

or email:

service@myriadservice.co.uk





Questionnaire for Your Biomass CHP Project

Please complete as much information as you can to help us find the most appropriate solution for your project. Scan/photo and email to info@myriadproducts.co.uk or call **0203 189 0665** to discuss your project and/or arrange a site survey.

| Customer and Project Information for CHP Enquiry | | | | | | | |
|--|---|---------------------------------------|-----------------|------------|------|-----|-----------|
| Name | | | | | | | |
| Company | | | | | | | |
| Postcode | | | | | | | |
| Contact Telephone | | | | | | | |
| Email address | | | | | | | |
| Description of nature, size and location of business, process or plant, and whether new build or upgrade. | | | | | | | |
| Do you have material for burning? Please describe. | | | | | | | |
| What do you need heating for? (Tick) If 'Other', please describe | Space Heating | Process | Drying | Other | | | |
| | | | | | | | |
| | | | | | | | |
| Existing Arrangements | | | | | | | |
| Access for fuel delivery? | | | | | | | |
| Site requirements | Hot Water | Steam | Thermal Oil | Other | | | |
| | | | | | | | |
| Mains supplies (Tick if present) | Nat. Gas | Electricity 1ph | Electricity 3ph | Generators | Oil | LPG | Water |
| | | | | | | | |
| Other supplies present (gas, oil, bio) or existing CHP systems | | | | | | | |
| Heating/hot water/cooling equipment installed | Type (Gas, Oil, Electric, Biomass) and Manufacturer | | | | | | Output/kW |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Annual energy consumption/kWh | Thermal | | | Electrical | | | |
| | | | | | | | |
| Approx total annual fuel bills/£ | | | | | | | |
| Describe the plant/process operating cycle in terms of thermal and electrical load profiles. (E.g. base load sizes, when peak loads occur and for how long, operating hours per day/ days per week) | | | | | | | |
| Finance | | | | | | | |
| Funding preference (tick) | Self-funded | Asset Finance/ Hire/Lease Purchase | | | ESCO | | |
| | | | | | | | |

Natural Gas CHP

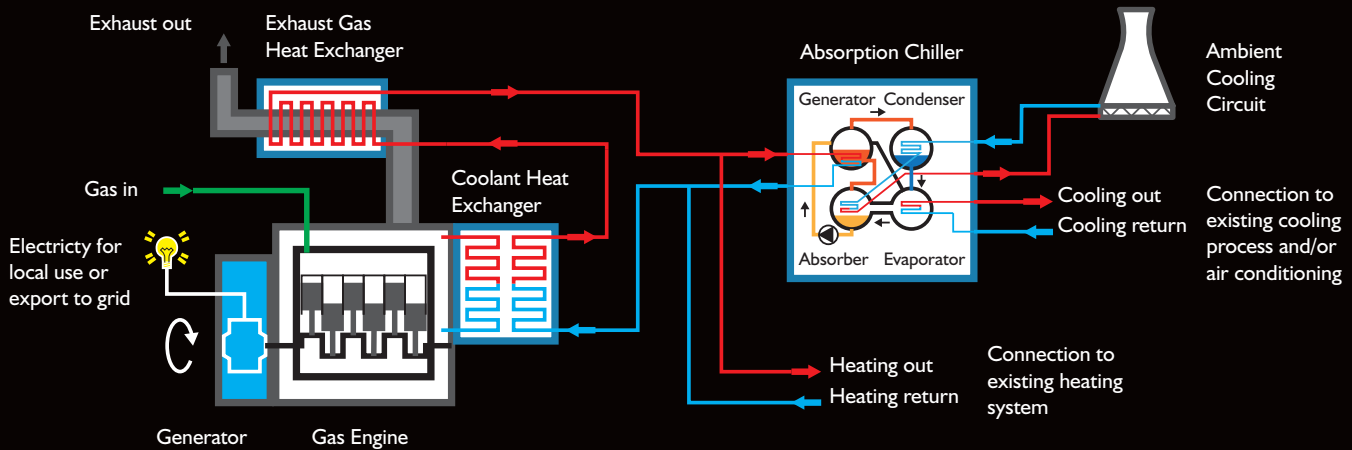
Where biomass is not feasible due to fuel availability or space constraints, natural gas CHP should be considered as an alternative. Although not eligible for RHI payments, with gas currently around a third of the price of electricity, there are distinct savings to be made by generating your own electricity using gas CHP where feasible.

Myriad can offer Combined Heat and Power modules fuelled by natural gas, biogas, sewer gas and LPG.



- Compact Modules—from 7 kW_e to 530 kW_e or 7 kW_{th} to 648 kW_{th}
- Project Design Modules—from 366 kW_e to 2 MW_e or 426 kW_{th} to 1.937 MW_{th}
- Overall efficiency up to 97%

For more information about our gas CHP offering, please refer to www.myriadproducts.co.uk/product/gas-chp



Your local Installer:

Contacts

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Burrough on the Hill
Melton Mowbray
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LE14 2QS

Tel: **0203 189 0665**

Email: info@myriadproducts.co.uk

Web: www.myriadproducts.co.uk



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