The Association for Decentralised Energy

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Bringing Energy Together

Combined Heat and Power Guidance for Contractors, Consultants and Customers

What does this guidance document provide?

This document highlights the key issues which contractors, consultants and customers should be aware of when considering or installing combined heat and power (CHP) systems. This guidance document's focus is on CHP units supplying heat in buildings, often less than 1MWe, and typically using reciprocating engines.

The document gives an introduction to the issues which will most determine the installation and operation of a successful CHP unit, while signposting to other more detailed technical guidance documents. [1]

Read existing guidance

The very first step on the journey towards the successful CHP project is reading the Chartered Institution of Building Services Engineers' (CIBSE) ***Combined Heat and Power for Buildings, also known as 'AM-12'.***

- Consultants, contractors, and suppliers should be delivering and installing a product and service which meet the standards set out in AM-12.
- Customers and energy users should not accept anything less than the AM-12 standards from their consultants and CHP providers.

What is CHP?

Combined heat and power captures usable waste heat that is produced in the process of generating electricity. This contrasts with conventional ways of generating electricity where vast amounts of heat are simply wasted.

Their relative sophistication means that the overall efficiency of CHP plants can reach in excess of 80% at the point of use, reducing emissions and energy costs.

As an energy generation process, CHP is fuel neutral. This means that a CHP process can be applied to both renewables like biomass and biogas and fossil fuels like natural gas and LPG.

CHP can use either turbines or engines, and each have specific traits:

- Spark-ignition gas-engines are the predominant technology used for CHP in buildings.
- Above 200kWe, engines can be turbo-charged, improving their electrical efficiency.
- Turbines are higher capital cost and have lower electrical efficiency, but are smaller, can provide higher temperature heat and can have greater reliability.

More detailed information on the different engines/turbines available can be found in AM-12.

[1] This document is for information only and does not constitute technical or investment guidance. It represents the best view of the Association at the time. Professional guidance should always be sought for investment or technical decisions. The Association cannot be held liable for any investment or technical decisions taken on the basis of this document.

Why install CHP?

CHP is typically considered to achieve one or more of the following aims:

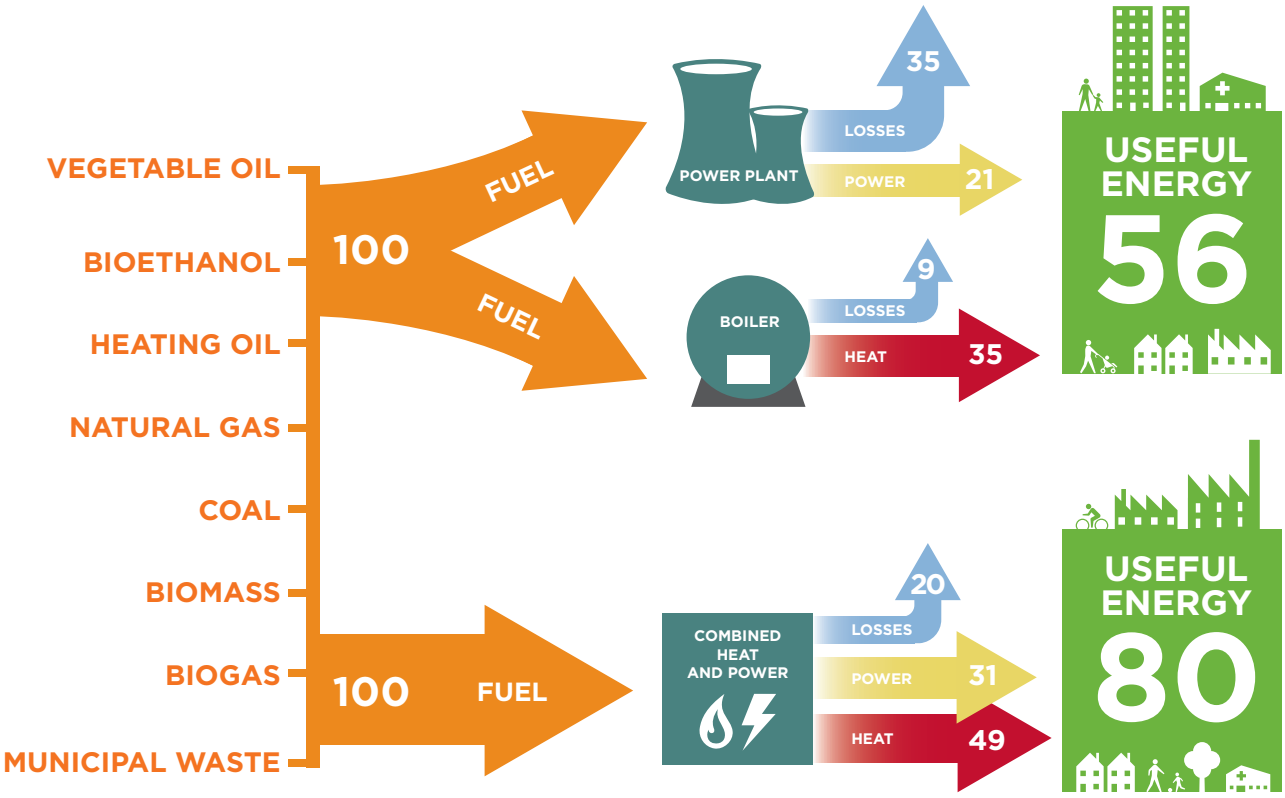
- Reduced energy costs
- Lower carbon emissions
- Improved security of supply, in some cases

However, CHP only provides these benefits if it is sized and installed correctly and ultimately operated properly.

By including the supplier, contractor and operator at the early stages of the feasibility and design of the project:

- The value of your investment will be more secure; and,
- The reputations of the contractor, consultant, supplier and operator will be protected.

It is these two key points that must be kept in mind throughout the process and the different players kept accountable by the customer.



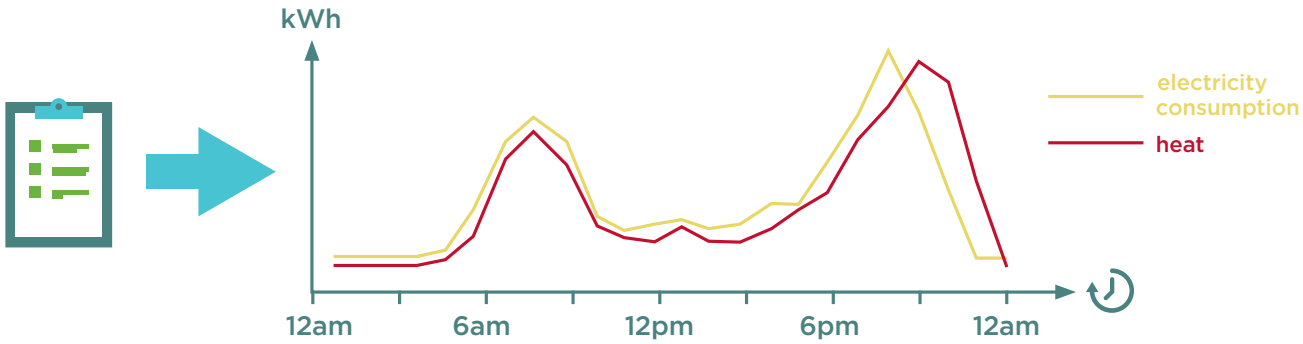
Feasibility

A CHP solution needs to be based on a number of considerations including technical, financial and operational factors, not just to meet planning or building regulation requirements. CHP only makes savings while running, meaning there must be a reliable need for heat and electricity.

AN ENERGY AUDIT IS KEY FIRST STEP

CHP is a technology which is built around the energy needs of the individual customer. Therefore, an energy audit is a vital first step in understanding whether CHP is a cost-effective way to reduce energy costs and emissions.

- **Contact a CHP supplier first.** Make initial contact with CHP suppliers to ensure the necessary data is collected by an energy audit. The CHP supplier may also be best to perform the audit.
- **Measure energy demand by kilowatt hours (kWh), not maximum capacity by kilowatts (kW).** It is just as important to know the minimum daily and seasonal demands as the maximum demands. Ideally, an hour by hour model over the whole year with heat and electricity demand profiles would be built. The kWh demands are required, not just peak and base loads in kW.

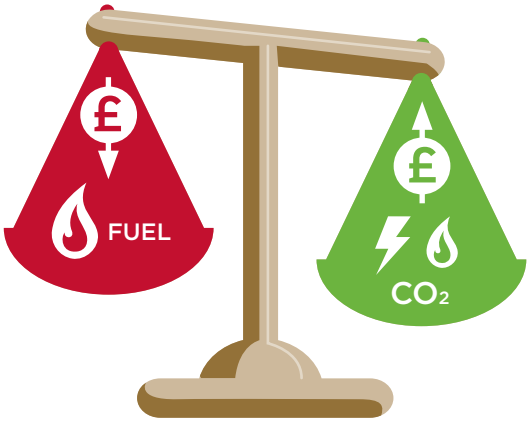


- **Energy data are not always available.** For new buildings, energy demand data can come from design data or benchmark data from similar buildings. For existing buildings, half-hourly electricity data should be available from the supplier. For heat consumption data, it is better to monitor heat consumption to determine daily and weekly profiles rather than depend on gas or electricity bills.
- **Consider other energy efficiency investments.** Before sizing the CHP unit, consider alternative energy efficiency options and build these data in the energy audit e.g. LED lights. Implementing energy saving measures after installing CHP could result in an oversized unit, compromising the benefits of the installation. Equally, the sizing should take into account future expected changes in energy demand, such as future development.
- **Include all on-site electricity, if possible.** The whole building use of electricity should also be considered and built into the energy audit e.g. if there is the potential to supply power to the apartments in a multi-residential buildings. However, in some cases the CHP operator may not be able to sell electricity to occupiers for commercial reasons and this should be taken into account.
- **Determine heat to power ratio.** There is no 'right' heat to power ratio, but cost-effective CHP will usually fall between 1.3 to 1 and 2 to 1.

CREATE A DETAILED MODEL

Develop an hour-by-hour model over an average year with the heat and electricity demand profiles. Modelling approaches are addressed in detail in AM-12, and any model should be able to:

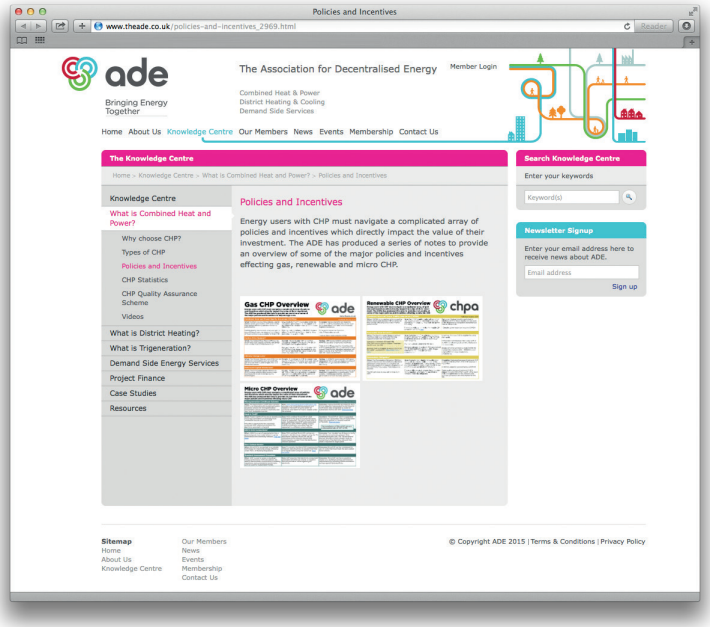
- Tell you whether the CHP is economic, based on fuel and electricity prices during each daily period
- Tell you the heat and electricity demand met by the CHP in each period, its percentage load, and total fuel used
- Include the expected electricity revenue and any imported electricity cost, obtained through estimates from energy suppliers
- Calculate the heat needed from boilers to meet peak demand, and any boiler fuel use
- Include allowances for CHP maintenance downtime
- Compare operating and capital costs with conventional boilers
- Measure CO2 savings. There are several methods to do so, and these are addressed in detail in AM-12.



CONSIDER FINANCIAL INCENTIVES

- CHP sites are eligible for a range of financial support mechanisms, including:
  - Enhanced Capital Allowances
  - Reliefs from carbon taxes like the Climate Change Levy
  - Business rates exemptions

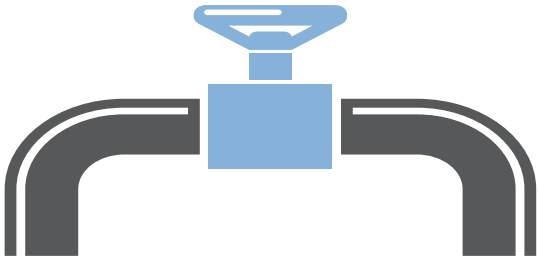
The Association for Decentralised Energy provides a complete breakdown of the value from these tax reliefs ***here***.



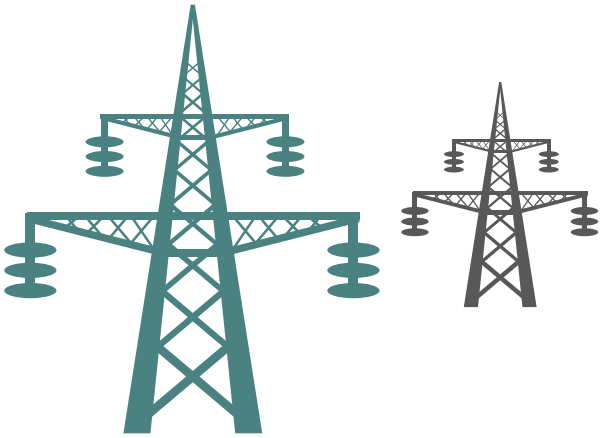
INVESTIGATE INFRASTRUCTURE REQUIREMENTS

Confirm sufficient space exists for a CHP, with adequate ventilation and good access for maintenance as required by the CHP supplier, including flue route, vibration and noise requirements. Furthermore, make sure there is sufficient:

- **Gas infrastructure.** For gas CHP, pipe-work that is the right size and has enough pressure for the increased rate of gas that is required. A lack of pressure may cause need for a compressor, which will cost more in terms of capital outlay and running costs.

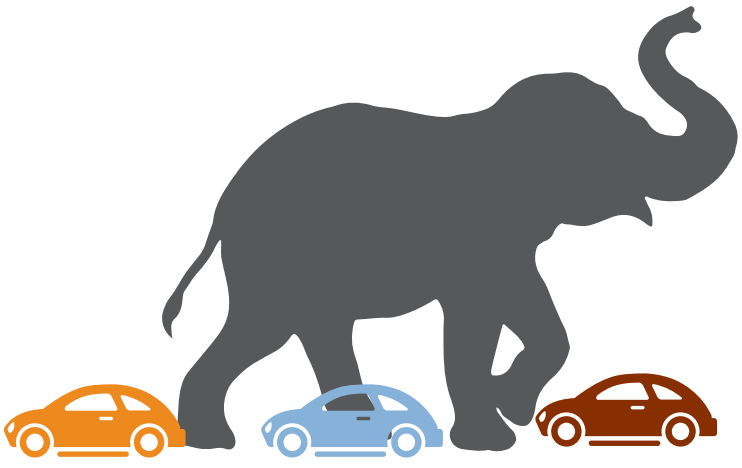


- **Electrical infrastructure.** In order to connect the CHP to the grid, you will need to confirm with the District Network Operator (DNO) that the local electricity network can support the connection. Furthermore, legal requirements, such as the safe disconnection of the CHP unit in the event of a power cut, must be met. Obtain an estimate for the connection cost.



DO NOT OVERSIZE

If a CHP plant is too large, it will run inefficiently and potentially lose you money, instead of saving it. It can be easy to overestimate the CHP capacity necessary to meet a heat demand. However, if a CHP unit is undersized, cost and carbon savings may not reach expectations. Great care needs to be taken and guidance sought from experienced CHP suppliers.



Design

The design of the CHP unit is a key process that must include a multitude of players in order for an effective and lasting project. The section is split between the technical aspects of CHP design and the commercial.

Commercial

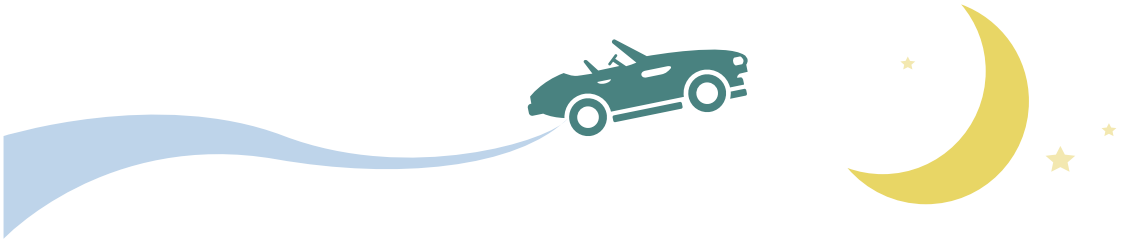
INVOLVE ALL POTENTIAL PLAYERS

Too often, developments are designed and installed before the specification is written. Allocate early in the project the responsibilities for the design, installation, operation and maintenance of the CHP unit. Only then can the proper specification be made.

TENDER AN OPERATION AND MAINTENANCE AGREEMENT

Over its lifetime, a CHP engine will drive the equivalent to the moon and back. Twice. Without good-quality maintenance, your CHP engine will be less reliable, stealing value from your investment and denting the reputation of the supplier.

Tender and buy an O&M contract at the same time as the installation. The supplier will understand the design and be incentivised to reduce maintenance through proper installation.



CREATE A HANDOVER STRATEGY

A coherent handover strategy that is embedded in the O&M contract is vital to the continued use of the CHP unit by any future users. If no handover strategy is created, there is a greater risk of the CHP being operated sub-optimally and the reputation of the supplier damaged.

Users, or energy or building managers, should be able to access and analyse pervious performance records to ensure they are receiving an efficient and effective energy supply and so that can see if changes in operation are needed.

Technical

CONNECTING TO THE ELECTRICITY NETWORK

In order to connect your CHP plant to one of the UK's electricity distribution networks, you must apply to the local Distribution Network Operator (DNO) by following the G59 connection procedure.

This connection procedure applies to generation installations that are either rated above 16A (3.68kW) per phase or that do not meet the requirements of the current version of the Energy Networks Association (ENA) document ***Engineering Recommendation G83/2.***[2]

- Where the G59 connection procedure applies, the generation and the installation must comply with ***ENA G59/3.***
- As approval from the DNO can take several months, it is advisable to start these discussions as soon as possible.

BUILDING AND EMISSION REGULATIONS

A new CHP unit may need to meet ***Part L of the Building Regulations.***

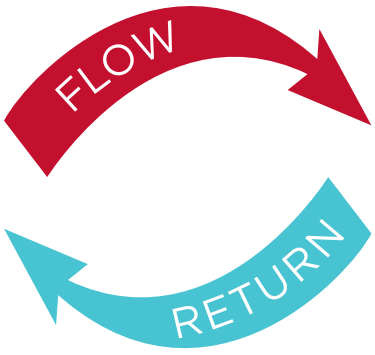
A CHP unit below 45kWe does not need planning permission as a 'permitted development' if:

- It is the first installed CHP unit
- The flue is not greater than 1 meter in height, or the height of an existing flue being replaced
- The building is not listed or scheduled monuments

CHP below 20MWth do not need to meet national emissions requirements, but you should understand Local Authority Air Quality requirements, as abatement technologies for NOx and other emissions may be necessary.

LOW TEMPERATURES KEY TO EFFICIENCY

When operating a CHP on a communal heating scheme, one of the most important design features for efficient operation is the low return water temperature. Modern energy efficient systems should be designed with as big a temperature difference (delta T) between flow and return as possible. This large delta T can only be achieved with the design of a variable volume system, with proper temperature and pressure controls. Designers/installers should consult the CHP supplier in order to ensure that flow and return temperatures are matched to different manufacturers' requirements.



[2] There can be type-tested sub-50kW units, as outlined in G59/3.

CHP SHOULD OPERATE IN PREFERENCE TO BOILERS

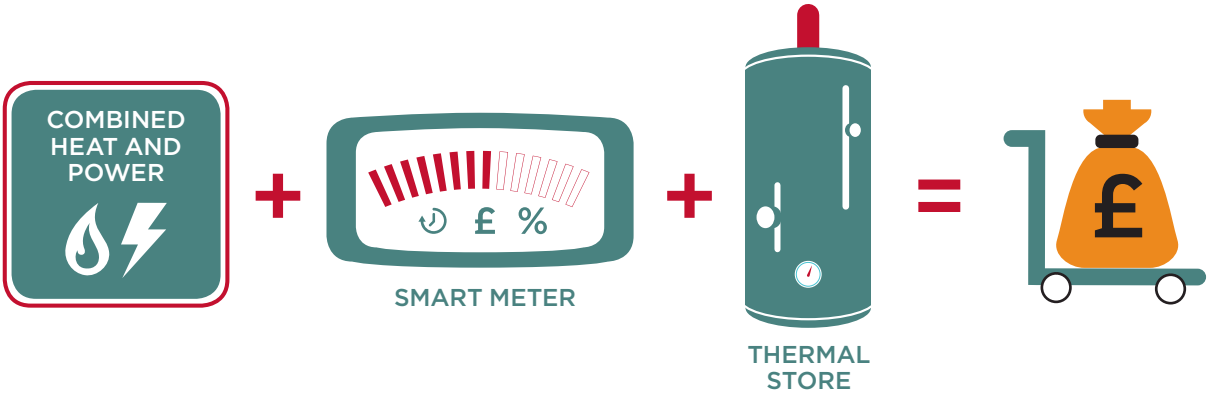
CHP should operate as lead heat generator (ahead of boilers) at all times in order to ensure you are relying on its higher efficiency. Having the CHP as lead will lead to higher gas costs, but lower electricity costs.

THERMAL STORAGE PROVIDES POTENTIAL VALUE

Thermal storage can potentially increase the amount of savings from a CHP. Thermal stores allow a CHP to continue generating consistently, providing an efficiency benefit, even at times of low heat demand. Thermal stores can also allow a CHP to generate electricity when electricity prices are high, or when responding to market services like the Short Term Operating Reserve (STOR), even if heat demand is low, as excess heat can be stored for later use.

METERING

The metering and sub-metering of all heat and electrical generation and fuel will enable the building owners/operators to analyse the efficiency and value of the CHP, and ensure that the site is built to deliver expected cost and carbon savings. Metering and sub metering is also essential for CHPQA compliance.



Specification and Purchase

REPUTABLE SUPPLIERS REDUCE RISK

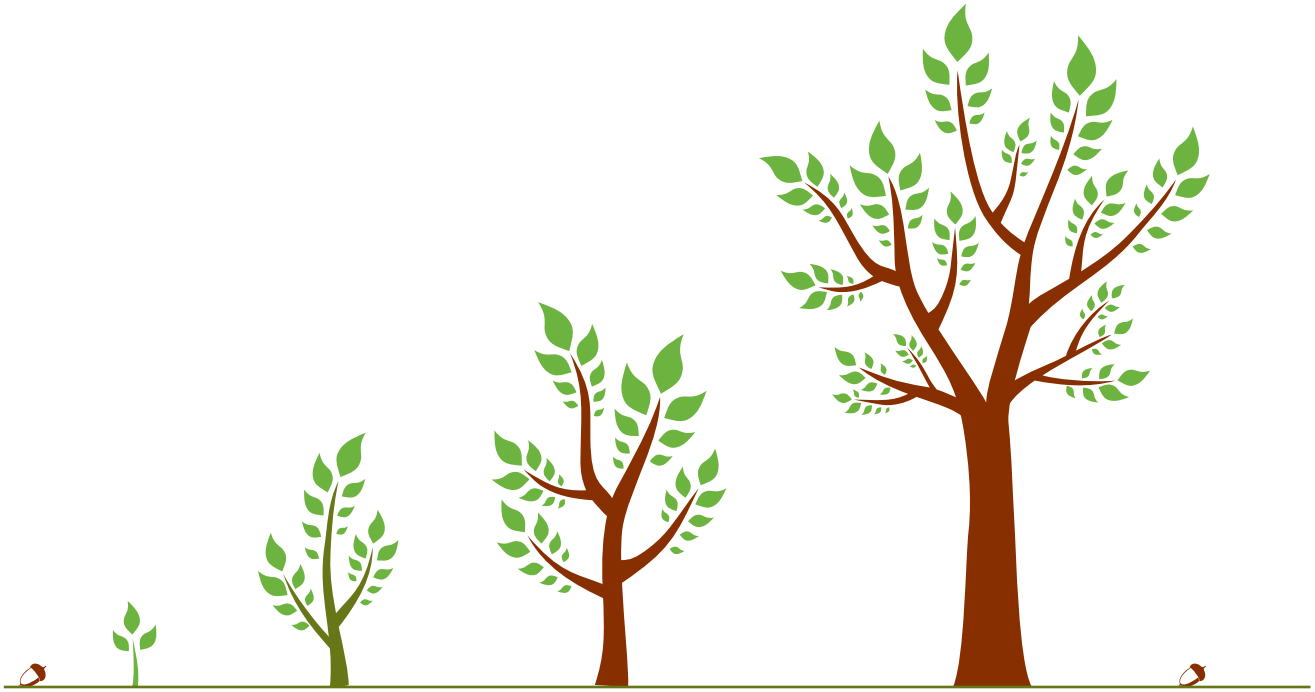
If not designed, installed and operated correctly, CHP systems can underperform, so look for a supplier with a good track record, and that provides long-term operation and maintenance contracts.

- Be wary of specifications prepared by anyone who does not own, operate or maintain CHPs.
- The Association for Decentralised Energy provides a ***list of member companies*** that are well-recognised within the industry.

LIFE-CYCLE COST VS. CAPITAL COST

The cheapest capital cost to supply and install the CHP solution identified during the procurement process will not necessarily be the cheapest to run over a period of time, as it may have higher maintenance costs.

- Consideration should always be given to both the capital costs and the overall long term life-cycle costing of a project as these have the greatest impact on the Internal Rate of Return (IRR).
- Maintaining the efficiency of CHP through regular servicing will prolong the value over its lifetime - an extra couple of percentage points of electrical and heat efficiency will make a big difference over the years.



Installation and Commissioning

CHP should be installed and commissioned by the manufacturer or supplier of the CHP unit and arrangements made for CHP user training for onsite maintenance staff/energy managers.

CHP MANAGEMENT

There may be an opportunity to upgrade the system in order to integrate CHP into the existing plant control system. You should assess the feasibility of integrating the cogeneration system with your existing controls.

- Modern CHP systems can include enough energy management capacity to look after additional plant and building operation.
- If you do not currently have a Building Energy Management System (BEMS), CHP could solve two problems at once.

CHP QUALITY ASSURANCE (CHPQA) PROGRAMME

Certifying the inputs and outputs from your CHP as 'Good Quality' through CHPQA is how Government determines eligibility for a range of tax reliefs and other financial benefits. The supporting documentation found on the CHPQA ***website*** is extensive and can appear daunting to the newcomer. The CHPQA provides a simpler, more accessible ***guide*** to the CHPQA programme to help smaller users.

TESTING

The CHP should be supplied, or handed, over with a performance test sheet showing that it meets the performance requirements of the original specification. Factory acceptance tests (FATS) are not usual for this size and type of equipment.

Operation

INVEST IN PEOPLE

Even with an operation and maintenance contract, it is important that key staff members are educated about the operation and benefits of the CHP plant, so they make the best use of the investment. There are risks that without that understanding, building or energy managers will change the CHP plant's operation, reducing value from the investment.

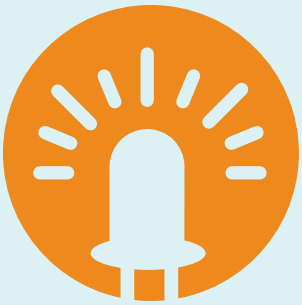
DO NOT OVER-INCREASE BOILER TEMPERATURE

Often in response to low outdoor temperatures, managers will increase boiler temperature above the designed or acceptable values. This can result in the water returning back to the CHP at too high a temperature, causing the CHP to shut down to prevent overheating. The result is that the CHP does not operate and the expected efficiency savings do not materialise.

MONITOR CHP PERFORMANCE

The operation of the CHP unit should be continuously monitored, likely remotely, as part of the operation contract. The end user should be provided with clear information on the performance of the unit.

The CHP unit should be serviced accordingly to the manufacturer schedule. The low temperature hot water system should be flushed periodically to remove any debris in the system as this has a very negative influence on the plate heat exchanger efficiency.



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More information

The ADE welcomes the opportunity to work with prospective contractors, consultants and customers and hopes this guidance document provides a clear and accessible document to all. Please do not hesitate to get in contact should you have queries or comments regarding the process of installing and operating a CHP unit.

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