GUIDANCE NOTE 14

CHP SCHEME ENERGY INPUTS

GN14.1

All fuel energy inputs shall be based on gross calorific value (GCV) (higher calorific value) and must be metered (kWh).

FUEL INPUTS

GN14.2

In completing a submission (Energy Inputs), please make a note of which category each fuel falls within as this can affect the calculation of QI. Fuels are classified as Conventional fuels or Alternative fuels:

- Natural gas, LPG, gas oil, commercial grade fuel oils, coal and coke are all conventional fuels as defined in GN14.3.
- Alternative fuels include waste fuels, process by- product fuels, renewable fuels and recovered heat as defined in GN14.4.

The fraction of the total energy input represented by each individual conventional and/or alternative fuel is determined in the submission journey.

CONVENTIONAL FUELS

GN14.3

Conventional Fuels are those described either by the Finance Act 2000, as amended, as a taxable commodity, or by the Hydrocarbon Oil Duties Act 1979 and covered by Excise Duty. Such fuels include:

- Any gas in a gaseous state that is of a kind supplied by a gas utility
- Any petroleum gas, or other gaseous hydrocarbon, in a liquid state
- Coal and lignite
- Coke, and semi-coke, of coal or lignite
- Petroleum coke
- Hydrocarbon oil or road fuel gas within the meaning of the Hydrocarbon Oil Duties Act 1979 (HODA), as amended.

ALTERNATIVE FUELS

GN14.4

Alternative Fuels are all other fuels. For selecting the QI definition there are now eleven different categories of Alternative Fuels (see categories A to K below). The purpose of the fuel categorisation is to group fuels according to the maximum efficiency of the most efficient prime mover technology in which they can be used. The categorisation is not intended to group fuels according to fuel properties, nor is the categorisation intended to distinguish between fuel sustainability, which is a fundamentally different objective dealt with separately under support measures such as the Renewables Obligation.

Category A:

- Gas produced by the anaerobic digestion (AD) of biological materials ,
- Sewage gas,
- Landfill gas.

Category B:

- Synthesis gas from gasification of biological material.

Category C:

- Fatty Acid Methyl Esters, Bio DiMethyl Ether,
- Biomass to Liquid fuels,
- Virgin vegetable oil,
- Pyrolysis oil from pyrolysis of biological material,
- Hydrogenated Vegetable Oil,
- Biomethanol,
- Bioethanol,
- Biobutanol,
- Bio Methyl Tertiary Butyl Ether,
- Bio Ethyl Tertiary Butyl Ether.

Category D:

- Tallow,
- Used cooking oil.

Category E:

- The biological fraction of;
    - Municipal solid waste,
    - Industrial waste,
    - Clinical waste,
    - Refuse derived fuel,
    - Solid recovered fuels,
    - Poultry litter,
    - De-watered sewage sludge,
    - Paper sludge.

Category F:

- Logs,
- Roundwood,
- Energy crops,
- Agricultural residues,
- Prunings,
- Milling residues,
- Arboricultural & Forestry residues,
- Distillers grain.

Category G:

- Contaminated waste wood (Grades B - D of PAS 111).

Category H:

- Wood pellets,
- Dry wood chips,
- Straw,
- Bagasse,
- Nut shells,
- Husks and Cobs,
- Visibly clean waste wood (Grade A of PAS 111).

Category I:

- By-product gases produced in industrial processes, for example blast furnace gas, coke oven gas and refinery fuel gas, which may include constituents such as hydrogen, ethane, propane etc.

Category J:

- Waste gases (such as carbon monoxide or volatile organic compounds),
- Waste heat (such as the exhaust gas from high temperature processes, or as a product of exothermic chemical reactions).

Category K:

- Non-renewable liquid waste

Where there is potential for defining the fuel stream differently depending on how the CHP Scheme boundary is drawn, please contact the CHPQA Administrator. For example, where gasification is employed, the boundary should be drawn at the gas feed into the CHP. Alternatively, the boundary could be drawn at the point where solid fuel is fed into the gasifier. In this case, the gasifier should be included within the Scheme boundary. This would have the effect of not only requiring a different approach to metering, but also a differing QI Definition.

There is a wide range of Renewable fuels available, for classification of fuels not listed above or to seek alternative categorisation in respect of a Scheme using one of the fuels listed (where there is evidence to support this), please again contact the CHPQA Administrator. Details of the criteria used for the categorisation of renewable fuels are given in Table 1 below.

Developers applying for the classification of a renewable fuel not listed above or seeking an alternative categorisation for a fuel in categories A to H should thus submit evidence based on demonstrating that the criteria in column 3 of Table 1 below are met. It is expected that the required evidence on maximum possible prime mover efficiency would take the form of data from prime mover manufacturers for prime movers using the fuel in question in the given physical state (solid, liquid, gaseous) at normal temperature and pressure. All efficiencies are quoted on a Gross Calorific Value, gross power output basis.

Table 1: Renewable Fuel Categories

Fuel Category	Fuels included	Criteria
A	Gas produced by anaerobic digestion of biological material, Sewage gas, Landfill gas	Most efficient prime mover is no higher than 36.9% (≤1 MWe) and 39% (> 1 MWe) ------------------------------------- Fuel State: Gaseous at Normal Temperature & Pressure
B	Synthesis gas from the gasification of biological material described under Categories D to H below.	Most efficient prime mover is no higher than 32% (≤1 MWe) and 34% (>1 MWe) ----------------------------------- Fuel State: Gaseous at Normal Temperature & Pressure
C	Fatty Acid Methyl Esters, Bio DiMethyl Ether, Biomass to Liquid fuels, Virgin vegetable oil, Pyrolysis oil from the pyrolysis of biological material described under Categories D to H below. Hydrogenated vegetable oil, Biomethanol, Bioethanol, Biobutanol, Bio Methyl Tertiary Butyl Ether, Bio Ethyl Tertiary Butyl Ether.	Most efficient prime mover is no higher than 38.9%. ------------------------------------- Fuel State: Liquid at Normal Temperature & Pressure
D	Tallow, Used cooking oil	Most efficient prime mover is no higher than 38.9%. ------------------------------------- Fuel State: Liquid at Normal Temperature & Pressure

E	The biological fraction of: Municipal solid waste, Industrial waste, Clinical waste, Refuse derived fuel, Solid recovered fuel, Poultry litter, De-watered sewage sludge, Paper sludge	Most efficient prime mover is no higher than: 23% (≤ 1 MWe) 25% (> 1 to ≤ 25 MWe) 27% (> 25 MWe) -------------------------------------- Fuel State: Solid at Normal Temperature & Pressure
F	Logs, Roundwood, Energy crops, Agricultural residues, Prunings, Milling residues, Arboricultural & Forestry residues, Distillers grain	Most efficient prime mover is no higher than: 25% (≤ 1 MWe) 27% (> 1 to ≤ 25 MWe) 28% (> 25 MWe) -------------------------------------- Fuel State: Solid at Normal Temperature & Pressure
G	Contaminated waste wood (Grades B - D of PAS 111)	Most efficient prime mover is no higher than: 25% (≤ 1 MWe) 28.2% (> 1 to ≤ 25 MWe) 29.4% (> 25 MWe) -------------------------------------- Fuel State: Solid at Normal Temperature & Pressure
H	Wood pellets, Dry wood chips, Straw, Bagasse, Nut shells, Husks and Cobs, Visibly clean waste wood (Grade A of PAS 111)	Most efficient prime mover is no higher than: 25% (≤ 1 MWe) 31% (> 1 to ≤ 25 MWe) 33% (> 25 MWe) -------------------------------------- Fuel State: Solid at Normal Temperature & Pressure

MIXED FUELS

GN14.5

The treatment of mixed fuel (conventional and alternative) inputs for the determination of QI is dealt with in GN24.10 on Quality Index.

IMPORTED STEAM FROM AN EXTERNAL SUPPLIER (AS EQUIVALENT FUEL INPUTS)

GN14.6

Steam imported from an external supplier will be treated for Self - Assessment as a CHP fuel input. The equivalent fuel input shall be based on the heat absorbed in the generation of the imported steam, assuming generation from feedwater at a temperature of 80˚C and pressure of 1.013 bar(a) in a boiler with a thermal efficiency of 75% (gross c.v.). The fuel descriptor should be based on the actual fuel(s) used.

RECOVERED HEAT INPUTS (AS EQUIVALENT ALTERNATIVE FUEL INPUTS)

GN14.7

Some of the CHP steam energy inputs may be generated in the manufacturing Process Area (which includes the main process plant that consumes some or all of the CHP heat - see GN11) by heat recovery from flue gases produced in combustion of fuel for high temperature processes, or by heat recovery from process products. **To be admissible under CHPQA as a CHP energy input this steam must be used for the generation of electrical or mechanical power within the Scheme.** Any part of these recovered heat energy inputs that simply passes through the Scheme to become a heat energy output to the process area is not admissible and so must be deducted.

For all process waste heat boilers included within the CHP Scheme the energy input is treated as an alternative fuel input (category J - waste heat). This shall be an equivalent energy input based on the energy content of the admissible waste heat boiler steam relative to a datum of water at a temperature of 10˚C and pressure of 1.013 bar(a) multiplied by a factor of 1.2. The 1.2 factor is used to convert the energy content of the steam into a fuel-equivalent and reflects typical boiler efficiencies and an allowance for the way in which CHPQA allows steam heat to be claimed relative to the enthalpy of 10°C water.

For example: saturated steam at a pressure of 10 bar(a), specific enthalpy, 2,778 kJ/kg, from steam tables (datum 0˚C) minus 42 kJ/kg (water at 10˚C and 1.013 bar(a)) = 2,736 kJ/kg x 1.2 = 3,283 kJ/kg equivalent boiler energy input = 0.912 MWh/tonne of steam.

METERING REQUIREMENTS

Natural Gas

GN14.8

For metering natural gas using a utility or billing meter, there are a number of specific requirements. Natural gas volumes fuelling the Scheme should be recorded by a meter with an uncertainty no greater than that specified in S.I. 1983/684 (Statutory Instruments 1983 No. 684, Gas – The Gas (Meters) Regulations 1983) and subsequent amendments, as summarised below:

- Diaphragm meters
  - ±2% between 2% and 100% of design maximum flow
- Other meters
  - ±1% between 20% and 100% of design maximum flow
  - ±2% between minimum design flow and less than 20% of design maximum flow

However, where local Scheme gas meters are used then the uncertainty should be no greater than ±2.0% of reading to be considered best practice. It is required that metered (and calculated) values of energy inputs (and outputs) meet reasonable standards, which are summarised in GN17, to be considered 'best practice'. For self-assessment, any values that do not achieve the required standard are considered to have excess uncertainty. This is then considered in the appropriate Sections of the submission journey to derive adjustment factors that are used in the calculation of the heat and power efficiencies. Excess uncertainty results in lower heat and/or power efficiencies, and hence reduced value of the QI of the Scheme.

The volume measured must be corrected for the temperature and pressure of the gas (to 15˚C and 1013.25 millibars absolute) to enable direct comparison with billed gas to the site. Whilst there are no statutory regulations surrounding the necessary 'correction', there are well-defined commercial agreements between shippers, suppliers and purchasers as laid down within the UK Network Code and related documents which are accepted as good practice - refer to your supplier. Calorific Values (CV) of natural gas change significantly across the UK from zone to zone and with time of year. Time averaged calorific values for the gas used must be estimated and, where not measured directly, should be based on the daily data published by National Grid for the Local Distribution Zones (LDZ). For CHPQA the calorific value used on the supplier's gas bills is accepted as the true calorific value for the period of gas supply covered by the bill. To be deemed 'best practice' the overall uncertainty of individual natural gas meters must be no greater than ±2%.

Coal

GN14.9

For coal, usage should, where possible, be metered by belt weighing machines or other gravimetric methods. Coal usage over extended periods may be determined from purchases and stocks. The effect of possible errors in estimating opening and closing stocks should be determined. A calculation is then required to determine the overall systematic uncertainty associated with the coal energy input. To be deemed 'best practice' the overall uncertainty of individual coal energy inputs must be no greater than ±2%. The user should ensure that the Supply Company has in place an appropriate sampling and analysis regime for determining gross CVs that are representative for the delivered fuel consignments. For example, BS ISO 13909: Parts 1-8 The Hard Coal Sampling Standard, and BS 1928: The Standard for Determination of Gross Calorific Value of Coals could be employed. The results should be linked to coal purchase documentation. As with natural gas, the calorific value used on the supplier's invoice is accepted as the true calorific value for the fuel supplied.

Oil Products

GN14.10

Oil products burned as either a main or a standby fuel will need to be monitored and recorded for use in the Self-Assessment of a CHP Scheme. Oil products are usually sold by the litre. The volume of oil burned in a CHP Scheme will need to be recorded. This may be accomplished by employing an installed volume flow meter. Fuel purchase documentation may also be used as evidence of oil consumption, but oil inventories (opening and closing stock) will need to be recorded and taken into account. The fuel supplier's declared calorific value is accepted as the true calorific value for commercial fuel oils. To be deemed 'best practice' the overall uncertainty of individual oil energy inputs must be no greater than ±2%.

Alternative Fuels

GN14.11

Calculation of the QI requires details of alternative fuel input to allocate their energy content. Where there are heat imports as steam, metering of the steam flow to the same standard as for steam exports is required. Accurate estimation of the CV of some alternative fuels (such as raw municipal waste) is extremely difficult. (See also GN14.15 for fuels of variable moisture content). Where the uncertainty in energy input exceeds ±2%, indirect means should be considered, for example, using an adaptation of the 'losses method' in conjunction with a reliable output measurement to reduce the uncertainty to less than ±2%[1]. Alternatively, the higher value of the uncertainty range should be used.

- Refer to GN20 for guidance on Indirect Determination of Energy Inputs.

UNCERTAINTIES

- Refer to GN17 for guidance on calculating actual Uncertainty in Metered Inputs and Outputs.
- Refer to GN18 for guidance on calculating actual Uncertainty in Calculated Energy Inputs and Outputs.

CHP Total Fuel Input (CHP_{TFI})

GN14.12

CHP Total Fuel Input (CHP_{TFI}) is the annual registered fuel input to a CHP Scheme (MWh), based on GCV plus the fuel equivalent of any heat energy supplied to the CHP Scheme.

Separate fuel inputs

GN14.13

Information provided under the CHPQA programme is used to prepare statistics on CHP in the UK. Until the UK ceased to be a member of the European Union, submissions were made to Eurostat which included a requirement to separate the fuel

[1] In the 'losses method' all of the possible losses from the CHP Scheme are summed, for example flue losses, case losses, etc. Losses are usually capable of evaluation to around ±5%, so if the losses account for say 40% of input energy, the overall uncertainty in efficiency should be ±2%. The method is explained in BS 845: Part 2: 1987, or the FDBR Guideline RL7.

used in the prime mover from that used in heat only boilers. This information does not form part of the self-assessment and although no longer a requirement for Eurostat reporting, it remains helpful in understanding current characteristics of CHP. For steam turbine CHP Schemes that are based on a simple steam cycle (boilers and steam turbines only), this information is not required but may be estimated based on a standard pass-out steam turbine's heat to power ratio. For CHP Schemes with steam turbines that generate power using steam that is provided by heat recovery from other prime movers such as gas turbines, and from boilers (auxiliary and top-up boilers and supplementary firing), an estimate of the proportion of the total steam to the steam turbine(s) is required.

Metering of fuel side-streams

GN14.14

In some cases, the total fuel input to the Scheme boundary, and a small fuel flow side-stream (to another user outside the boundary), are monitored using a single installed meter. In such instances, as separate metering of each fuel stream (as required by CHPQA) is not being carried out, the Responsible Person should contact the CHPQA Administrator to discuss how this should be addressed.

Fuels with variable moisture content

GN14.15

The calorific value of fuels as fired varies greatly depending on moisture content (see GN 29.12). This is particularly relevant to fuels such as solid waste (e.g. raw domestic refuse) or waste wood and other biofuels. For this reason, calorific value data is usually reported on a dry fuel basis, and more often than not as net calorific value.

For example, dry waste wood may have a dry net calorific value of 18.3 MJ/kg.

It can be shown that dry gross CV, MJ/kg = dry net CV + (0.218 x H%), where H = hydrogen content of dry wood, percent by weight, is typically 6%.

This results in a dry gross CV of 19.608 MJ/kg (see table GN 29-1 in GN 29.12).

Providing moisture content can be determined on a regular basis as weight % of the total weight of wet (as fired) fuel, the energy input on gross CV basis, as required for CHPQA can be calculated as follows:

Data:

Gross CV (dry)	= 19.608 MJ/kg = 19.608 GJ/tonne
Mass of wet fuel fired (F)	= 200 tonnes (for example)
Moisture content (M)	= 60% of total mass of fuel (for example)

Calculation:

Mass of dry fuel	= F x (100 – M) / 100	
	= 200 x (100 – 60) / 100	= 80 tonnes
Energy input (gross)	= 80 x 19.608	
	= 1,568.64 GJ = 1,568.64 / 3.6	= 435.73 MWh

