



**Quality Assurance for Combined Heat and Power**

## **The CHPQA Standard**

**Issue 7**

**December 2018**

Prepared by CHPQA on behalf of the Department for Business, Energy and Industrial Strategy.

*Product code [00EP0798]  
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First Published August 2000*

Prepared by CHPQA on behalf of the Department for Business, Energy and Industrial Strategy.

This document can be downloaded from:

<https://www.gov.uk/combined-heat-power-quality-assurance-programme>

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# CITATION AND APPLICABILITY

This Document may be cited as 'The CHPQA Standard Issue 7'. It has been prepared for the Department for Business, Energy and Industrial Strategy (BEIS), which is the custodian of the document.

Assessment, Registration and Certification under CHPQA shall be available to Schemes in the whole of the United Kingdom (UK) of Great Britain and Northern Ireland.

This latest Issue of the CHPQA Standard (Issue 7) replaces Issue 6. Having reviewed responses to the Call for Evidence<sup>1</sup>, the results of analysis and reviewed performance across Europe, the government is concerned that the energy efficiency requirements set out in Issue 6 of Guidance Note 44 (GN44) are no longer sufficient to ensure that only good quality CHP receives CfD support. In response to this, there was a government consultation and response to proposed amendments to the Contracts for Difference (CfD) scheme<sup>2</sup>. The changes have resulted in the overall efficiency, of dedicated biomass with combined heat and power (CHP) and energy from waste with CHP schemes, required to qualify for a CfD being increased in the third allocation round. As a result, a revised version of Guidance Note 44 (GN44) has been Issued (Issue 7) to which the Standard refers. In this update of the Standard (Issue 7) these references are updated but with no changes to the Standard formulae.

Issue 7 of the CHPQA Standard applies to any CHP schemes in respect of which a CfD contract is entered into on or after the publication of Issue 7 of GN44.

The various QI formulae set out in this CHPQA Standard Issue 7 and the means by which those formulae are to be applied are subject to any amendments or revisions necessary to assist the United Kingdom in complying with any obligation arising under or in connection with European law.

Note that, as further described below, GN44 Issue 7 contains a set of QI formulae which are separate from the CHPQA Standard Issue 7 QI formulae at Table 1 below and which are relevant to the RO and CfD schemes.

GN44 Issue 7 contains detailed guidance as to how and when the GN44 Issue 7 QI formulae will be applied in respect of the RO and CfD.

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<sup>1</sup> Call for Evidence – Contracts for Difference: A call for evidence on fuelled and geothermal technologies in the Contracts for Difference (CfD scheme), November 2016, found on Gov.UK

<sup>2</sup> Contracts for Difference for renewable electricity generation: Consultation on proposed amendments to the scheme, December 2017, found on Gov.UK

# **GRANDFATHERING ARRANGEMENTS**

## **Existing Schemes**

Existing Schemes that received an F3 or an F4 CHPQA certificate prior to 1 January 2016 will continue to receive CHPQA certification on the basis of the CHPQA Standard QI formulae under which they were previously certified.

## **New Schemes**

The CHPQA Standard Issue 6 QI formulae (Table 1, pages 17-18) applies to all new Schemes which did not receive an F3 or an F4 certificate prior to 1 January 2016, with the exception of any scheme in respect of which a CfD contract is entered into on or after the publication of Issue 7 of Guidance Note 44, in which case Issue 7 applies.

## **Existing Scheme upgrades and expansions**

A Scheme that is already in operation and has been certified by CHPQA will continue to be certified based on its existing QI formula, where it is upgraded or expanded under one of the following scenarios:

- The existing prime mover is replaced with a new prime mover with the same capacity.
- The existing prime mover is replaced with a new larger prime mover.
- A new prime mover is added to the existing Scheme, becoming an integral part of the existing Scheme.
- Other plant improvements, such as the installation of additional heat recovery equipment, that upgrade the Scheme.

## **Existing Scheme replacements**

Where such an existing certified Scheme is completely replaced, it will be treated as a new CHP Scheme and the CHPQA Standard Issue 7 QI formulae (Table 1) will apply.

## **Guidance Note 44**

GN44 Issue 7 contains a set of QI formulae, which are separate from the CHPQA Standard Issue 7 QI formulae at Table 1 below, and which are relevant to the RO and CfD schemes.

GN44 Issue 7 contains detailed guidance as to how and when the replacement GN44 Issue 7 QI formulae will be applied.

GN44 Issue 7 provides that, notwithstanding the grandfathering arrangements described above, any GN44 certificate issued in connection with any 'with CHP' CfD contract entered into on or after the publication of GN44 Issue 7 will be issued using the GN44 Issue 7 QI formulae.

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# 1 SCOPE

The Combined Heat and Power Quality Assurance programme (CHPQA) is a government initiative that assesses the quality of CHP in the UK, to ensure that entitlements to fiscal and other benefits are commensurate with, and incentivise, the energy efficient performance of CHP Schemes. This is in line with the requirements of the EU Directive 2012/27/EU on Energy Efficiency (the EED), and UK policy to only provide support to energy efficient CHP Schemes.

This Standard sets out definitions, criteria and methodologies for the operation of CHPQA. It should be read in conjunction with the supporting CHPQA Guidance Notes, which provide detailed information on how this Standard will be interpreted by the Administrator, BEIS and other government departments and agencies, as well as guidance on compliance with this Standard.

It is the intention that this Standard should be subject to minimum change; developments in the application of the Standard will, whenever possible, be reflected in changes in the CHPQA Guidance Notes.

This Standard does not address issues relating to the use of CHPQA for determining eligibility for particular fiscal benefits or incentives. For these matters, reference should be made to the CHPQA Guidance Notes and, where necessary, the appropriate government department or agency.

# 2 PURPOSE AND AIMS

CHP can make significant fuel, cost and emissions savings over conventional, separate forms of power generation and heat-only boilers. The generation and supply of electricity from power stations is generally at an efficiency in the range 25-50%, based on the Gross Calorific Value (GCV) of the fuel and including transmission and distribution losses. This means that 50-75% of the energy content of the fuel is not usefully employed. This unused energy is rejected as heat directly to the atmosphere or into seas or rivers. The generation of electricity and the recovery of heat in CHP Schemes typically achieves overall efficiencies of 60-80%, and sometimes more.

Unlike conventional methods of electricity generation, some of the heat cogenerated in a CHP Scheme is put to good use, typically for industrial processes or for space heating and hot water in buildings. The heat used in this way displaces heat that would otherwise have to be supplied by burning additional fuel, and so leads directly to a reduction in emissions. The deployment of CHP is a particularly cost-effective approach for reducing CO<sub>2</sub> emissions and therefore plays an important role in tackling climate change.

The aims of CHPQA are to:

- Define, assess and monitor the quality of CHP Schemes based on energy efficiency and environmental performance.
- Ensure fiscal and other benefits available to CHP Schemes are in line with environmental performance.

- Provide clear signals to users and potential users of the scope to reduce the costs of satisfying energy requirements through the use of CHP.
- Achieve the above at minimum cost to CHP users and to government.

### **3 USES FOR CHPQA**

CHPQA provides the following:

- A methodology for assessing the quality of CHP Schemes, and their qualification as Good Quality CHP for all or part of their inputs, outputs and capacity.
- A programme whereby Responsible Persons can apply for the Registration and Certification of their Schemes in accordance with the criteria for Good Quality CHP and hence qualify for benefits. Application to the CHPQA programme is voluntary.
- A programme that provides a robust methodology for calculating primary energy savings from CHP and is used to determine the eligibility of Schemes for fiscal and other benefits.

Certification issued under the CHPQA programme may be used for determining the eligibility of Schemes for fiscal or other benefits and for determining compliance of Schemes with regulatory requirements where quality is relevant to entitlement.

For CHPQA to be consistent with the Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency (the Directive), Good Quality CHP (GQCHP) Schemes with a total installed capacity of:

- < 1MWe, must provide > 0% primary energy savings compared with the EU's harmonised reference values for the separate production of heat and electricity;
- $\geq$  1MWe, must provide  $\geq$  10% primary energy savings compared with the EU's harmonised reference values for the separate production of heat and electricity;
- > 25MWe, must have an overall efficiency of  $\geq$ 70% (based on Net Calorific Value).

These criteria have been accommodated within the CHPQA framework through the development of a specific set of CHPQA QI formula, detailed in Table 1 (pages 17-18).

## 4 INTERPRETATION

**Administrator** is that body contracted by the government to have responsibility for the management of the CHPQA programme.

**Alternative Fuels** are fuels other than Conventional Fuels and they fall into broad categories for the purposes of CHPQA (see Table 1).

**Annual Operation (AO)** represents the calendar year when the Scheme is in operation; the period from 1 January to 31 December inclusive. For new Schemes, in the first year of operation, this should be from the date of commencing to supply heat to user(s) to 31 December of that year.

**Audit** is any activity carried out by the Administrator to confirm compliance with this Standard. It typically includes a site-based evaluation of the operation of a CHP Scheme to confirm that the Self-Assessment is founded on a correct interpretation of the CHPQA Standard and that the data and calculations submitted are corroborated by site data records.

**BEIS** is the Department for Business, Energy and Industrial Strategy, which is the government department responsible for CHPQA.

**Certification** is the issuing by the Administrator of a certificate that a Scheme meets the criteria for Good Quality for all or part of its energy inputs, outputs and capacity, based on Validation of Self-Assessment submitted by a Responsible Person.

**CHP (Combined Heat and Power)** is defined as the simultaneous generation of heat and power in a single process. The power output is usually electricity but may include mechanical power. Heat outputs can include steam, hot water or hot air for process heating, space heating or absorption chilling.

**CHPQA programme** is a management and administrative process under which Registration and Certification of CHP Schemes is being taken forward. It proceeds through the application for Registration and Self-Assessment of CHP Schemes by a Responsible Person to Certification in accordance with the criteria for Good Quality CHP. The Administrator will carry out Registration, Validation, Certification and Audit on behalf of the Secretary of State for Business, Energy and Industrial Strategy.

**CHP Scheme (Scheme)** means all the equipment, operating systems and monitoring systems for the total system defined to be within the Scheme boundary, being that to which CHPQA applies. This can be at any stage of development from design to actual operation. It will include one or more prime movers (e.g. gas turbine or reciprocating engine) driving electrical generator(s) or mechanical loads and some means of recovering waste heat, which would otherwise be released to the environment, for a useful purpose.

A Scheme can consist of a number of prime movers connected in series or in parallel. A gas turbine or a reciprocating engine operated in combined cycle mode, where the heat generated is used to produce steam that feeds into a steam turbine, would be an example of connection in series. An example of parallel connection is a number of gas



turbines with suitable heat recovery steam generators connected to a common steam system.

Where prime movers are connected in series, they shall be treated as part of a single Scheme. Where prime movers are connected in parallel, they may be treated as part of a single Scheme or as separate, individual Schemes. The decision on how to treat multiple prime movers in parallel rests with the Responsible Person making the application for Registration.

The Scheme boundary may be defined to include associated auxiliary or back-up boilers.

**CHP Qualifying Fuel Input ( $CHP_{QFI}$ )** is the registered annual fuel input to a CHP Scheme qualifying as input to Good Quality CHP (MWh), based on GCV. Most Schemes will meet the Threshold Power Efficiency Criterion for Good Quality CHP in Annual Operation and therefore  $CHP_{QFI}$  is the total annual fuel input ( $CHP_{TFI}$ ). For a Scheme that does not achieve the Threshold Power Efficiency Criterion for Good Quality CHP,  $CHP_{QFI}$  is that portion of the annual fuel input to a Scheme that would have achieved the Power Efficiency Criterion, based on the actual annual power generation ( $CHP_{TPO}$ ).

**CHP Qualifying Heat Capacity ( $CHP_{QHC}$ )** is the registered maximum heat supply capacity of a CHP Scheme ( $MW_{th}$ ). It is the maximum rate of heat supply demonstrably utilised to displace heat that would otherwise be supplied from other energy sources.

**CHP Qualifying Heat Output ( $CHP_{QHO}$ )** is the registered amount of useful heat supplied annually from a CHP Scheme ( $MW_{th}$ ). It is heat output that is demonstrably utilised to displace heat that would otherwise be supplied from other sources.

Note:  $CHP_{QHO}$  excludes any heat rejected to the environment without any beneficial use. Examples include, *inter alia*, heat lost from chimneys or exhausts and heat rejected in equipment such as condensers and radiators.

**CHP Qualifying Power Capacity ( $CHP_{QPC}$ )** is the registered power generation capacity of a CHP Scheme ( $MW_e$ ) that qualifies as Good Quality CHP. It is used for monitoring and statistical purposes regarding the installed capacity of Good Quality CHP in the UK.

Where a Scheme meets the relevant Threshold QI Criterion for Good Quality CHP Capacity,  $CHP_{QPC}$  equals the total power capacity ( $CHP_{TPC}$ ). For a Scheme that does not achieve the Threshold QI Criterion for Good Quality CHP,  $CHP_{QPC}$  is that portion of the total generation capacity that would achieve the Threshold QI Criterion, under the conditions of Maximum Heat Output under Normal Operating Conditions.

**CHP Qualifying Power Output ( $CHP_{QPO}$ )** is the registered annual power generation from a CHP Scheme ( $MW_e$ ) that either fully or partially qualifies as Good Quality CHP. For Schemes that meet the relevant Threshold QI Criterion for Good Quality CHP,  $CHP_{QPO}$  equals the total power output ( $CHP_{TPO}$ ). For a Scheme that does not achieve the Threshold QI Criterion for Good Quality CHP,  $CHP_{QPO}$  is that portion of the annual power output from a Scheme that would have achieved the Threshold QI Criterion, based on the qualifying heat supplied ( $CHP_{QHO}$ ).

**CHP Total Fuel Input (CHP<sub>TFI</sub>)** is the total registered annual fuel input to a CHP Scheme (MWh), based on GCV. This includes any fuel used for pilot burners or other 'parasitic' uses and fuels of all types whether Conventional or Alternative.

**CHP Total Power Capacity (CHP<sub>TPC</sub>)** is the registered maximum power generation capacity of the CHP Scheme (MW<sub>e</sub>), at the reference conditions defined in the CHPQA Guidance Notes. It defines the size of the Scheme for the purpose of selecting the appropriate Quality Index formula. Where there is more than one electrical generator in a Scheme, CHP<sub>TPC</sub> shall include the total electrical capacity of all generators that can run together, i.e. the actual maximum generation capacity. Where a Scheme includes mechanical power output, this shall be converted to an equivalent electrical power output and included in CHP<sub>TPC</sub>.

**CHP Total Power Output (CHP<sub>TPO</sub>)** is the total annual power generation from a CHP Scheme (MWh<sub>e</sub>), as measured at the generator terminals, plus the electrical equivalent of any qualifying mechanical power supplied by the Scheme.

**The CHPQA Unit List** is available at <https://www.gov.uk/combined-heat-power-quality-assurance-programme>. This details the performance of a number of CHP units, based on manufacturers' specifications, which meet the following criteria:

- CHP Total Power Capacity (CHP<sub>TPC</sub>) less than 500 kW<sub>e</sub>,
- No in-built facility to dump heat,
- Only includes a single prime mover,
- One main heat output system e.g. a single system recovering heat from the engine cooling systems, or/as well as exhaust gases in the case of a reciprocating engine.

This allows the gas consumption and/or heat output of CHP Schemes based on these units to be estimated.

For each unit, the list shows: Manufacturer; Model; Engine Type; Total Power Capacity (equivalent to instantaneous power output) and Qualifying Heat Capacity (equivalent to instantaneous heat output).

**Community Heating (CH)** is the centralised provision of heat to a number of residential, institutional, commercial, industrial or other sector buildings, premises, sites and users, typically for the purpose of providing hot water, space heating or cooling and can include the provision of process steam. CH Schemes may also provide heat users with associated electricity. Community Heating includes both of what are frequently referred to as district heating and communal heating.

**Conventional Fuels** are those described as taxable commodities under the Finance Act, 2000, Schedule 6, or oil as defined in the Hydrocarbon Oil Duties Act, 1979. See also Alternative Fuels.

**Directive** refers to Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency. This Directive repealed Directive 2004/8/EC on the promotion of cogeneration.

**F3 Certificate** is a certificate granted by CHPQA based on the technical design data of a proposed new CHP Scheme (which is at the final design stages or under construction)

or based on technical design data of an upgrade of the prime mover of an existing CHP Scheme. The F3 Certificate is based on design data provided to CHPQA in an F3 (or F3(s)) Form.

**F4 Certificate** is a certificate granted by CHPQA for Schemes that have any operational data and for new Schemes in the 1<sup>st</sup> year of operation have at least one month of operational data and reflects the actual performance of the Scheme. The purpose of the F4 certification is to ascertain the portions of inputs, outputs and capacity that qualify as Good Quality CHP. The F4 Certificate is based on operational data provided to CHPQA in an F4 (or F4(s)) Form.

**Gross Calorific Value (GCV)** of a fuel is the total energy available from that fuel (solid, liquid or gas) when it is completely burnt. It is expressed as heat per unit weight or volume of fuel. 'Gross' signifies that the water formed or liberated during combustion is condensed to the liquid phase. The GCV of a solid or liquid fuel is determined at constant volume and the GCV of a gaseous fuel is determined at constant pressure.

**Guidance Notes** provide detailed information on how this Standard will be interpreted by the Administrator, BEIS and other government departments and agencies, as well as guidance on compliance with this Standard.

**Guidance Note 44 (GN44)** is the CHPQA guidance document concerned with the use of CHPQA in respect of the RO and CfD. For the purposes of calculating the Quality Index for Renewables Obligation Certificates eligibility, GN44 values are used, rather than those in the CHPQA Standard. GN44 values are also used in place of those in the CHPQA Standard by the Contracts for Difference regime, where they are a factor in calculating the payments that CHP plants receive under the Contract.

**Heat Efficiency ( $\eta_{heat}$ )** is the qualifying heat output divided by the total fuel input over the period in question. Normally,  $\eta_{heat}$  is calculated over Annual Operation and is therefore  $CHP_{QHO}$  divided by  $CHP_{TFI}$ .

**Heating Season (HS)** for a Residential Community Heating Scheme is defined by seven months during Annual Operation selected at the discretion of the Responsible Person.

**Initial Operation (IO)** is the period that commences when the Scheme in question has begun operating as CHP, generating electricity and at the same time supplying heat to one or more users. For the purpose of Climate Change Levy exemption, and the use of a QI threshold of 95, a CHP Scheme serving an individual user or site ends IO after the first complete AO. For a CHP Scheme serving Community Heating, Initial Operation ends after the first two complete AOs.

**Maximum Heat Output under Normal Operating Conditions (MaxHeat).** Maximum Heat Output under Normal Operating Conditions varies with application as some Schemes have very distinct patterns of heat demand that can cycle over varying periods. It is expected that Responsible Persons will take this into account when deciding the specific periods of output to count towards their aggregate Maximum Heat Output.

To qualify as Normal Operating Conditions, the Maximum Heat Output shall be maintained for an absolute minimum of not less than the following cumulative periods during Annual Operation:

Industrial, commercial or institutional ( $< 10\%$ CHP <sub>QHO</sub> to Residential Users)	1,000 hours
Mixed residential, institutional, commercial or industrial ( $\geq 10\%$ residential)	750 hours
Residential Community Heating	500 hours

For Schemes under AO, MaxHeat shall be based on actual performance. For proposed, new Schemes, evidence shall be required to support predictions of future loads, for example, projected build-up of a Community Heating Scheme.

**Monitoring** is the measurement of those energy inputs and outputs for a Scheme relevant to the Self-Assessment, together with the provision of maintenance of records and calibration of metering equipment. A Scheme includes the Monitoring systems required for compliance with this CHPQA Standard.

**Operating** or **operational** in respect of a CHP Scheme means that the Scheme is generating power and supplying useful heat to one or more heat users for at least one month during the first year of operation.

**Power Efficiency ( $\eta_{power}$ )** is one of two key parameters for assessing a CHP Scheme (the other being the Quality Index) and it is the total annual power output (CHP<sub>TPO</sub>) divided by the total annual fuel input (CHP<sub>TFI</sub>). Where a Scheme includes mechanical power output, this shall be converted to an equivalent electrical power output as described in Section 5.10 and included in the calculation of Power Efficiency.

**Quality Index (QI)** is one of two key parameters for assessing a Scheme (the other being Power Efficiency). QI is an indicator of the energy efficiency and environmental performance of a Scheme, relative to the generation of the same amounts of heat and power by separate, alternative means.

**Registration** is the process of recording initial details about the Responsible Person and the CHP Scheme outline by the Administrator. Further details shall be recorded on the appropriate forms issued to the Responsible Person by the Administrator.

**Residential Community Heating (RCH)** is the centralised supply of heat, predominantly for Residential Users for space heating and domestic hot water. Residential Use is defined by the Finance Act 2000 and the term Residential User is defined in the CHPQA Guidance Notes. For a Community Heating Scheme to qualify as RCH, the Responsible Person must demonstrate that it meets at least one of the following criteria:

- The proportion of CHP Qualifying Heat Output (CHP<sub>QHO</sub>) in Annual Operation provided for Residential Use is  $> 60\%$ .
- The proportion of CHP Qualifying Heat Output (CHP<sub>QHO</sub>) during the Heating Season provided for Residential Use is  $> 70\%$ .
- The proportion of CHP Qualifying Heat Output (CHP<sub>QHO</sub>) at MaxHeat provided for Residential Use is  $> 60\%$ .

- Residential Users out-number institutional, commercial and industrial customers by at least 50:1 and the proportion of CHP<sub>QHO</sub> in Annual Operation supplied for Residential Use is  $\geq 10\%$ .
- In the case of proposed new Schemes, Schemes in Initial Operation and Schemes that are developing as defined in the CHPQA Guidance Notes, the proportion of CHP<sub>QHC</sub> for Residential Use is  $> 60\%$ .

**Responsible Person (RP)** means that person registered with the Administrator as responsible for the operation of a Scheme.

**Self-Assessment** is the evaluation by the Responsible Person of the quality of a CHP Scheme, including calculation of key parameters, using the appropriate documentation for Self-Assessment as issued by the Administrator. The forms that come with the documentation for Self-Assessment shall be used to define the CHP Scheme and to record the Self-Assessment data.

**Small-Scale Scheme** is a Scheme for which the CHP<sub>TPC</sub> is less than 2MW<sub>e</sub>.

### Threshold Criteria for Good Quality CHP

- **For Fuel Inputs under Annual and Initial Operation:**  
A Scheme that qualifies as Good Quality CHP for its entire annual energy inputs is one where the Power Efficiency equals or exceeds 20%.
- **For Power Outputs under Annual Operation:**  
A Scheme that qualifies as Good Quality CHP for its entire annual energy outputs is one where the Quality Index equals or exceeds 100. Normally, the **Threshold QI Criterion** is based on Annual Operation, but it can be based on other periods, for example on the Heating Season in the case of RCH Schemes.
- **For Power Outputs under Initial Operation:**  
A Scheme that qualifies as Good Quality CHP for its entire annual energy outputs is one where the Quality Index equals or exceeds 95. Normally, the Threshold QI Criterion is based on Annual Operation, but it can be based on other periods, for example on the Heating Season in the case of RCH Schemes.
- **For Power Generation Capacity under Annual Operation:**  
The Threshold Criterion for existing Good Quality CHP Capacity is that the CHP Scheme achieves a QI of at least 100 at its Maximum Heat Output under Normal Operating Conditions.
- **For Proposed New Power Generation Capacity:**  
Threshold Criteria for proposed new Good Quality CHP Scheme Capacity, at design, specification, tendering and approvals stages, are  
  - QI  $\geq 105$  (at MaxHeat) and Power Efficiency  $\geq 20\%$ , both under Annual Operation.

**Useful Heat** is the heat from a CHP Scheme delivered to satisfy an economically justifiable demand for heat or cooling. Evidence of this demand should be available (e.g. a business case, contract or memorandum of understanding). It is not sufficient for a Scheme to be simply “CHP ready” without clear plans to supply heat.

Heat used for drying incoming biomass or waste fuel to a CHP plant may be classified as a useful CHP heat output, but only if it can be demonstrated that such a use of heat is an economically justifiable precursor to the combustion of the fuel within the CHP plant.

Applicants wishing to claim such a use of heat as a CHP heat output will be expected to provide an economic justification and calculations in support of their claim. For example, it must be demonstrated that the drying of the fuel independent of the CHP plant could be justified economically as an alternative to using CHP heat, taking account of the required capital expenditure, operating and maintenance costs and the resulting benefit (including the capital cost of the alternative boilers and the cost of the displaced fuel that would otherwise be used for the drying). A simple 'payback' analysis should be included:

$$\text{Simple payback} = \frac{\text{Capex of alternative boilers}}{(\text{Theoretical benefit from improved efficiency} - \text{Cost of fuel})}$$

Where: '*Cost of fuel*' is the theoretical cost of the alternative boilers' fuel.

A statement of the Company's investment criteria should also be included that sets out what is considered to be an acceptable payback period.

**Validation** is the confirmation by the Administrator of the assessment method, assumptions made, and consistency of the information provided in a Self-Assessment. Validation, unlike Audit, is the routine confirmation that a Self-Assessment has been carried out properly. It includes verification that the Scheme definition and calculations are correctly applied.

**X and Y coefficients** are values used in the calculation of a CHP Scheme's Quality Index depending on the size of Scheme and fuel(s) used. X is a coefficient related to alternative power supply options, and Y is related to alternative heat generation options. The X and Y coefficients set out in the CHPQA Standard are used for most purposes, but in relation to obtaining benefits for CHP in relation to the RO and CfD, separate X and Y coefficients are set out in Guidance Note 44 along with details of their applicability.

**Z ratio** is the ratio of heat extracted from a pass-out condensing steam turbine to the resulting reduction in power output.

# 5 DETAILED REQUIREMENTS

Responsible Persons operating CHP Schemes must demonstrate compliance with this CHPQA Standard in order to gain and maintain Good Quality CHP Certification. Certification may be used to determine eligibility for fiscal or other benefits associated with the operation of such Schemes.

For each Scheme, the Responsible Person shall:

- Apply for Registration (Section 5.2).
- Install appropriate monitoring systems and maintain appropriate records (Section 5.3).
- Conduct a Self-Assessment and apply for Certification under CHPQA (Section 5.4).
- Comply with Validation and Audit obligations (Section 6).
- Notify the Administrator of any changes to the Scheme relevant to the Registration and Self-Assessment.

The Administrator of the CHPQA programme shall:

- Produce and maintain Guidance Notes for the operation of CHPQA (Section 5.1).
- Define and maintain a timetable for the operation of CHPQA, including submissions and recertification.
- Process applications for Registration and Certification (Section 5.2).
- Issue appropriate documentation for Self-Assessment.
- Respond to enquiries from Responsible Persons submitting Self-Assessments.
- Establish and maintain a database of Registered Schemes (Section 5.2).
- Receive and Validate reports of Self-Assessments carried out by Responsible Persons (Section 5.4).
- Carry out Validation and Audit activities as appropriate (Section 5.4 and Section 6).
- Issue Certificates of Good Quality CHP as appropriate (Section 5.4).

## 5.1 CHPQA Guidance Notes

The Administrator shall produce and maintain CHPQA Guidance Notes for use by Responsible Persons applying for Registration and Certification.

The CHPQA Guidance Notes provide details of how the requirements of this Standard will be interpreted by the Administrator, BEIS and other government departments and agencies.

The CHPQA Guidance Notes explain the operation of the programme, and provide explanations of technical aspects, including worked examples. They also contain standard forms to be used in applying for Registration and Certification.

The Administrator will regularly review, evaluate and update the CHPQA Guidance Notes. Updates may be made to reflect technology and market developments in order to ensure that the objectives of CHPQA continue to be met. Changes may also be made to maintain consistency with relevant regulatory developments. Such updates shall be approved by BEIS and made available as quickly as possible.

## **5.2 Registration**

Persons wishing to register a Scheme shall submit to the Administrator an Application for Registration (Form F1), providing information on the Responsible Person, and the location of the Scheme.

Responsible Persons shall provide any additional information reasonably required by the Administrator for assessing an Application for Registration. All information supplied shall be treated in confidence by the Administrator but may be shared with BEIS and Ofgem for the purposes of assessing the operation of the Scheme; to fulfil legislative requirements; for the administration of measures supporting Good Quality CHP; and for statistical and research purposes.

Should an application be unsuccessful, the Administrator shall notify the Responsible Person and BEIS in writing, stating the reasons for rejection.

## **5.3 Monitoring**

Monitoring is the determination of those energy inputs and outputs of the Scheme relevant to the Self-Assessment, together with provision for the calibration of metering equipment and the maintenance of records. In some cases, monitoring may include the use of indirect methods as an alternative to direct metering.

The Responsible Person shall ensure that there are appropriate systems in use to monitor all energy inputs and outputs for the Scheme that are relevant to the calculation of QI, Power Efficiency and, if appropriate,  $CHP_{QPO}$ ,  $CHP_{QPC}$  and  $CHP_{QFI}$ . Monitoring systems shall apply to both main and auxiliary fuel inputs, and all energy outputs of the Scheme.

All monitoring systems shall be designed, installed and verified to provide the appropriate standards of accuracy as defined in the CHPQA Guidance Notes.

The Responsible Person shall maintain records of annual energy inputs and outputs and shall retain the records for a minimum of six years. Records of heat and power metering and equipment calibration should also be maintained by the Responsible Person.

## **5.4 Self-Assessment**

Self-Assessment requires that the Responsible Person shall specify, determine or calculate the following:

- (i) Scheme boundary and selected QI formula
- (ii) Monitoring and recording provisions
- (iii) Power Efficiency
- (iv) Heat Efficiency
- (v) Quality Index (QI)
- (vi) Qualifying Power Capacity ( $CHP_{QPC}$ )



- (vii) Qualifying Heat Capacity ( $CHP_{QHC}$ )
- (viii) Qualifying Fuel Input ( $CHP_{QFI}$ )
- (ix) Qualifying Power Output ( $CHP_{QPO}$ )
- (x) Qualifying Heat Output ( $CHP_{QHO}$ )

The Self-Assessment shall be reported to the Administrator using the appropriate CHPQA Forms to define the CHP Scheme, to record fuel inputs and energy outputs and to calculate the required parameters.

Responsible Persons may define Scheme boundaries to include items such as auxiliary or back-up boilers and power-only generators but should be aware of the implications for quality assessment and thereby eligibility for benefits (see CHPQA Guidance Notes).

In order to maintain the Certification of a Scheme, the Responsible Person shall submit a Self-Assessment for each Annual Operation.

The Administrator shall validate the Self-Assessment. Validation activities shall be appropriate to the size of the Scheme. The Administrator shall determine whether the Scheme meets the Good Quality CHP Threshold Criteria, for all or part of its inputs, outputs and capacity, and issue Certification to this effect.

Responsible Persons shall provide any additional information reasonably required by the Administrator for Validation of a Self-Assessment. Responsible Persons shall provide access to the Scheme site if required. All information provided for the purposes of Validation shall be treated in confidence by the Administrator.

Responsible Persons shall notify the Administrator of any changes made to the Scheme that are relevant to the Self-Assessment.

#### **5.4.1 Small-Scale Schemes with No Heat Rejection Facility**

For Small-Scale Schemes with no heat rejection facility (that is where all available heat output is utilised beneficially; see definition of  $CHP_{QHO}$ ), the requirement for Self-Assessment is normally limited to determination of the Power Efficiency and Quality Index. If the Power Efficiency is less than the Threshold Criterion, the  $CHP_{QFI}$  shall be calculated. Where suitable heat metering does not exist, the annual heat supplied ( $CHP_{QHO}$ ) may be determined based on the estimated heat supply profile and design information for the Scheme. If the CHP unit upon which the Scheme is based is on the CHPQA Unit List, the annual heat supplied ( $CHP_{QHO}$ ) may be estimated by multiplying the Total Power Output ( $CHP_{TPO}$ ) by the Heat to Power ratio for that unit as specified in the Unit List.

#### **5.4.2 Small-Scale Schemes with Heat Rejection Facility**

Small-Scale Schemes with a heat rejection facility must comply with the heat monitoring requirement as applied to Schemes where  $CHP_{TPC}$  is  $2MW_e$  or above.

### **5.5 The Quality Index (QI)**

The Quality Index is one of two key parameters for assessing a CHP Scheme. The QI is an indicator of the energy efficiency and environmental performance of a Scheme.

The general form of the QI formula is:

$$QI = (X \times \eta_{power}) + (Y \times \eta_{heat})$$

X is a coefficient related to alternative power supply options. Similarly, Y is a coefficient for heat generation related to alternative heat supply options. The values of X and Y vary for different sizes and types of Scheme as shown in Table 1 in Section 9.

Where a Scheme uses a mix of fuels, weighted mean values of X and Y shall be calculated and used for the derivation of QI.

QI is normally calculated on an annual basis where:

$$\text{Power efficiency, } \eta_{power} = \text{CHP}_{\text{TPO}}/\text{CHP}_{\text{TFI}}$$

$$\text{Heat efficiency, } \eta_{heat} = \text{CHP}_{\text{QHO}}/\text{CHP}_{\text{TFI}}$$

QI may also be calculated for other specific periods, most commonly under conditions of Maximum Heat Output under Normal Operating Conditions (MaxHeat) or over the Heating Season in the case of Residential Community Heating.

Efficiency values shall be based on the Gross Calorific Value (GCV) of the input fuel.

CHP Schemes may be Registered, Self-Assessed and Certified at various stages from design through operation to improvement and upgrading. For this reason, the values of power supplied, heat supplied and fuel used may be derived from design data for new and upgraded Schemes or determined by monitoring actual annual performance for operational Schemes.

The annual power supplied ( $\text{CHP}_{\text{TPO}}$ ) is the total electricity generated, as measured at the generator terminals, plus the electrical equivalent of any mechanical power supplied by the Scheme (see Section 5.10).

The annual heat supplied ( $\text{CHP}_{\text{QHO}}$ ) is the total heat supplied across the CHP Scheme boundary that is utilised in a manner that demonstrably displaces heat that would otherwise be supplied from other energy sources.

The QI formulae shall be subject to periodic review to ensure that the following criteria are met:

- (i) The values of X and Y remain applicable and appropriate for each size and type of CHP Scheme.
- (ii) Certified Good Quality CHP will continue to provide significant environmental and other benefits compared to conventional energy supply alternatives.
- (iii) The QI formulae provide a challenging threshold for all CHP Schemes and promote continuous improvement of CHP plant.
- (iv) The QI formulae remain compatible with the EU efficiency reference values used for calculating primary energy savings.

## 5.6 Power Efficiency, $\eta_{power}$

Power Efficiency is one of two key parameters for assessing a CHP Scheme under CHPQA (the other being Quality Index). It is the total annual power output ( $\text{CHP}_{\text{TPO}}$ ) divided by the total annual fuel energy input ( $\text{CHP}_{\text{TFI}}$ ).

$$\eta_{power} = \text{CHP}_{\text{TPO}}/\text{CHP}_{\text{TFI}}$$

The Threshold Power Efficiency Criterion,  $\eta_{power-threshold} = 20\%$ .

## 5.7 CHP Qualifying Fuel Input, $CHP_{QFI}$

Where the Power Efficiency meets or exceeds the Threshold Criterion, all of the fuel input to the Scheme qualifies, i.e.  $CHP_{QFI} = CHP_{TFI}$ . Where the Power Efficiency for a Scheme is less than the Threshold Criterion, the fuel use that qualifies as input to Good Quality CHP ( $CHP_{QFI}$ ) shall be calculated.  $CHP_{QFI}$  is that portion of the fuel input that would have provided a Power Efficiency equal to the Threshold Criterion, based on the annual power output ( $CHP_{TPO}$ ).

$$CHP_{QFI} = CHP_{TFI} \times (\eta_{power} / \eta_{power-threshold}) \text{ [in MWh]}$$

## 5.8 CHP Qualifying Power Output, $CHP_{QPO}$

For Schemes that meet the Threshold QI Criterion, the qualifying power output is the same as the total power output, i.e.  $CHP_{QPO} = CHP_{TPO}$ . For Schemes that do not qualify as Good Quality CHP for the whole of their output, the power output is considered in two portions:

- (i) The portion that is the CHP Qualifying Power Output,  $CHP_{QPO}$ . This is the portion of the actual annual electrical (or mechanical) energy supplied that would result in a QI equal to the Threshold QI Criterion, given, depending on circumstances, the actual or design annual heat supplied ( $CHP_{QHO}$ ). This portion may be eligible for benefits.

$$CHP_{QPO} = CHP_{QHO} / (\text{Heat-to-power ratio at QI=100}) \text{ [in MWh]}$$

$$\text{Where: Heat-to-power ratio at QI=100} = \eta_{heat (QI=100)} / \eta_{power}$$

$$\eta_{heat (QI=100)} = [100 - (X \times \eta_{power})] / Y$$

- (ii) Annual electrical energy supplied in excess of the  $CHP_{QPO}$ . This portion does not qualify as an output from Good Quality CHP.

The treatment of these two separate portions in government policies shall depend on the purpose and scope of the individual policy instruments.

Note that for fully or partially qualifying condensing steam turbines, including those in combined cycle CHP Schemes, a Z Ratio must be used. The Z Ratio provides a means of accounting for the interdependency between heat and power outputs in this type of Scheme; see relevant CHPQA Guidance Notes.

## 5.9 CHP Qualifying Power Capacity, $CHP_{QPC}$

For Schemes that meet the Threshold QI Criterion, the qualifying power capacity is the same as the total power capacity, i.e.  $CHP_{QPC} = CHP_{TPC}$ . For Schemes that do not qualify as Good Quality CHP for the whole of their output, the CHP Qualifying Power Capacity ( $CHP_{QPC}$ ) shall be calculated.  $CHP_{QPC}$  is that portion of the power generating capacity that would provide a QI value of 100 for existing Schemes and 105 for new Schemes, under the conditions of Maximum Heat Output under Normal Operating Conditions. Normally, for an existing CHP Scheme based on gas turbines or reciprocating engines:

$$CHP_{QPC} = \text{MaxHeat} / (\text{Heat-to-power ratio at which } QI_{\text{MaxHeat}} = 100) \text{ [in MW}_e\text{]}$$

Where: MaxHeat = Maximum Heat Output under Normal Operating Conditions  
(Heat-to-power ratio at which  $QI_{MaxHeat=100} = \eta_{heat (QI_{MaxHeat=100})} / \eta_{power}$   
 $\eta_{heat (QI_{MaxHeat=100})} = [100 - (X \times \eta_{power})] / Y$

Note: for fully or partially qualifying condensing steam turbines including those in combined cycle Schemes, a Z Ratio must be used. The Z Ratio provides a means of accounting for the interdependency between heat and power outputs in this type of Scheme; see CHPQA Guidance Notes.

## 5.10 Mechanical Power

Where mechanical power is provided by a Scheme, this shall be included in the Self-Assessment of CHP<sub>TPO</sub> as an equivalent electrical output, by multiplying the mechanical energy by a factor of 1.05.

# 6 AUDIT

The Administrator shall carry out periodic, selective Audits of CHP Schemes, the scope of which shall be appropriate to the size of the Scheme. Audits will typically involve a site-based evaluation of a CHP Scheme but can include any activity carried out by the Administrator to confirm compliance with this Standard.

In addition to confirming that this Standard and the Guidance Notes have been correctly interpreted and that any data submitted at the time of the Self-Assessment can be corroborated, the Audit may extend to the overall operation of the total Scheme, including management systems and documentation.

The Responsible Person shall provide access to the Scheme and all associated documentation as required and shall retain records for six years from the time that they were created.

# 7 PENALTIES

Any Responsible Person, who submits misleading information under the CHPQA programme in order to gain eligibility for benefits, shall be subject to penalty arrangements enforced by the appropriate government department.

# 8 APPEALS

Appeals concerning Registration, Validation or Certification can be made using the appeals process described in the Guidance Notes. All such appeals shall be directed in the first instance to the Administrator, with ultimate referral, if necessary, to BEIS.

# 9 QUALITY INDEX (QI) FORMULAE

## 9.1 Applicability of the QI Formulae

Table 1 presents the CHPQA Standard Issue 7 QI formulae for various sizes and types of CHP Scheme.

These formulae apply to all new Schemes that receive an F3 or an F4 CHPQA certificate on or after 1 January 2017, where they have not received an F3 or an F4 certificate prior to 1 January 2016. From 1 January 2017 all such schemes will be assessed using the QI formulae in the CHPQA Standard Issue 6 (Table 1), based, as appropriate, on their design or operational data for the year commencing 1 January 2016.

All Schemes that received an F3 CHPQA certificate (based on design data) for the first time between 1 January and 31 December 2016 based on CHPQA Standard Issue 5 QI formulae will be treated as new Schemes. Therefore, from 1 January 2017 the CHPQA Standard Issue 6 QI formulae will be applied for the recertification of such Schemes, based, as appropriate, on their design or operational data for the year commencing 1 January 2016, with the exception of any scheme in respect of which a CfD contract is entered into on or after the publication of Issue 7 of Guidance Note 44, in which case Issue 7.

The various QI formulae set out in this CHPQA Standard Issue 7 and the means by which those formulae are to be applied are subject to any amendments or revisions necessary to assist the United Kingdom in complying with any obligation arising under or in connection with European law.

**Existing Schemes** that received an F3 or an F4 CHPQA certificate prior to 1 January 2016 will continue to receive CHPQA certification on the basis of the QI formulae under which they were previously certified.

**Guidance Note 44 (GN44) Issue 7** contains detailed guidance as to how and when the GN44 Issue 7 QI formulae will be applied in respect of RO and CfD.

Notwithstanding the grandfathering arrangements described above, any GN44 certificate issued in connection with any 'with CHP' CfD contract entered into on or after the publication of GN44 Issue 7 will be issued using the replacement GN44 Issue 7 QI formulae.

## 9.2 Use of QI Formulae

Except for fuel cells, which are shown as a special case, the fuel type and  $CHP_{TPC}$  are used to select the appropriate formula for a particular Scheme.

The general form of the formula of QI is:

$$QI = (X \times \eta_{power}) + (Y \times \eta_{heat})$$

Where: Power efficiency,  $\eta_{power} = CHP_{TPO}/CHP_{TFI}$

Heat efficiency,  $\eta_{heat} = CHP_{QHO}/CHP_{TFI}$

X is a coefficient related to alternative power supply options

Y is a coefficient for heat generation, related to alternative heat supply options.

**Table 1 QI Formulae by Size and Type of CHP Scheme**

Size of Scheme (CHP <sub>TPC</sub> )	QI Formula			
<b>CONVENTIONAL FOSSIL FUELS SCHEMES</b>				
<b>Natural gas</b>				
≤1MWe	QI =	249 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>1 to ≤10MWe	QI =	195 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>10 to ≤25MWe	QI =	191 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>25 to ≤50MWe	QI =	186 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>50 to ≤100MWe	QI =	179 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>100 to ≤200MWe	QI =	176 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>200 to ≤500MWe	QI =	173 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
>500MWe	QI =	172 x	$\eta_{power}$	+ 113 x $\eta_{heat}$
<b>Oil</b>				
≤1MWe	QI =	249 x	$\eta_{power}$	+ 115 x $\eta_{heat}$
>1 to ≤25MWe	QI =	191 x	$\eta_{power}$	+ 115 x $\eta_{heat}$
>25MWe	QI =	176 x	$\eta_{power}$	+ 115 x $\eta_{heat}$
<b>Coal</b>				
≤1MWe	QI =	249 x	$\eta_{power}$	+ 115 x $\eta_{heat}$
>1 to ≤25MWe	QI =	191 x	$\eta_{power}$	+ 115 x $\eta_{heat}$
>25MWe	QI =	176 x	$\eta_{power}$	+ 115 x $\eta_{heat}$
<b>SPECIAL CASES</b>				
FUEL CELL SCHEMES	QI =	180 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
<b>ALTERNATIVE FUEL SCHEMES</b>				
<b>Category A (e.g. AD gas, sewage gas, landfill gas)</b>				
≤1MWe	QI =	238 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>1 to ≤25MWe	QI =	225 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>25MWe	QI =	182 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
<b>Category B (e.g. synthesis gas)</b>				
≤1MWe	QI =	275 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>1 to ≤25MWe	QI =	223 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>25MWe	QI =	191 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
<b>Category C (e.g. fatty acid methyl ester, pyrolysis oil etc.)</b>				
≤1MWe	QI =	226 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>1 to ≤25MWe	QI =	191 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>25MWe	QI =	171 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
<b>Category D (e.g. tallow, used cooking oil)</b>				
≤1MWe	QI =	226 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>1 to ≤25MWe	QI =	226 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>25MWe	QI =	171 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
<b>Category E (e.g. municipal waste, sewage sludge, paper sludge etc.)</b>				
≤1MWe	QI =	370 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>1 to ≤10MWe	QI =	370 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>10 to ≤25MWe	QI =	364 x	$\eta_{power}$	+ 120 x $\eta_{heat}$
>25MWe	QI =	220 x	$\eta_{power}$	+ 120 x $\eta_{heat}$

**Table 1 (cont.) QI Formulae by Size and Type of CHP Scheme**

Size of Scheme (CHP <sub>TPC</sub> )	QI Formula
<b>ALTERNATIVE FUEL SCHEMES</b>	
<b>Category F</b> (e.g. logs, energy crops, agricultural residues etc.)	
≤1MWe	$QI = 346 \times \eta_{power} + 120 \times \eta_{heat}$
>1 to ≤10MWe	$QI = 347 \times \eta_{power} + 120 \times \eta_{heat}$
>10 to ≤25MWe	$QI = 303 \times \eta_{power} + 120 \times \eta_{heat}$
>25MWe to ≤50MWe	$QI = 220 \times \eta_{power} + 120 \times \eta_{heat}$
>50MWe	$QI = 196 \times \eta_{power} + 120 \times \eta_{heat}$
<b>Category G</b> (e.g. contaminated waste wood)	
≤1MWe	$QI = 346 \times \eta_{power} + 120 \times \eta_{heat}$
>1 to ≤10MWe	$QI = 331 \times \eta_{power} + 120 \times \eta_{heat}$
>10 to ≤25MWe	$QI = 303 \times \eta_{power} + 120 \times \eta_{heat}$
>25MWe to ≤50MWe	$QI = 214 \times \eta_{power} + 120 \times \eta_{heat}$
>50MWe	$QI = 191 \times \eta_{power} + 120 \times \eta_{heat}$
<b>Category H</b> (e.g. wood pellets, straw, clean waste wood etc.)	
≤1MWe	$QI = 329 \times \eta_{power} + 120 \times \eta_{heat}$
>1 to ≤10MWe	$QI = 291 \times \eta_{power} + 120 \times \eta_{heat}$
>10 to ≤25MWe	$QI = 284 \times \eta_{power} + 120 \times \eta_{heat}$
>25MWe to ≤50MWe	$QI = 214 \times \eta_{power} + 120 \times \eta_{heat}$
>50MWe	$QI = 191 \times \eta_{power} + 120 \times \eta_{heat}$
<b>Category I</b> (e.g. by-product gases produced in industrial processes)	
≤1MWe	$QI = 294 \times \eta_{power} + 120 \times \eta_{heat}$
>1 to ≤25MWe	$QI = 221 \times \eta_{power} + 120 \times \eta_{heat}$
>25MWe	$QI = 193 \times \eta_{power} + 120 \times \eta_{heat}$
<b>Category J</b> (e.g. waste gases such as carbon monoxide, or waste heat such as the exhaust gas from high temperature processes, or as a product of exothermic chemical reactions).	
≤1MWe	$QI = 329 \times \eta_{power} + 120 \times \eta_{heat}$
>1 to ≤25MWe	$QI = 299 \times \eta_{power} + 120 \times \eta_{heat}$
>25MWe	$QI = 193 \times \eta_{power} + 120 \times \eta_{heat}$
<b>Category K</b> (e.g. non-renewable liquid waste)	
≤1MWe	$QI = 275 \times \eta_{power} + 120 \times \eta_{heat}$
>1 to ≤25MWe	$QI = 260 \times \eta_{power} + 120 \times \eta_{heat}$
>25MWe	$QI = 171 \times \eta_{power} + 120 \times \eta_{heat}$