



Department for  
Business, Energy  
& Industrial Strategy



## Energy Technology List

# Boilers: **controls and heat recovery**

A guide to energy efficient equipment listed on the Energy Technology List (ETL)



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# Introduction



## Energy Technology List

The ETL is a government register of energy saving products. When you select products from the list you are choosing from amongst the most energy efficient products in the marketplace.

When replacing equipment, businesses are often tempted to opt for equipment with the lowest capital cost. However, such immediate cost savings may prove to be a false economy. Considering higher energy efficient products, means that life cycle costs are reduced, improving cash flow in the longer term.

Businesses can also claim accelerated tax relief through the Annual Investment Allowance (AIA) for investments in plant and machinery equipment. The AIA has been temporarily increased to £1 million from January 2019.

**This leaflet illustrates the benefits of investing in energy saving boilers which qualifies for the ETL.**

The ETL comprises two lists:

- **Energy Technology Criteria List:** defines the performance criteria that equipment must meet to qualify for the ETL;
- **Energy Technology Product List:** is the list of products that have been assessed as being compliant with ETL criteria.

Eligible boiler products on the ETL can be searched at:

[https://etl.beis.gov.uk/engetl/fox/live/ETL\\_PUBLIC\\_PRODUCT\\_SEARCH](https://etl.beis.gov.uk/engetl/fox/live/ETL_PUBLIC_PRODUCT_SEARCH)



# Setting the scene – controls

Boilers themselves are also available on the ETL, for further information see the 'Boilers' technology information leaflet.

## Definition

The Energy Technology List offers three different types of controls for boiler systems. These are aimed at ensuring boilers operate at their most efficient level, and produce heat only when and where it is needed.

- **Burners with Controls:**

Burners with Controls covers products that are specifically designed to create and burn air and fuel mixtures in a safe, efficient and controlled manner, and to direct the heat released through combustion into a pressurised vessel (or other combustion chamber).

- **Heating Management Controllers (for wet heating systems):**

Heating management controllers (for wet heating systems) are products that are specifically designed to control heat generation and distribution within a wet heating system in an energy efficient manner that reflects weather conditions, occupation schedules and user requirements.

- **Retrofit Burner Control Systems:**

Retrofit burner control systems are products that are specifically designed to automatically control, in an energy efficient manner, the operation of industrial and commercial burners, and the matching of burner heat production with heat demand.



# Setting the scene – heat recovery

## Definition

The Energy Technology List offers three different types of heat recovery for boiler systems. These are aimed at ensuring boilers operate at their most efficient level, and produce heat only when and where it is needed.

- **Condensing Economisers:**  
Condensing Economisers are products specifically designed to improve boiler net thermal efficiency by recovering both sensible and latent heat from boiler flue gases.
- **Flue-gas Economisers:**  
Flue Gas Economisers are products that are specifically designed to improve boiler net thermal efficiency by recovering sensible heat from boiler flue gases.
- **Heat Recovery from Condensate and Boiler Blowdown:**  
Heat recovery from condensate and boiler blowdown covers products that are specifically designed to recover heat from steam condensate and / or water from boiler blowdown, by means of heat exchangers and/or flash steam recovery vessels.



# Setting the scene

## Assumptions

ETL listed boilers must meet defined energy efficiency levels under various load conditions. In this document, the baseline scenario below has been used to calculate the potential financial (£), energy (kWh) and carbon savings (tonnes CO<sub>2</sub>) unless otherwise indicated:

- Boilers operate at full load for 4,000 hours a year unless stated otherwise
- Price for gas is 2.6p/kWh
- Carbon emissions for gas is 0.18416 kgCO<sub>2</sub>/kWh
- Price for gas oil is 4.8p/kWh
- Carbon emissions for gas oil is 0.27588 kgCO<sub>2</sub>/kWh
- Boiler efficiency assumed to be 80% unless otherwise stated
- ETL listed products are presumed to be in the top 25% of energy efficient products available in the marketplace

Energy cost and emissions data from BEIS 2017





# Products on the Energy Technology List: Burners with Controls



## Burners with Controls

Burners with controls are used to provide heat for hot water, steam and thermal oil boilers, heaters and processes. They are widely used in industry and commerce. A wide range of burners are available, and these are fitted with combustion controls that offer different levels of precision and repeatability of control. Mounted on a furnace, a burner combines air, fuel and ignition energy in the right proportion and admits the fuel-air mixture into the furnace, where the combustion reaction takes place. A burner has three main functions:

1. Flame stability
2. Air-fuel mixing
3. Emission control

A selected range of burner systems designed to recover combustion exhaust gas heat are also available. The Energy Technology List aims to encourage the purchase of products that are able to accurately control combustion and maintain their efficiency over a specified turn down range. Eight different categories of burners with controls are covered, and products that are designed to use liquid or gaseous biofuels are also covered by these categories.

Both recuperative and regenerative burners are covered; recuperative burners use flue gasses to preheat combustion air through a heat exchanger, regenerative burners fire only half their burners at a time and their flue gasses heat a material of high thermal density which can then pre-heat combustion air for the next set of burners.

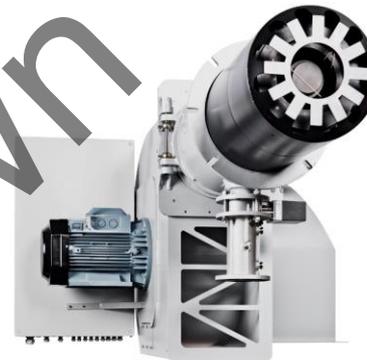


# Products on the Energy Technology List: Burners with Controls

## Burners with Controls

It is crucial to ensure accurate control of the amounts of fuel and air passing through a burner, to ensure complete combustion whilst minimising the energy used heating air. Burners combust boiler fuel to generate heat. Burners and their control systems can have a major impact on overall boiler efficiency.

The level of improvement that can be achieved by upgrading burners depends on the age and design of the boiler system. Fuel savings of 3%-5% may result from upgrading to burners whose heat output is modulated to ensure that it matches the heat demand. The benefits are greatest in applications where the output needs to be frequently adjusted to meet variations in demand.



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Installing ETL compliant burners with controls to two gas fired boilers with a total capacity of 2MW, efficiency of 84% and that run for 8,000 hours per year offer potential annual savings of:

- £11,400
- 440,000 kWh
- 81 tonnes CO<sub>2</sub>

With a typical capital cost of £20,000, lifetime energy and AIA benefits could be around £115,000 at today's prices. With a potential AIA of £3,800 and energy savings of approximately £11,400 in year 1, the extra capital cost is recovered in less than 1 year of purchase.

\* Burners with controls typically result in a 4% energy saving. Assume boiler load factor of 60%.



# Products on the Energy Technology List: Heating Management Controllers



## Heating Management Controllers

Heating management controllers (for wet heating systems) realise fuel savings by adapting boiler firing and heat distribution patterns to match variations in heat demand and user requirements.

A wide range of heating management controls are available for wet heating systems including products designed to control space heating within both zoned and un-zoned buildings. The Energy Technology List aims to encourage the purchase of products that automatically adapt to changes in weather conditions, and thermal response time of the building and/or heating system.

The ETL covers three categories of product:

- **Standalone units** are self-contained control units that are designed to directly control the operation of, and to be directly connected to, the external control inputs of the boilers/burners, pumps and control valves in a wet heating system.
- **'Add-on' modules** are designed to be incorporated into other control systems, and to either directly, or indirectly, control the operation of wet heating systems.
- **Packaged products** consist of two or more control modules or units that are designed to be connected together during installation, and to either directly, or indirectly, control the operation of wet heating systems.



# Products on the Energy Technology List: Heating Management Controllers



## Key Features

Some of the key energy saving features that can be used to manage wet heating systems include:

- Temperature control to +/-0.5°C.
- Time scheduling
  - 7 day with 2 switching periods per day
  - Holiday programme
- Optimum start
  - Automatically vary switch-on time with ambient conditions with self-learning / tuning algorithm
- Weather compensation
  - Automatically vary wet heating temperature with outside temperature, with self – adjusting algorithm
- Override control
  - Limits use of temperature or time override
  - Night setback option with automatic reset.
  - Frost & fabric protection
- Interlocks & inhibit mechanisms
  - Used to prevent simultaneous heating & cooling
- Access control (anti- tampering)
  - Prevents unauthorised parameter adjustment



# Products on the Energy Technology List: Heating Management Controllers

## Target market and future development

Installing heating management controllers needn't mean that an entire heating system or boiler be replaced; any building with a wet heating system or other heating equipment can benefit. Controls are thus ideally suited to small and medium sized commercial and industrial premises (up to 1000m<sup>2</sup>), including: offices, factories, shops & pubs, residential care homes, healthcare premises, small schools, or fire stations. These premises can be divided into zones (if over 150m<sup>2</sup>) or one single zone.

The key energy saving features of the products have not changed, but suppliers have invested heavily in adding new user friendly interfaces, and remote monitoring and control facilities. Key technological changes include:

- High visibility graphic displays
- Remote internet access
- Access from mobile devices
- Use of wireless networks to reduce installation costs (particularly sensors)

Increased functionality includes:

- Control of other types of heating equipment (e.g. electrical water heaters used in summer mode)
- Built-in energy metering
- Text messages to managers when override activated



# Products on the Energy Technology List: Heating Management Controllers

## Heating Management Controllers

Heating management controllers reduce fuel consumption by adapting boiler firing and heat distribution patterns to match variations in heat demand. They shut off boilers during pre-set periods of no demand, and respond to changing weather conditions by providing heat when needed to protect from frost, and by adjusting the starting time to the minimum needed to reach the required temperature in time for use.

They are available either as standalone units for direct control of boilers, burners and other wet heating system components, or as add-ons for incorporation into other control systems. The energy savings available depend on the functionality, configuration and set-up of any existing system.

Potential annual savings from adding an ETL listed heat management controller to a 450kW (three 150kW boilers) heating system operating for 3,000 hours per year at an average of 60% load where a 10% fuel saving is achieved:

- £2,900
- 113,000 kWh
- 20.7 tonnes CO<sub>2</sub>

With a typical additional capital cost of £6,000 and lifetime energy and AIA benefits of around £30,000 at today's prices, the financial benefit of choosing an ETL listed product is over 5 times the additional cost. Furthermore with a potential AIA of approximately £1,140 in year 1 plus additional energy savings, the extra capital cost is recovered within 2 years of purchase.

\* Typical cost of ETL compliant unit is £9,000



# Products on the Energy Technology List: Retrofit Burner Control Systems



## Retrofit Burner Control Systems

Burners are used to provide heat for hot water, steam and thermal oil boilers, heaters and processes. They are widely used in industry and commerce. Traditionally, adjustable cams and mechanical linkages have been used to control the fuel valves and air dampers that modulate burner heat output. These mechanisms are susceptible to mechanical wear and hysteresis, and are progressively being replaced by more accurate burner control systems.

A range of retrofit burner control systems is available, and these offer different levels of precision and repeatability of control. The Energy Technology List aims to encourage the purchase of microprocessor based products that are able to accurately control combustion and maintain burner efficiency over a specified turn down range.

As installers assemble retrofit burner control systems on site from standard components from different manufacturers, reflecting the specific requirements of the installation, only the retrofit control units are listed on the Energy Technology List.



# Products on the Energy Technology List: Retrofit Burner Control Systems

## Retrofit Burner Control Systems

It is crucial to ensure accurate control of the amounts of fuel and air passing through a burner, to ensure complete combustion whilst minimising the energy used heating air. Burners combust fuel to generate heat, and their control systems can have a major impact on overall boiler / oven / furnace efficiency.

Microprocessor-based burner control systems offer precise and reproducible control of the fuel and air flows. These can be retrofitted to existing burners to improve fuel efficiency. Savings are achieved through reducing the excess oxygen level in the flue gas, and depend on the quality of the controls replaced. For example, a 3.5% reduction in the flue gas oxygen level can improve efficiency by around 2%. Although this is lower than the improvements that may be available from complete burner replacement, the improvement in efficiency that can be achieved means that this is still an attractive option.



# Products on the Energy Technology List: Condensing Economisers

## Condensing Economisers

Economiser plant is used in a wide range of industrial and commercial applications, and are used in applications where lower grade heat is required or with hot water boilers with low return temperatures (<60°C). These could include a range of commercial, public sector or industrial, applications:

- Industrial sites with low grade heat demand/large quantities of make up water in steam systems (no condensate recovery);
- Leisure facilities with swimming pools
- Boiler applications providing space heating.

Fitting an economiser to a boiler can increase the net efficiency by 9% across different boiler output ratings. Condensing economisers are able to recover more heat by recovering both sensible heat and latent heat of evaporation, cooling flue gases below the dew point. This heat is normally used to preheat the boiler's feed water and to supply low grade heating requirements. The materials of construction ensure that the economiser is resistant to acid gas corrosion.

However, condensing economisers are typically more expensive than flue-gas economisers (see next slide). There are a range of product designs available.

These vary in configuration, from horizontal to vertical configurations. Technology is scalable and can be incorporated into a wide range of system sizes.

**Potential annual savings from installing an ETL listed condensing economiser to a 1MW gas-fired steam boiler operating for 3,000 hours per year at an average of 65% load where an 13% energy saving is achieved:**

- £6,800
- 263 MWh
- 48.6 tonnes CO<sub>2</sub>

**With a typical capital cost of £28,000, lifetime energy and AIA benefits could be around £74,000 at today's prices. With a potential AIA of £5,300 and energy savings of approximately £6,800 in year 1, the extra capital cost is recovered within less than 4 years of purchase.**



# Products on the Energy Technology List: Flue-Gas Economisers

## Flue-Gas Economisers

Flue gas economisers recover heat from the boiler flue gases before they are released to the atmosphere. This allows the heat to be recycled, and raises boiler system efficiency. Installing a specified energy saving ETL flue gas economiser can provide fuel savings of more than 3%.

Flue gas economisers are more likely to be deployed where higher temperature heat recovery is required such as steam boilers (and pre-heat of condensate return), in applications: food manufacturing, chemical industries, oil refineries, paper industry, laundries, hospitals and prisons.

Flue gas economisers are a type of heat exchanger that enables some of the sensible heat in boiler flue gases to be recovered. This heat is normally used to preheat the boiler's feed water. Typically a flue gas economiser will increase boiler net thermal efficiency (expressed in percentage terms) by at least 3 points (i.e. a boiler with efficiency of 89.0% is improved to at least 92.0%).

Potential annual savings from installing an ETL listed flue gas economiser to a 5MW gas-fired steam boiler operating for 3,000 hours per year at an average of 65% load where a 4% energy saving is achieved:

- £12,000
- 468 MWh
- 86 tonnes CO<sub>2</sub>

With a typical capital cost of £30,000, lifetime energy and AIA benefits could be around £127,000 at today's prices. With a potential AIA of £5,700 and energy savings of approximately £12,000 in year 1, the extra capital cost is recovered in less than 3 years of purchase.



# Products on the Energy Technology List: Heat Recovery from Condensate and Boiler Blowdown

## Heat Recovery from Condensate and Boiler Blowdown

To ensure that a steam boiler continues to operate efficiently, the level of total dissolved solids (TDS) in the boiler water must be controlled by draining off a portion of the water (known as 'blowdown water'). The 'blowdown water' from both boiler blowdown water and condensate contain significant amounts of heat, which can be recovered and recycled to heat boiler feedwater and supply low-grade heating requirements.

The rationale for including this type of heat recovery equipment on the ETL is that they offer a means of significantly improving the efficiency of steam boiler systems by 3-4% (heat recovery from blowdown) and 10% (heat recovery by condensate). It is a well established technology, that uses proven designs which, in general, remains unchanged apart from minor refinements.

The ETL encourages the purchase of heat recovery equipment that is specifically designed to recover heat from steam condensate and/or water from boiler blowdown.

The ETL covers three categories of product:

- Flash steam recovery vessels or packages with associated control and safety devices
- Heat exchanger units or packages with associated control and safety devices
- Flash steam vessel with heat exchanger packages with associated control and safety devices



# Products on the Energy Technology List: Heat Recovery from Condensate and Boiler Blowdown



## Heat Recovery from Condensate and Boiler Blowdown

Water from both boiler blowdown and condensate contain significant amounts of heat, which can be recovered and recycled to heat boiler feed water and supply low-grade heating requirements.

The condensate resulting from condensed steam typically contains 15% of the heat originally used to generate the steam. Condensate pumping equipment enables condensate, containing useful heat, to be returned effectively to the boiler house for re-use. Most steam systems include some level of condensate recovery. The additional benefit from installing condensate pumping equipment depends on the amount of condensate that could be recovered and reused to heat the boiler's feed water.

Two techniques are used to recover heat from boiler blowdown water and condensate:

- Flash steam vessels can be used to separate 'flash steam' which forms at points where boiler pressure is reduced. This can then be used to fulfil low-grade heating requirements. Typically, around 10% of condensate can be lost as flash steam. Recovering 80% of flash steam would lead to a fuel saving of around 2%.
- Heat exchangers can be used to transfer heat from boiler blowdown water or condensate to a clean water stream for further use. Heat recovery from boiler blowdown is most effective where there is a continuous water flow, such as that resulting from the use of automatic boiler blowdown control equipment. ETL heat exchangers typically have an efficiency of at least 85%, therefore application to the total condensate produced could save up to 8% of fuel.



## Where can I find more information?

### Energy Technology List



For information about the ETL please visit: <https://www.gov.uk/guidance/energy-technology-list> and see our [Information for Purchasers](#) factsheet. Or contact the ETL Help Line on 0300 330 0657; email [ETLQuestions@carbontrust.com](mailto:ETLQuestions@carbontrust.com)



To search for a product on the ETL please visit:  
[https://etl.beis.gov.uk/engetl/fox/live/ETL\\_PUBLIC\\_PRODUCT\\_SEARCH](https://etl.beis.gov.uk/engetl/fox/live/ETL_PUBLIC_PRODUCT_SEARCH)



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